DOE/CF-0130
Volume 3

Department of Energy

FY 2018 Congressional Budget Request

Energy Efficiency and Renewable Energy
Electricity Delivery and Energy Reliability
Fossil Energy Research and Development
Naval Petroleum and Oil Shale Reserves
Strategic Petroleum Reserve
Northeast Home Heating Oil Reserve
Nuclear Energy
Advanced Research Projects Agency - Energy
Advanced Tech. Vehicles Manufacturing Loan Program
Title 17—Innovative Tech. Loan Guarantee Program
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($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016 $	FY 2018 vs FY 2016 %
Department of Energy Budget by Appropriation					
Energy and Water Development, and Related Agencies					
Energy Programs					
Energy Efficiency and Renewable Energy	2,069,194	2,069,059	636,149	-1,433,045	-69.3%
Electricity Delivery and Energy Reliability	206,000	205,608	120,000	-86,000	-41.7%
Nuclear Energy	986,161	984,286	703,000	-283,161	-28.7%
Fossil Energy Programs					
Fossil Energy Research and Development	632,000	630,799	280,000	-352,000	-55.7%
Naval Petroleum and Oil Shale Reserves	17,500	17,467	4,900	-12,600	-72.0%
Strategic Petroleum Reserve	212,000	211,597	180,000	-32,000	-15.1%
Strategic Petroleum Account	0	0	8,400	+8,400	N/A
Northeast Home Heating Oil Reserve	7,600	7,586	6,500	-1,100	-14.5%
Total, Fossil Energy Programs	**869,100**	**867,449**	**479,800**	**-389,300**	**-44.8%**
Uranium Enrichment Decontamination and Decommissioning (UED&D) Fund	673,749	767,014	752,749	+79,000	+11.7%
Energy Information Administration	122,000	121,768	118,000	-4,000	-3.3%
Non-Defense Environmental Cleanup	255,000	254,515	218,400	-36,600	-14.4%
Science	5,347,000	5,336,835	4,472,516	-874,484	-16.4%
Advanced Research Projects Agency - Energy	291,000	290,446	20,000	-271,000	-93.1%
Nuclear Waste Disposal	0	0	90,000	+90,000	N/A
Departmental Administration	130,971	130,722	145,652	+14,681	+11.2%
Office of the Inspector General	46,424	46,336	49,000	+2,576	+5.5%
Title 17 - Innovative Technology Loan Guarantee Program	17,000	14,920	0	-17,000	-100.0%
Advanced Technology Vehicles Manufacturing Loan Program	6,000	5,989	0	-6,000	-100.0%
Total, Energy Programs	**11,019,599**	**11,094,947**	**7,805,266**	**-3,214,333**	**-29.2%**
Atomic Energy Defense Activities					
National Nuclear Security Administration					
Weapons Activities	8,846,948	8,830,130	10,239,344	+1,392,396	+15.7%
Defense Nuclear Nonproliferation	1,940,302	1,936,614	1,793,310	-146,992	-7.6%
Naval Reactors	1,375,496	1,372,881	1,479,751	+104,255	+7.6%
Federal Salaries and Expenses	363,766	363,937	418,595	+54,829	+15.1%
Total, National Nuclear Security Administration	**12,526,512**	**12,503,562**	**13,931,000**	**+1,404,488**	**+11.2%**
Environmental and Other Defense Activities					
Defense Environmental Cleanup	5,289,742	5,279,686	5,537,186	+247,444	+4.7%
Other Defense Activities	776,425	774,949	815,512	+39,087	+5.0%
Defense Nuclear Waste Disposal	0	0	30,000	+30,000	N/A
Total, Environmental and Other Defense Activities	**6,066,167**	**6,054,635**	**6,382,698**	**+316,531**	**+5.2%**
Total, Atomic Energy Defense Activities	**18,592,679**	**18,558,197**	**20,313,698**	**+1,721,019**	**+9.3%**
Power Marketing Administrations					
Southeastern Power Administration	0	0	0	0	N/A
Southwestern Power Administration	11,400	11,378	11,400	0	N/A
Western Area Power Administration	93,372	93,194	93,372	0	N/A
Falcon and Amistad Operating and Maintenance Fund	228	228	228	0	N/A
Colorado River Basins Power Marketing Fund	-23,000	-23,000	-23,000	0	N/A
Total, Power Marketing Administrations	**82,000**	**81,800**	**82,000**	**0**	**N/A**
Federal Energy Regulatory Commission (FERC)	0	0	0	0	N/A
Subtotal, Energy and Water Development and Related Agencies	**29,694,278**	**29,734,944**	**28,200,964**	**-1,493,314**	**-5.0%**
Excess Fees and Recoveries, FERC	-23,587	-15,882	-9,000	+14,587	+61.8%
Title XVII Loan Guarantee Program Section 1703 Negative Credit Subsidy Receipt	-68,000	-67,871	-35,000	+33,000	+48.5%
Sale of Northeast Gas Reserve	0	0	-69,000	-69,000	N/A
Use of Advanced Research Projects Agency - Energy Balances	0	0	-46,367	-46,367	N/A
Total, Funding by Appropriation	**29,602,691**	**29,651,191**	**28,041,597**	**-1,561,094**	**-5.3%**

*The Consolidated Appropriations Act was not available when the Department of Energy developed the FY 2018 Congressional Budget. Therefore, the FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year.

Energy Efficiency and Renewable Energy

Energy Efficiency and Renewable Energy

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Energy Efficiency and Renewable Energy
Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for energy efficiency and renewable energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $636,149,000, to remain available until expended: Provided, That of such amount, $125,849,000 shall be available until September 30, 2019, for program direction.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

Deleted Defense Production Act Fund transfer authority provided in FY 2016.

Public Law Authorizations

P.L. 93-275, "Federal Energy Administration Act" (1974)
P.L. 93-410, "Geothermal Energy Research, Development, and Demonstration Act" (1974)
P.L. 93-577, "Federal Non-Nuclear Energy Research and Development Act" (1974)
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 94-413, "Electric and Hybrid Vehicle Research, Development and Demonstration Act" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act" (1978)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95 620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 95-238, Title III – "Automotive Propulsion Research and Development Act" (1978)
P.L. 96-512, "Methane Transportation Research, Development and Demonstration Act" (1980)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act" (1987)
P.L. 100-357, "National Appliance Energy Conservation Amendments" (1988)
P.L. 100-494, "Alternative Motor Fuels Act" (1988)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-566, "Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Act of 1990"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 104-271, "Hydrogen Future Act of 1996"
P.L. 106-224, "Biomass Research and Development Act" (2000)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-140, "Energy Independence and Security Act of 2007"
P.L. 110-234, "The Food, Conservation, and Energy Act of 2008"
P.L. 111-5, "American Recovery and Reinvestment Act of 2009"

Energy Efficiency and Renewable Energy
($K)

FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
2,069,194	2,069,059	636,149

Overview

The Office of Energy Efficiency and Renewable Energy (EERE) invests in research and development (R&D) as part of the Department of Energy's (DOE's) broad portfolio approach to address our Nation's energy and environmental challenges. This Budget Request focuses DOE resources toward early-stage R&D and reflects an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies. It emphasizes energy technologies best positioned to support American energy independence and domestic job-growth in the near to mid-term.

The FY 2018 Budget Request maintains America's leadership in transformative science and emerging energy technologies in sustainable transportation, renewable power, and energy efficiency. Knowledge generated by EERE early-stage R&D enables U.S. industries, businesses, and entrepreneurs to develop and deploy innovative energy technologies and gives them the competitive edge needed to excel in the rapidly changing global energy economy. Industry deployment of these technologies creates jobs, reduces U.S. reliance on imported oil, increases energy affordability, improves energy security, ensures environmental responsibility and offers Americans a broader range of energy choices.

EERE works with industry, academia, National Laboratories, and other partners to create technology-specific roadmaps which focus DOE resources on the most fundamental technology challenges. EERE investment strategies fall under three primary areas:

- Early-stage (R&D) to build the knowledge base upon which industry can reduce costs, improve performance, and develop and deploy new materials and manufacturing technologies;
- Limited validation through testing and simulation to provide feedback to R&D; and
- Analysis to support regulatory activities for appliance and equipment standards, building codes, Federal energy management and alternative fuel vehicles.

EERE early-stage research focuses on technology challenges that have the potential for high return on investment, but which present a significant degree of scientific or technical uncertainty across a relatively lengthy time span, making it unlikely that industry will invest significant R&D on their own. Industry typically focuses on near term (2-4 years) investments in marginal improvements to capacity or efficiency, while EERE early-stage R&D focuses on longer-range (5-15 years) transformational technologies, materials and processes. Thus, this request maintains the most critical core capabilities and infrastructure at DOE National Laboratories related to sustainable transportation, renewable power and energy efficiency technologies. It proposes cost-shared funding opportunity announcements or competitive solicitations aimed at universities, industry, and entrepreneurs. National Laboratories will be encouraged to form Cooperative Research and Development Agreements with industry, enter into Strategic Partnership Projects (also known as Work for Others) and conduct User Facility calls for university and industry proposals (e.g., Energy Systems Integration Facility at National Renewable Energy Laboratory) to further leverage DOE National Laboratory expertise and infrastructure.

After four decades of investment in American innovation, EERE-sponsored technologies have made enormous strides toward cost competitiveness in the transportation, energy efficiency and renewable power areas.[1] To date, third party evaluators have assessed one-third of EERE's portfolio (by amount invested from 1976 to 2012) through multiple impact evaluations covering R&D investments in PV energy systems, wind energy, vehicle combustion engines, advanced battery technologies for electric-drive vehicles, and geothermal technologies. The combined results of these studies show that the total EERE taxpayer investment of $12 billion (inflation-adjusted 2013 dollars) for the R&D investments evaluated has already yielded an estimated net economic benefit to the United States of more than $230 billion, with an overall annual rate of return on investment of more than 20%.[2]

In 2016, one in seven new jobs for Americans were in the energy sector. Of the 6.4 million Americans working in the energy sector currently, more than a third, or 2.2 million, are employed full-time or part-time in energy efficiency. More than half a million Americans, about 660,000, are employed in renewable power production and generation jobs.[3] The low capitalization required for energy efficiency and renewable energy is enabling developing world economies to grow, which is creating greater demand for U.S. goods and services and new job opportunities for Americans. Of the nearly 2.4 million Americans employed in the motor vehicle/parts sector, over 259,000 work with alternative fuels – an increase of 69,000 jobs in 2016.[4] All of these economic benefits can be traced to previous EERE investments in early-stage research, and EERE is committed to continuing in its role as a global leader in enabling the development of the next generation of energy technologies.

Major Changes in the FY 2018 Budget Request

In FY 2018, EERE will invest $695,249,000 (including $59,100,000 use of prior year funds) focused on early-stage research to strengthen our knowledge and understanding of promising technologies, with the potential to enable American consumers and businesses' to increase energy productivity, expand renewable power and energy security options, pursue alternative fuels and vehicles, and develop new materials and systems. EERE will also conduct rigorous analysis and evaluations of its portfolio, and achieve the greatest possible impact in each of its three sectors (Sustainable Transportation, Renewable Power, and Energy Efficiency).

The shift away from later-stage development and deployment activities and the increased focus on early-stage R&D provides an opportunity to reorganize and move toward a more efficient organizational structure. In an effort to eliminate redundancies and increase efficiencies across the Department, staff and associated functions from the Office of Strategic Programs will be centralized within corporate offices, including International Affairs and Public Affairs within Departmental Administration and the Office of Technology Transitions. Therefore, no funds are requested for Strategic Programs within the EERE account in FY 2018.

Similarly, as resources are shifted toward early-stage R&D, the Weatherization Assistance Program and State Energy Program are terminated in FY 2018. Therefore, no funds are requested in this Budget Request for the Weatherization and Intergovernmental Program.

Program Direction funding enables EERE to maintain and support a world-class Federal workforce to manage the wide range of projects and activities funded through the EERE programs. The FY 2018 Budget Request for Program Direction provides sufficient resources for program and project management, oversight activities, contract administration, workforce management, IT support, stewardship of the National Renewable Energy Laboratory, and headquarters and field site non-laboratory facilities and infrastructure. Of EERE's current portfolio of approximately 2,500 multi-year (3-5 year) projects, at least two-thirds will remain active in 2018. In keeping with the direction to generate efficiencies and reduce the cost of government, and to align with reductions in technology program budgets, the Department will reduce EERE funded Full-Time Equivalents (FTEs) by approximately 30 percent from the FY 2016 level. Remaining staff will ensure continuity of the

[1] U.S. Department of Energy, "Revolution…Now: The Future Arrives for Five Clean Energy Technologies – 2016 Update" (2016), https://www.energy.gov/eere/downloads/revolutionnow-2016-update

[2] Aggregate Return on Investment for R&D Investments in the U.S. DOE Office of Energy Efficiency and Renewable Energy, prepared by Jeff Dowd, U.S. Department of Energy, February 2016

[3] U.S. Department of Energy, "2017 U.S. Energy and Employment Report (USEER)" (2017), https://energy.gov/downloads/2017-us-energy-and-employment-report

[4] Ibid.

essential oversight activities for EERE's project portfolio and maintaining proper stewardship of taxpayer dollars. A limited amount of staff will remain in the Weatherization and Intergovernmental Program Office to provide required oversight of existing projects. Due to the reduced financial assistance project and grant workload in FY 2018, EERE will consolidate procurement and project management functions at the Golden Field Office, allowing for the elimination of staff support at the National Energy Technology Laboratory (NETL).

Highlights of the FY 2018 Budget Request

- **Sustainable Transportation ($183,600,000)**
  EERE's sustainable transportation portfolio supports comprehensive and analysis-based, early-stage research strategies that ultimately enable industry to accelerate the development and widespread use of a variety of promising sustainable transportation technologies. Broadly, EERE pursues three key parallel solution pathways: (1) replacing conventional fuels with cost-competitive, domestically produced, sustainable alternatives (alternative fuels) (2) using less petroleum-derived fuel to move people and freight (vehicle efficiency) and (3) improving the overall energy efficiency and efficacy of the mobility system.

  - **Vehicle Technologies:** The Budget Request provides $82,000,000 in FY 2018 to support early-stage R&D to generate knowledge upon which industry can develop and deploy innovative energy technologies for the efficient and secure transportation of people and goods across America. Vehicle Technologies will focus on research that industry either does not have the technical capability to undertake or is too far from market realization to merit sufficient industry focus and critical mass. Within Battery and Electrification Technologies, Advanced Battery R&D will explore new battery chemistry and cell technologies with the potential to reduce the cost of electric vehicle batteries by more than half, to less than $100/kWh (ultimate goal is $80/kWh), increase range to 300 miles, and decrease charge time to 15 minutes or less. Building upon work started in FY 2016, Energy Efficient Mobility Systems (EEMS) will create new ideas and knowledge focused on pathways to significantly improve transportation system efficiency. EEMS research will include the application of new computational models and simulation capabilities to create and test new theories that use vehicle connectivity and automation to improve energy efficiency, big data tools, machine/deep-learning and artificial intelligence, as well as new information science approaches that improve mobility decision making and increase transportation choice. In Advanced Engine and Fuel Technologies, research will aim to improve our understanding of and ability to manipulate combustion, generating knowledge and insight necessary for industry to develop the next generation of engines and fuels capable of improving passenger vehicle fuel economy by 50 percent from a 2009 baseline. In Materials Technology, research will focus on novel approaches to build lightweight, multi-material structures and on creating new materials that can meet the extreme temperatures and pressures that the next generation of vehicle engines will require.

  - **Bioenergy Technologies:** The Budget Request provides $56,600,000 in FY 2018 to fund early-stage R&D that bolsters the body of scientific and engineering knowledge enabling industry to develop and deploy high-performing drop-in biofuels and renewable chemicals at $3 per gallon gasoline equivalent ($3/gge) in the near-term, with an ultimate target of $2/gge. The Program's early-stage R&D emphasizes processes to produce renewable-gasoline, -diesel, and -jet fuels from non-food sources. Research focus areas include: (1) detailed understanding and optimization of the physics and chemistry of each preprocessing step of highly variable biomass; (2) identification and molecular characterization of four high performing algal strains; and (3) development of engineered organisms and novel catalysts. Also, in collaboration with the Vehicles Technology Program, the Program will explore the co-optimization of fuels and engines enabling the development of bio-based fuels/additives that have the potential to realize 15-20% fuel economy gain when blended with petroleum and used in high-efficiency engines.

  - **Hydrogen and Fuel Cell Technologies:** The Budget Request provides $45,000,000 in FY 2018 for early-stage R&D to investigate novel hydrogen and fuel cell technologies and concepts that could enable American energy independence and domestic job growth through industry development and deployment. To be cost competitive with gasoline on a cents-per-mile driven basis, the cost of hydrogen from domestic resources needs to be less than $4/gge and the cost of a durable fuel cell system needs to be less than $40/kW. In FY 2018, research will emphasize the acceleration of materials breakthroughs through National laboratory consortia that bring together state-of-the-art core capabilities from multiple labs, while leveraging the results of ongoing projects with university

and industry partners using prior year funding. Key areas of research include platinum-free catalysts, materials for advanced water splitting, and hydrogen storage, as well as component and materials research to enable "H2@Scale," a vision for the wide-scale production and utilization of hydrogen across sectors.

- **Renewable Power ($134,300,000)**
  Through its renewable power portfolio, EERE will perform early-stage research to enable solar, wind, water, and geothermal industries to develop and deploy novel power generation technologies that can directly compete with other sources of electricity, without subsidies. Through investments with DOE labs, industry, and academia, EERE's renewable power technology offices will continue to lead the world in developing domestic, clean, alternative choices in power generation, which strengthen the U.S. economy while increasing energy security.

  - **Solar Energy:** The Budget Request provides $69,700,000 in FY 2018 to support the DOE SunShot Initiative's goal of making solar power one of the least expensive forms of electricity by enabling cost reductions toward the 2030 target of $0.03/kWh for utility-scale solar power. Funding will support early-stage R&D at the National Laboratories, in partnership with academia and industry, with a focus on the next generation of photovoltaics and concentrating solar power technologies. In addition, the Program will advance the state of knowledge necessary for industry to incorporate increasing solar generation into the electric grid, including focuses on solar power forecasting, power electronics, and power system integrity. National Laboratory research also supports the development of experimental test and evaluation standards and analytic models to guide the direction of R&D activities. Some additional funding is provided for a limited research portfolio at universities, in close coordination with the Office of Science and the National Science Foundation.

  - **Wind Energy:** The Budget Request provides $31,700,000 in FY 2018 to fund early-stage R&D, and related testing that builds the knowledge base upon which industry can develop and deploy novel technologies. FY 2018 activities will focus on investigating fundamental systems-level interactions influenced by atmospheric conditions, variable terrain, and machine-to-machine wake interactions. A new R&D effort will focus on the scientific challenges associated with the design and manufacturing of low-specific power rotors for tall wind applications, aimed at enabling industry improvement of wind plant capacity factors by as much as 10%, and mitigating challenges associated with aerodynamic and gravitational loading. Funding will advance collaboration with DoD, FAA, DHS, and other agencies to complete a suite of wind-turbine radar-interference mitigation algorithms for long-range and terminal radar systems. Finally, funded R&D will address long-term wind-related grid integration and grid infrastructure modernization challenges.

  - **Water Power:** The Budget Request provides $20,400,000 in FY 2018 to support early-stage R&D exploring novel concepts and approaches to capturing hydropower and marine hydrokinetic energy resources. Hydropower activities will advance new approaches to hydropower design, enabling industry to develop and deploy standardized, modular hydropower systems across a range of geologic and hydrologic conditions. Outputs from computationally intensive R&D efforts will also enable industry to incorporate biological modeling in turbine design as well as model approaches to increase hydropower's ability to operate flexibly and respond to the requirements of the grid. Marine hydrokinetic research activities will focus on improving understanding of hydrodynamic loads and power conversion optimization and analytical capabilities to evaluate device and array performance and reliability across operational and extreme conditions.

  - **Geothermal Technologies:** The Budget provides $12,500,000 in FY 2018, supporting GTO's Enhanced Geothermal Systems (EGS) collaborative effort, bringing together National Laboratory-led teams, academia, and industry to conduct early-stage R&D that explores the fundamental relationships between seismicity, stress state, and permeability to validate and verify models, providing feedback to inform the next stage of EGS research. The Program will fund the final year of a three-year Hydrothermal effort for three National Laboratory projects targeting innovative, early-stage research on approaches to geothermal exploration through microhole drilling applications, self-healing cements, and subsurface imaging, all of which present such a significant degree of scientific uncertainty that industry is unlikely to invest significant resources.. The Budget Request also supports early-stage R&D in waterless fracturing and stimulation fluids, investigating alternative hydraulic fracturing methods to reduce, or eliminate, the use of water. Combined efforts will strengthen the body of knowledge necessary to enable industry to achieve a cost target of $0.06/kWh by 2030 from newly developed geothermal systems.

- **Energy Efficiency ($159,500,000)**
  EERE's energy efficiency portfolio will build on the considerable progress made over the last 40 years and pursue early-stage R&D targeted at high impact technology areas such as advanced lighting, space heating and cooling, building envelopes, and manufacturing materials and processes. The overall goal of the energy efficiency portfolio is to strengthen the body of knowledge that enables businesses, industry and the Federal government to improve affordability, energy security-resiliency, and energy productivity of our buildings and manufacturing sectors. The knowledge outputs of this research can support a foundation for economic growth and job creation as businesses, consumers, and energy managers develop and deploy new energy-efficiency and manufacturing technologies and best practices.

  - **Advanced Manufacturing:** The Budget Request provides $82,000,000 in FY 2018 to support early-stage applied R&D focused on advancing and creating new understanding of underlying technologies, materials and processes relevant to the productive use of energy in manufacturing, as well as the competitive manufacturing of energy related products. The Budget for AMO reasserts the proper role of the Federal Government by reflecting an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies and focusing funding toward early-stage R&D. By fostering collaboration between National Laboratories, universities and companies (for-profit and not-for-profit), this budget will enhance the foundational knowledge base in materials and manufacturing processes, focusing on research challenges that present a significant degree of scientific or technical uncertainty and are beyond the horizon in terms of commercialization, making it unlikely that industry will pursue independently.

  - **Federal Energy Management Program (FEMP):** The Budget Request provides $10,000,000 in FY 2018 to continue FEMP's core activities of assisting Federal agencies to meet energy-related goals and provide Federal energy leadership to the country. FY 2018 funds will support continued assistance on energy projects and energy savings performance contracts, including Energy Savings Performance Contracts (ESPC), Utility Energy Service Contracts (UESC), and Power Purchase Agreements (PPA), enhancing the energy management skills of the federal workforce, and supporting agency accountability toward federal goals.

  - **Building Technologies:** The Budget Request provides $67,500,000 in FY 2018 to support early-stage R&D of innovative building energy technologies such as lighting, space conditioning and refrigeration, windows and envelope and their effective integration into efficient, resilient, grid-connected, and secure building systems. The goal of the program is to overcome the high degree of fragmentation across the heterogeneous buildings industry spanning construction to appliance and equipment manufacturing. BTO's research also focuses on developing the physics-based algorithms for improved energy modeling and system controls required to better predict and manage energy efficient appliance/equipment, system, and whole-building energy usage. Additionally, BTO's early stage R&D on advanced and transactive controls will help strengthen the body of knowledge to enable industry to develop and deploy truly "smart" buildings capable of connecting with the power grid in new and increasingly adaptive manners to help with overall electric system efficiency, resiliency and bringing down energy prices across the grid. Finally, it supports DOE working with industry and stakeholders to meet requirements for statutorily-mandated efficiency standards and building energy codes determinations.

  - **Weatherization and Intergovernmental Program:** The Budget Request provides no funding in FY 2018 for both the Weatherization Assistance Program (WAP) and the State Energy Program (SEP) due to a departmental shift in focus away from deployment activities and towards early-stage R&D for energy efficiency and renewable energy technologies. In FY 2018 WAP will continue to administer, support and monitor multi-year formula financial assistance awards to 59 grantees (50 states, the District of Columbia, 5 U.S. Territories and 3 Native American Tribes) made with FY 2017 and prior year funding, and accomplish approximately 20,000 to 30,000 low income household retrofits during the latter part of FY 2017 through the end of each grantee's award period of performance. SEP in FY 2018 will continue to administer, support and monitor multi-year formula financial assistance awards to 56 grantees (50 states, the District of Columbia, and 5 U.S. Territories) made with FY 2017 and prior year funding, totaling between $50 million to $70 million. SEP will also complete another cycle of competitive financial assistance awards using FY 2017 funding (subject to final FY 2017 appropriations), and manage 32 to 50+ awards, totaling between $11 million and $16 million.

Cybersecurity

DOE is engaged in two categories of cyber-related activities: protecting the DOE enterprise from a range of cyber threats that can adversely impact mission capabilities and improving cybersecurity and grid resilience in the energy sector. The cybersecurity crosscut supports central coordination of the strategic and operational aspects of cybersecurity and facilitates cooperative efforts such as the Joint Cybersecurity Coordination Center (JC3) for incident response and the implementation of Department-wide Identity, Credentials, and Access Management (ICAM).

Energy Efficiency and Renewable Energy
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Vehicle Technologies	**310,000**	**309,411**	**82,000**	**-228,000**
Bioenergy Technologies	**225,000**	**224,571**	**56,600**	**-168,400**
Hydrogen and Fuel Cell Technologies	**100,950**	**100,758**	**45,000**	**-55,950**
Solar Energy	**241,600**	**241,141**	**69,700**	**-171,900**
Wind Energy	**95,450**	**95,269**	**31,700**	**-63,750**
Water Power	**70,000**	**69,867**	**20,400**	**-49,600**
Geothermal Technologies	**71,000**	**70,865**	**12,500**	**-58,500**
Advanced Manufacturing	**228,500**	**228,066**	**82,000**	**-146,500**
Federal Energy Management Program	**27,000**	**26,949**	**10,000**	**-17,000**
Building Technologies	**200,500**	**200,119**	**67,500**	**-133,000**
Weatherization and Intergovernmental Programs				
Weatherization Assistance Program				
Weatherization Assistance	211,600	211,198	0	-211,600
Training and Technical Assistance	3,000	2,994	0	-3,000
NREL Site-Wide Facility Support	400	399	0	-400
Total, Weatherization Assistance Program	215,000	214,591	0	-215,000
State Energy Program	50,000	49,905	0	-50,000
Total, Weatherization and Intergovernmental Programs	**265,000**	**264,496**	**0**	**-265,000**
Program Direction	**155,000**	**154,705**	**125,849**	**-29,151**
Strategic Programs	**21,000**	**20,960**	**0**	**-21,000**
Facilities and Infrastructure	**62,000**	**61,882**	**92,000**	**30,000**
Subtotal, Energy Efficiency and Renewable Energy	**2,073,000**	**2,069,059**	**695,249**	**-1,377,751**

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Use of Prior Year Balances[b]	0	0	-59,100	-59,100
Rescission of Prior Year Balances	-3,806	0	0	3,806
Total, Energy Efficiency and Renewable Energy	**2,069,194**	**2,069,059**	**636,149**	**-1,433,045**
Federal FTEs	**645**	**680**	**458**	**-187**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $26,240,000; STTR: $3,936,000
- FY 2017 Projected: SBIR $26,190,000; STTR: $3,929,000
- FY 2018 Request: SBIR $13,794,000; STTR: $1,941,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[b]The proposed Use of Prior Year Balances is not a reprogramming request, but provides notice of intent to use unobligated balances within Congressional Control points to supplement FY 2018 appropriations for the activities described with the CJ for each program.

Vehicle Technologies

Overview

Vehicles move our national economy. Annually, vehicles transport 11 billion tons of freight[1] – more than $32 billion worth of goods each day[2] – and move people more than 3 trillion vehicle-miles.[3] Growing our economy requires transportation, and transportation requires energy, yet our dependence on oil for transportation remains a significant challenge. The transportation sector accounts for 70 percent of U.S. petroleum use and is 93% dependent on petroleum.[4] On-road vehicles consume the majority (more than 85 percent) of this amount.[5] The U.S. sends more than ten billion dollars per month[6] overseas for crude oil, and the average U.S. household spends nearly one-fifth of its total family expenditures on transportation,[7] making it the second-most expensive spending category after housing. Oil price volatility also affects our national economy and household budgets. Over the past ten years, U.S. regular conventional retail gasoline prices have fluctuated from around $1.50 to over $4 per gallon,[8] causing difficult fluctuations in annual household budgets and business operating expenses.

To support future U.S. economic growth and help consumers and businesses reduce their transportation energy costs, the Vehicle Technologies Program funds early-stage, high-risk research to generate knowledge upon which industry can develop and deploy innovative energy technologies for the efficient and secure transportation of people and goods across America. Vehicle Technologies leverages the unique capabilities and world-class expertise of the national laboratory system to develop new innovations in electrification, including advanced battery technologies; advanced combustion engines and fuels, including co-optimized systems; advanced materials for lighter-weight vehicle structures and better powertrains; and energy efficient mobility technologies and systems, including connected and autonomous vehicles as well as innovations in connected infrastructure for significant energy efficiency improvement . Vehicle Technologies is also uniquely positioned to address early stage challenges due to its strategic public-private research partnerships with industry (e.g., U.S. DRIVE and 21st Century Truck Partnerships) that leverage relevant technical and market expertise, prevent duplication, ensure public funding remains focused on the most critical R&D barriers that are the proper role of government, and accelerate progress– at no cost to the Government. Vehicle Technologies will focus on research that industry either does not have the technical capability to undertake on its own, usually because there is a high degree of scientific or technical uncertainty, or it is too far from market realization to merit sufficient industry focus and critical mass.

Highlights of the FY 2018 Budget Request

The Vehicle Technologies Budget Request supports key efforts that contribute to achieving its high-level goals:

- **Advanced Battery R&D:** Explore new battery chemistry and cell technologies with the potential to reduce the cost of electric vehicle batteries by more than half, to less than $100/kWh (Ultimate goal is $80/kWh), increase range to 300 miles and decrease charge time to 15 minutes or less.
- **Advanced Engines and Fuels:** Improve our understanding of, and ability to manipulate, combustion processes, generating knowledge and insight necessary for industry to develop the next generation of engines and fuels capable of improving passenger vehicle fuel economy by 50 percent (vs. 2009 baseline).

[1] Bureau of Transportation Statistics, DOT, 2016. Table 3-1 Weight and Value of Shipments by Transportation Mode https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/transportation_statistics_annual_report/2016/tables/ch3/table3_1.
[2] Ibid.
[3] Transportation Energy Data Book 34th Edition, ORNL, 2015. Table 3.7 Shares of Highway Vehicle-Miles Traveled by Vehicle Type, 1970-2014
[4] Ibid. Table 1.13 Consumption of Petroleum by End-Use Sector, 1973-2015
[5] Ibid. Table 1.16 Transportation Petroleum Use by Mode, 2013-2014
[6] Ibid. Table 1.7 Imported Crude Oil by Country of Origin, 1973-2015; Table 10.3 Prices for a Barrel of Crude Oil and a Gallon of Gasoline, 1978-2015. Overseas includes countries and territories outside the 50 States and the District of Columbia.
[7] Bureau of Labor Statistics, Consumer Expenditure Survey, 2015. Average annual expenditures and characteristics of all consumer units, 2013-2015. https://www.bls.gov/cex/2015/standard/multiyr.pdf
[8] Energy Information Administration, 2016. Weekly U.S. All Grades All Formulations Retail Gasoline Prices https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPM0_PTE_NUS_DPG&f=W

- **Advanced Materials Research:** Research novel approaches to build light weight, multi-material structures, with the potential to reduce vehicle weight 25 percent.
- **Energy Efficient Mobility Systems:** Create cutting-edge modeling, simulations, and high performance computing-enabled data analytics to allow industry and cities and States to improve the energy efficiency of light vehicles, trucks, and the overall mobility system . This builds on Vehicle Technologies prior-year Transportation as a System (TAAS) work and rapidly changing connected and autonomous vehicle technology.

Vehicle Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Vehicle Technologies (FY 2016 Structure)				
Battery and Electrification Technologies	**141,100**	**—**	**36,300**	**-104,800**
Vehicle Systems	**30,600**	**—**	**0**	**-30,600**
Energy Efficient Mobility Systems	**0**	**—**	**12,200**	**+12,200**
Advanced Combustion Engine R&D	**37,141**	**—**	**0**	**-37,141**
Fuel and Lubricant Technologies	**22,500**	**—**	**0**	**-22,500**
Advanced Engine and Fuel Technologies	**0**	**—**	**22,000**	**+22,000**
Materials Technology	**26,959**	**—**	**7,500**	**-19,459**
Outreach, Deployment, and Analysis				
Vehicle Technologies Deployment	34,000	—	0	-34,000
Advanced Vehicle Competitions	2,500	—	0	-2,500
Legislative and Rulemaking[1]	1,500	—	0	-1,500
Analysis	10,400	—	0	-10,400
Total, Outreach, Deployment, and Analysis	**48,400**	**—**	**0**	**-48,400**
Outreach	**0**	**—**	**2,000**	**+2,000**
Analysis	**0**	**—**	**2,000**	**+2,000**
NREL Site-Wide Facility Support	**3,300**	**—**	**0**	**-3,300**
Total, Vehicle Technologies	**310,000**	**309,411**	**82,000**	**-228,000**

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Vehicle Technologies (FY 2018 Structure)				
Battery and Electrification Technologies	**141,100**	**—**	**36,300**	**-104,800**
Vehicle Systems	**30,600**	**—**	**0**	**-30,600**
Energy Efficient Mobility Systems	**0**	**—**	**12,200**	**+12,200**
Advanced Combustion Engine R&D	**59,141**	**—**	**22,000**	**-37,141**
Materials Technology	**26,959**	**—**	**7,500**	**-19,459**
Outreach	**48,400**		**2,000**	**-46,400**
Analysis	**0**	**—**	**2,000**	**+2,000**
NREL Site-Wide Facility Support	**3,300**	**—**	**0**	**-3,300**
Total, Vehicle Technologies	**309,500**	**309,411**	**82,000**	**-228,000**

[1] Legislative and Rulemaking funding reduced and moved to the new subprogram, Outreach.

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

SBIR/STTR:

- FY 2016 Transferred: $7,244,000; STTR $1,087,000
- FY 2017 Projected: SBIR $7,230,000; STTR $1,085,000
- FY 2018 Request: SBIR $2,560,000; STTR $360,000

Budget Structure Crosswalk ($K)

FY 2016 Budget Structure	Proposed FY 2018 Budget Structure						
	Battery and Electrification Technologies	Energy Efficient Mobility Systems	Advanced Engine and Fuel Technologies	Materials Technology	Outreach	Analysis	Total
Vehicle Technologies							
Batteries and Electric Drive Technologies	34,000	0	0	0	0	0	**34,000**
Vehicle Systems	2,300	12,200	0	0	0	0	**14,500**
Advanced Combustion Engine R&D	0	0	15,450	0	0	0	**15,450**
Materials Technology	0	0	0	7,500	0	0	**7,500**
Fuel and Lubricant Technologies	0	0	6,550	0	0	0	**6,550**
Outreach, Deployment, and Analysis	0	0	0	0	2,000	2,000	**4,000**
NREL Site Wide Facility Support (Moved to F&I)	0	0	0	0	0	0	**0**
Total, Vehicle Technologies	**36,300**	**12,200**	**22,000**	**7,500**	**2,000**	**2,000**	**82,000**

Vehicle Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Vehicle Technologies	
Battery and Electrification Technologies: Batteries and Electric Drive Technologies is renamed Battery and Electrification Technologies to better reflect program objectives. No funds are requested for former activity Electric Drive Technologies R&D (-$38,100); all Electric Drive Technologies R&D activities will conclude in FY 2017 including Advanced Wide Band Gap Power Electronics and Non-rare Earth Magnet Materials and Motors R&D. Former activity Battery Technology R&D is decreased by $66,700, as a result of fewer planned activities in the following areas: Battery Testing, Analysis, and Design Research; Advanced Battery Materials and Electrochemical Optimization Research; and Advanced Battery Cell Design and Cost Reduction. The lower priority area, Advanced Electrode Processing Research for Lithium Ion Batteries, will be eliminated . Support for the U.S. China Clean Energy Research Center (CERC) – Light Duty continues from FY 2016.	**-104,800**
Vehicle Systems: The Vehicle Systems subprogram is subsumed into other subprograms but the following later stage development and lower priority activities will be terminated in FY2018: SuperTruck II, Advanced Vehicle Testing and Evaluation (AVTE), and work to optimize vehicle powertrains. In FY 2017, a portion of the Vehicle Systems subprogram supported work that is now included in the new subprogram, Energy Efficient Mobility Systems. Grid modernization and charging infrastructure activities are realigned to Battery and Electrification Technologies.	**-30,600**
Energy Efficient Mobility Systems: This new subprogram will create new cutting-edge systems modeling, simulations and high performance computing-enabled data analytics, such as artificial intelligence, machine learning, and big data tools. The knowledge generated by this effort will strengthen understanding of how evolving technology (connectivity, mobility & autonomous vehicles) and consumer preferences impact energy efficiency, and ultimately how the energy efficiency of transportation as a system (i.e. Mobility) can be improved. Energy Efficient Mobility Systems will leverage emerging disruptive technologies such as connected and autonomous vehicles, information-based mobility-as-a-service platforms, and advanced powertrain technologies to identify and exploit energy efficiency opportunities at the transportation system level. Opportunity exists to leverage unique lab capability (e.g., vehicle controls, high performance computing, simulation capability, machine learning and other big data techniques) to accelerate innovation.	**+12,200**
Advanced Engine and Fuel Technologies: The former Advanced Combustion Engine R&D, Fuel, and Lubricant Technologies subprograms are combined and realigned to Advanced Engine and Fuel Technologies to better reflect program management objectives. This new subprogram supports the Co-Optimization of Engine and Fuels and includes the following early-stage research areas: Lean/Next Generation Compression Ignition Combustion Engines and Fuels R&D; Predictive Modeling of engine combustion and fuels; Catalyst R&D for Emission Control/After-treatment; and Heavy-duty Combustion Engines and Fuels R&D. The following later-stage development and lower priority activities will be terminated in FY2018: SuperTruck II; Engine Enabling Technologies; Particulate Emissions Control/After-treatment; Lubricant R&D; and Reactivity Controlled Compression Ignition. Support for the U.S. China Clean Energy Research Center (CERC) – Medium/Heavy Duty continues from FY 2016.	**-37,641**

	FY 2018 vs FY 2016
Materials Technology: The following later stage development and lower priority activities will be terminated in FY 2018: SuperTruck II, Advanced High Strength Steel and Safety Statistics. No funding is requested to complete Aluminum Alloy, Carbon Fiber and Magnesium, but activities related to execution of prior year appropriations will continue until completion. The FY 2018 Budget Request supports Joining of Dissimilar Materials, including related Corrosion Research, and Propulsion Materials.	**-19,459**
Outreach: Outreach, Deployment, and Analysis is renamed Outreach. The FY 2018 Budget Request provides minimal support for the statutorily required State and Alternative Fuel Provider Fleet Program, the Alternative Fuel Data Center, and the Fuel Economy Guide booklet only. The former Analysis key activity, which informs technology decisions in entire Vehicle Technologies portfolio, is now its own subprogram. All other activities funded in the former Outreach, Deployment, and Analysis subprogram will be terminated in FY 2018 to focus on early-stage R&D: Vehicle Technologies Deployment (Clean Cities coalitions and Alternative Community Partner projects) and Advanced Vehicle Competitions (final year of EcoCar3 student competition).	**-46,400**
Analysis: Analysis is a new subprogram (formerly a key activity in the Outreach, Deployment, and Analysis subprogram) that supports the planning and execution of mission-critical technology, economic, and interdisciplinary analyses to inform and prioritize Vehicle Technologies technology investments and research portfolio planning, including activities such as research target-setting and benefits estimation.	**+2,000**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-3,300**
Total, Vehicle Technologies	**-228,000**

Vehicle Technologies
Battery and Electrification Technologies

Description

The Battery and Electrification Technologies subprogram supports early-stage R&D to explore new battery chemistry and cell technology with the potential to reduce the cost of electric vehicle batteries by more than half to less than $100/kWh and increase the range to 300 miles while decreasing the charge time to less than 15 minutes.

The Battery and Electrification Technologies R&D activity funds research programs with partners in academia, National Laboratories, and industry, focusing on generating knowledge of high-energy and high-power battery materials and battery systems that can enable industry to significantly reduce the cost, weight, volume and charge time of plug-in electric vehicle (PEV) batteries. The activity supports the development of innovative materials and cell technologies capable of realizing significant cost reductions in three major R&D areas: Advanced Battery Materials R&D, Advanced Battery Cell R&D, and Electrification R&D.

The Advanced Battery Materials Research ($26.5 million) will focus on early-stage R&D of new lithium-ion cathode, anode, and electrolyte materials, which account for 50-70 percent of PEV battery cost of current technologies. Specifically, this work will focus on the development of new materials that offer a significant improvement in either energy or power and have the potential to achieve the DOE battery cost target of $100/kWh and capable of charging in 15 minutes or less. In addition, the subprogram will continue the Battery500 research consortium, which includes industry, university and labs and is focused on the development of "Beyond Lithium-Ion" technologies that have the potential to significantly reduce the weight, volume and cost by 3 times ($80/kWh). The Battery500 consortium consists of researchers from national laboratories and academia focused on multi-discplined research to overcome performance barriers associated with high energy density battery technology. The activity focus is to design novel electrode and cell architectures that utilize a lithium anode combined with a compatible electrolyte system, and high capacity cathodes that prohibit lithium dendrite growth or polysulfide dissolution and achieve 500 Wh/kg and 1000 cycles at the lab cell level.

The Advanced Battery Cell R&D effort ($7.5 million) will focus on early-stage R&D of new battery cell technology that contain new materials and electrodes that can reduce the overall battery cost, weight, and volume while improving energy, life, safety, and fast charging. This work will be carried out through competitively awarded, cost-shared awards with industry through funding opportunity supported through the DOE Cooperative Agreement with the U.S. Advanced Battery Consortium (USABC). This activity also supports high fidelity battery performance, life, fast charging, and safety testing of innovative battery technologies.

The Electrification R&D effort ($2.3 million) focuses on early-stage research to understand the potential impacts of electric vehicle (EV) charging on the Nation's electric grid. This research will inform the development of communication and cybersecurity protocols; enable industry to enhance the interoperability between charging equipment, the on-board vehicle charger, and charging networks; and foster technology innovations to improve EV refueling such as wireless and extreme fast charging which are too far from market realization to merit sufficient industry focus and critical mass. In FY 2018, this effort will focus on Extreme Fast Charging (XFC) research to understand the charging infrastructure and electricity grid challenges to enabling a 15-minute or less battery charge. Current Direct Current Fast Charge (DCFC) equipment operates at 50-120 kW. The goal for extreme fast charging research is to enable industry to develop and deploy 350+ kW power (over 3X improvement) capability that will enable EVs to charge in 15 minutes or less.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Battery and Electrification Technologies $141,000,000	**$36,300,000**	**-$104,800,000**
Advanced Battery Materials Research & Battery500		
• Support materials research activities through a competitive Lab Call focused on beyond lithium-ion technologies such as lithium metal and non-lithium battery technologies (sulfur, air, and sodium electrodes) through up to seven projects at National Laboratories. • Initiate up to fifteen new competitively selected awards for advanced battery materials research to develop novel electrolytes and cathodes that will significantly improve the performance, resilience and cost to enable the commercialization of high-energy, next-generation lithium-ion chemistries. Of particular interest are electrolytes that are stable up to 4.8 Volts and high-voltage cathodes including non-intercalation materials that are highly reversible and deliver more than 250 mAh/g of capacity. • National Laboratory research will also focus on the synthesis and diagnostics of advanced Ni rich high capacity cathodes and the investigation of disordered cathode materials.	• Support the Battery500 National Laboratory and University Research Consortium (composed of 4 labs and 5 universities) focused on beyond lithium-ion research. Three keystone research projects conducted by multi-disciplined teams include (1) investigating solvent in salt electrolytes for lithium metal anodes, (2) research to enable sulfur cathodes, and(3) novel electrode construction coupled with solid state electrolytes. The activity includes 5-10 “seedling” projects that explore other beyond lithium-ion. technology • Support 45 National Laboratory, 20 University and 4 industry R&D Advanced Battery Materials projects in the following focus areas: development and synthesis of high voltage/high capacity cathode materials; high voltage electrolytes; development of new synthesis routes for making lithium rich materials to mitigate voltage fade problem; modeling and first principles calculations of electrode materials, solid-electrolyte interphase (SEI) layer and electrode microstructure; and assembly of high density low tortuosity electrodes.	• In FY18, 1 to 2 additional Keystone projects will be added to the activity focused on mitigation of lithium dendrite formation, polysulfide dissolution, and solid-state materials research. • No new university projects will be awarded. Current university and industry awards will continue using prior year funds. Laboratory materials research will be down-selected to 20-25 projects.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Support 3rd generation lithium-ion battery materials and cell R&D focused on advanced metal alloy or silicon composite anode technology through projects at National Laboratories.	• Support two multi-disciplined, multi-Laboratory research teams to enable next-generation intermetallic anodes for lithium-ion batteries to address a critical problem in getting to higher energy cells. Research is expected to evolve in FY 2018 to the following topics: Team 1 will focus on fundamental research to understand and improve the solid-electrolyte-interphase in order to improve calendar and cycle life, and team 2 will explore concentration gradient particles and advanced particle coating technologies, and binder materials to understand and improve power capability and reduce material expansion during lithiation.	• Research focused on exploring concentration gradient particles and advanced particle coating technologies will be reduced in order to focus on higher priority areas of improving the solid-electrolyte interphase and exploring new binder technology.
• Support four to six National Laboratory research projects on advanced processing and enabling cell chemistry focused on developing lower-cost production processes for the laboratory level scale-up of advanced metal alloy or silicon composite anode materials, new cathode materials, innovative electrolytes, and other battery materials with the potential to significantly reduce battery material costs.	• Continue to support R&D at National Laboratories to engineer new cathode and electrolyte materials and develop processes to scale up these materials from lab quantities (grams) to batch quantities (10's of kilograms). This activity enables expanded laboratory level research on innovative battery materials. The research will focus on the engineering and batch scale-up of 2-3 new, innovative cathode materials and 1-2 new electrolyte material.	• The program will downselect the most promising projects for engineering and scale up of innovative cathode and electrolyte materials.
• Continue to support R&D at National Laboratories to develop advanced electrode processing technologies with the potential to significantly reduce production cost or increase battery performance.	• No funding is requested.	• Eliminate advanced electrode processing research at National Laboratories.
Advanced Battery Cell R&D		
• Support advanced battery development of robust prototype battery cells and modules	• Continue to support the USABC effort to lower battery costs to $125/kWh by selecting	• Cost-shared battery cell R&D projects awarded and funded in FY 2016 and FY 2017

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
that incorporate new materials and advanced electrodes that offer a significant reduction in cost. Conduct extensive performance, cycle life, and safety testing of deliverables from battery development efforts with industry. This work will be conducted through eight to twelve battery development projects under the program's cooperative agreement with the U.S. Advanced Battery Consortium (USABC).	up to two new USABC awards that focus on cell research to significantly reduce battery cell cost, increase performance and life, and be capable of extreme fast charging.	will continue. Only two new awards will be started in FY 2018 through a competitively awarded funding opportunity through the DOE-USABC cooperative agreement.
• Support high fidelity battery performance, life, and safety testing at the National Laboratories.	• Support 12 to 18 high fidelity battery performance, life, thermal response, and safety testing projects at 3 National Laboratories.	• Consolidate high fidelity performance and life battery testing from 2 to 1 National Lab and downselect to the 8 to 12 most promising projects. The battery thermal testing projects will be reduced from 10 projects to focus only on 2 to 3 extreme fast charging cell designs, Battery abuse response and safety projects will be reduced from 10 projects to 2 to 3 cell designs that incorporate novel active materials and non-flammable electrolytes
• Support the development of Computer Aided Engineering Battery Design Tools, leveraging the unique capabilities of National Laboratories. • Support National Laboratory research to improve computational efficiency of state-of-the-art (SOA) electrochemical models.	• Develop advanced Computer Aided Engineering Battery Design Tools. Activity will be limited to up to 2 multi-National Laboratory projects to couple electrochemical reactions with structural degradation and to improve computational performance	• No new FOA projects with industry will be awarded. Current industry awards will continue using prior year funds. Laboratory activity will be downselected from 8 projects to 2 to 3 projects focused on coupling crash and safety conditions with electrochemical response models.
Electrification R&D		
• Fast-charging standards (50-100 KW) and advanced high-power wireless charging systems development supported in the former Vehicle Systems subprogram (see Energy Efficient Mobility Systems subprogram chapter).	• Initiate 3 to 5 research projects focused on the (1) cost, safety & reliability of extreme fast charging (XFC, 300-400 KW) equipment, (2) the impact of XFC to the electric grid, (3) evaluations and testing of existing Combined Charging System (CCS) connectors for XFC	• In FY 2018, this activity will focus on the higher power, extreme Fast Charging (300-400 KW) research. The current Grid Modernization activities will end other than fast charging and cyber related work.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	applications needed to determine safe, reliable and robust operating limits, and implications to cybersecurity, and (4) standardization to ensure interoperability so that new and legacy vehicles are able to access XFC and existing Direct Current Fast Charge (DCFC) networks. Continue cyber related research.	
U.S. - China Clean Energy Research Center (CERC) - Light Duty		
• U.S. – China Clean Energy Research Center (CERC) focuses on research in areas where advances in technology can lead to major improvements in energy efficient. The Center facilitates joint research and development by teams of scientists and engineers from the U.S. and China.	• Continue research through the U.S. – China Clean Energy Research Center (CERC) at the same funding levels as FY 16 and same research focus. Major collaborative research efforts include; precompetitive battery materials research, connected and automated vehicles, vehicle hybridization and wireless charging, and life cycle analysis.	• This is the third year of funding of the 5-year Clean Energy Research center for Light Duty Vehicles in support of the U.S-China Bilateral Agreement for Clean Vehicles.
Electric Drive Technologies R&D		
• Support projects at the National Laboratories to conduct research of high temperature materials, devices, and components including interfaces and interconnects that enable innovative power electronics designs such as use of wideband gap semiconductors; and advanced motor materials and configurations to eliminate rare earth materials. Efforts will emphasize materials and processes for manufacturing to reduce cost with improved performance and reliability to accelerate commercialization. • Initiate three to four new projects through a FOA for Electric Drive Technologies Development to focus on advances in low cost vehicle motors. These projects will	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
develop and demonstrate advanced electric machine designs, technologies, materials, and production pathways to significantly lower cost. Of particular interest are projects that emphasize materials-based developments, which can enable meeting performance targets for specific power, power density, and cost.		

Vehicle Technologies
Energy Efficient Mobility Systems

Description

The Energy Efficient Mobility Systems (EEMS) subprogram supports early-stage research to enable industry innovation that improves efficiency of the overall mobility system. Recent analysis by DOE indicates that the future energy impact of connected and autonomous vehicles may be quite large, ranging from a potential 60% reduction in overall transportation energy use to a 200% increase in energy consumption. EEMS will apply complex modeling and simulation expertise, experience with big data, and high-performance computing capabilities unique to DOE national laboratories to explore the energy impact of emerging disruptive technologies such as connected and autonomous vehicles, information-based mobility-as-a-service platforms, and advanced powertrain technologies to identify opportunities for industry and consumers to realize energy efficiencies at the transportation system-level. The EEMS subprogram consists of two primary activities: the SMART Mobility National Laboratory Consortium and high performance computing-enabled data analytics, but also builds upon Vehicle Technologies work in advance powertrains, controls and EV charging.

The SMART Mobility National Laboratory Consortium will push the boundaries of understanding the energy efficiency and fuel use reduction impacts from future mobility technologies and applications, and conduct pioneering research and development of mobility solutions that benefit the U.S. economy and improve American competitiveness in the transportation sector. Efforts within SMART (**S**ystems and **M**odeling for **A**ccelerated **R**esearch in **T**ransportation) are organized into five coordinated research pillars, representing a multi-disciplinary approach that is beyond the scope or capability of a single company or organization:

1. Connected and Automated Vehicles - research focuses on understanding the energy efficiency opportunity presented by new vehicle connectivity and automation solutions, including simulation and validation of how these technologies will perform in real-world operation.
2. Mobility Decision Science - research evaluates the interaction between new mobility options and human decision-making to develop transportation choices that American consumers will support.
3. Urban Science - research considers the unique transportation challenges faced by American cities, including the interactions among travelers, infrastructure, and the built-in environment.
4. Advanced Fueling Infrastructure – research evaluates optimization opportunities for fueling infrastructure required to support future mobility scenarios, in order to inform infrastructure investments that drive consumer adoption and improve return-on-investment.
5. Multimodal Transport - research evaluates passenger and freight flows, including first/last mile services and modal interfaces to support the efficient and seamless multi-modal transport of people and goods.

The high performance computing-enabled data analytics effort will research how to apply artificial intelligence, machine learning and big data tools to vehicles and transportation. The exponential growth in available transportation-related data presents opportunities to evaluate and improve mobility and energy efficiency at the city and regional transportation network level, but challenges exist in management, analysis, and visualization of these large and complex data sets. DOE and its National Laboratories are highly qualified and well positioned to use their unique expertise in artificial intelligence, machine learning and high-performance computing to develop actionable information from big data to identify the most promising research pathways leading to more energy efficient transportation systems. High performance computing-enabled data analytics represents a targeted effort that merges the exploratory findings of the SMART Mobility Consortium, specific data sets from public and private entities, and unparalleled computic and analytical resources to solve specific transportation energy challenges faced by cities, states, and regions of the U.S.

Energy Efficient Mobility Systems

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Vehicle Systems $30,600,000	**$0**	**-$30,600,000**
Energy Efficient Mobility Systems $0	**$12,200,000**	**+$12,200,000**
Vehicle Systems		
• Complete final SuperTruck I projects and initiate up to four new SuperTruck II projects to develop energy-efficient powertrain technologies that will improve commercial vehicle freight hauling efficiency of heavy-duty Class 8 long-haul vehicles by 100 percent in 2020, compared to a 2009 baseline, through systems-level improvements and to demonstrate applicability and cost-effectiveness of these technologies to heavy-duty Class 8 regional-haul vehicles.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
• Provide a vehicle systems context in support of Vehicle Technologies' component-level R&D activities. Enhance advanced vehicle models and simulation capabilities by developing and validating higher-fidelity models based on test data from the Advanced Powertrain Research Facility.	• Support advanced transportation system modeling and simulation to vet complex future mobility scenarios and identify areas for pre-competitive R&D to provide cost-effective mobility choice to consumers. Provide minimal updates to Autonomie vehicle level modeling.	• Modeling and simulation will shift focus from vehicle-level model development to transportation system-level simulation tools, with only basic level functionality maintained for vehicle level models.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• In coordination with industry partners, support National Laboratory project to conduct lab and field testing of two new emerging advanced electric-drive vehicle models by incorporating them into the Advanced Vehicle Testing & Evaluation (AVTE) fleet, and disseminate data regarding performance and fuel consumption benefits. This inter-laboratory collaborative research is focused on conducting repeatable, structured experiments of advanced vehicles, vehicle systems, and component technologies to create an unbiased database of performance, efficiency, and system response.	No funding is requested.	• The Advanced Vehicle Testing & Evaluation (AVTE) activity will conclude in FY 2017.
• Provide technical support for PEV standards development, and promote international harmonization of vehicle codes and standards through participation in key standards development organizations.	• No funding is requested.	• PEV charging and related research activities moved to the Battery and Electrification Technologies subprogram.
• Continue vehicle/grid integration R&D efforts by supporting three vehicle-specific projects and additional foundational work proposed through the Grid Modernization Laboratory Consortium, coordinated with other EERE and DOE offices to ensure synergy and optimal integrated impact.	• No funding is requested.	• PEV charging and related research activities moved to the Battery and Electrification Technologies subprogram.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Support the development of enabling technologies, including thermal management of vehicle powertrains and cabin loads, aerodynamic drag reduction designs, and advanced high-power wireless charging systems.	• No funding is requested.	• PEV charging and related research activities moved to the Battery and Electrification Technologies subprogram. Research on thermal management and aerodynamic drag reduction will conclude in FY 2017.
Energy Efficient Mobility Systems		
• See Outreach subprogram chapter (funded by the Analysis key activity in FY 2016).	• Develop modeling and simulation tools through five projects utilizing the SMART Mobility National Laboratory Consortium. Projects will create new understanding of the energy efficiency opportunities related vehicle connectivity and automation, urban transportation and infrastructure changes, mobility decision science, advanced fueling infrastructure, and new forms of multi-modal transport across both passengers and freight. • Utilize high performance computing to develop new analytical tools and methods capable of managing, analyzing, and visualizing large and complex transportation data sets. This work will identify future research pathways and provide the knowledge companies and other third parties can use to develop mobility energy efficiency opportunities.	• The initial foundational analysis work from FY 2016 (from the former Outreach, Deployment, and Analysis subprogram) will be expanded to five projects across the SMART Mobility Lab Consortium. Projects will expand from analysis to full model and simulation development, including detailed simulation studies and model validation for transportation systems in specific cities and regions. Advanced analytical tools at the national labs will be used on big data problems related to mobility to identify opportunities to improve transportation energy efficiency.

Description

The Advanced Engine and Fuel Technologies subprogram supports early-stage R&D to improve our understanding of, and ability to manipulate, combustion processes, generating knowledge and insight necessary for industry to develop the next generation of engines and fuels. Co-Optimization of higher-efficiency engines and high performance fuels utilizing the fundamental knowledge and new understanding created by this subprogram has the potential to improve light-duty fuel economy by 50 percent (35% from advanced engine research and 15% from co-optimization with fuels percent compared to 2009 gasoline vehicles). The subprogram supports cutting-edge research at the National Laboratories, in close collaboration with academia and industry, to strengthen the knowledge base of high-efficiency, advanced combustion engines and fuels.

The Advanced Engine and Fuel Technologies subprogram will utilize unique facilities and capabilities at the National Laboratories to develop knowledge, new concepts and research tools that industry can use to develop advanced combustion engines and co-optimize fuels that will provide further efficiency improvements. These unique facilities include the Combustion Research Facility at Sandia National Lab, Advanced Photon Source at Argonne National Lab, Institute for Integrated Catalysis at Pacific Northwest National Lab and the Spallation Neutron Source at Oak Ridge National Lab along with their high performance computing resources. The subprogram will work closely with the DOE Office of Science to utilize their basic research results.

The subprogram has three major activities: predictive modelling, experimental combustion including fuels and engine, and emissions control.

Predictive, high fidelity models will be developed to simulate the fundamental physics of fuel injection sprays, heat transfer, turbulence and combustion phenomena using high performance computing resources at the National Labs to achieve results comparable to the detailed experiments. The subprogram will conduct fundamental early-stage research of fuel properties utilizing chemical kinetics modeling of different molecules to determine their impact on combustion efficiency and emissions. Numerical routines will be developed for models that can reduce the computational time required for high fidelity engine models making them viable as engine design tools for industry.

Experimental combustion projects will develop data to establish quantitative relationships between fuel properties and efficiency improvement potential for engines operating in advanced compression ignition combustion and multi-mode spark ignition/compression ignition regimes. Advanced laser, high intensity X-Ray and neutron-based optical diagnostics will be conducted to determine how fuel injection, air mixing and combustion take place in the engine and how emissions are formed. In combination, the knowledge from this research will enable companies to develop a new generation of low-temperature combustion engines.

The subprogram will conduct experiments using high-resolution microscopy for understanding chemical reactions at the atomistic level on catalyst surfaces and within the catalysts that have the potential to reduce emissions at low exhaust temperatures. New catalyst compounds with higher activity and lower costs will be synthesized and models to simulate the chemical reactions rates using high performance computing will be developed.

The knowledge and high fidelity models developed for combustion, fuels and emission control will be available for use by industry to design, develop and deploy more efficient and clean engines. Industry does not have the unique facilities and scientific capabilities that are available at the National Laboratories to conduct this early-stage R&D. The subprogram will utilize cost-shared CRADAs to address critical industry needs while still leveraging unique National Laboratory resources.

Advanced Engine and Fuel Technologies

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Combustion Engine R&D $37,141,000	**$0**	**-$37,141,000**
Fuel and Lubricant Technologies $22,500,000	**$0**	**-$22,500,000**
Advanced Engine and Fuel Technologies $0	**$22,000,000**	**+$22,000,000**
SuperTruck II		
• Initiate up to four new competitively-awarded SuperTruck II projects to develop energy efficient powertrain technologies that will improve commercial vehicle engine efficiency by 30 percent and freight hauling efficiency of heavy-duty Class 8 long-haul vehicles by 100 percent in 2020, compared to a 2009 baseline vehicle, and demonstrate applicability and cost-effectiveness of these technologies to heavy-duty Class 8 regional-haul vehicles.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
Predictive Modeling of Engine Combustion and Fuels		
• Develop computer simulations of combustion and emission control processes that utilize the high performance computing capabilities at the National Laboratories. • Continue to develop chemical kinetic models of fuels at the National Laboratories to optimize combustion and reduce emissions.	• Conduct development of computer simulations of engine combustion using high performance computing facilities at the National Laboratories. Includes: modeling of fuel injection sprays, intake and exhaust flows and heat transfer processes, chemical kinetics mechanisms of combustion and fuels, and air-fuel motion and mixing inside an engine along with movement of internal engine components.	• Eliminate projects at the National Laboratories for modeling combustion using large eddy simulation (LES), Computational Fluid Dynamics (CFD) model development and modeling of multi-cylinder engines.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Lean/Next Generation Compression Ignition Combustion Engines and Fuels R&D and Heavy-Duty Combustion Engines and Fuels R&D		
• Support laser- and X-Ray-based National Laboratory research of advanced combustion concepts and fuel injection systems to improve engine efficiency.	• Conduct single-cylinder engine research at National Laboratory projects supporting only fundamental advanced combustion and fuels research in optically accessible engines with in-cylinder optical and laser diagnostics, and X-Ray- and neutron-based fuel injection spray visualization providing experimental validation for simulation models.	• Eliminate projects at the National Laboratory for light-duty optical diesel engine, multi-cylinder high-energy ignition systems.
• Investigate the fundamental impact of fuel properties on engine performance and how they can be optimized to achieve higher efficiency and lower emissions in support of the Co-Optimization of Fuels and Engines effort.	• Continue 35 of 53 National Laboratory consortium projects on the Co-Optimization of Engines and Fuels with emphasis on fuel properties research to remove barriers to higher vehicle efficiency. Research will focus on performance tailored blendstocks, including bio-derived, synthetic and petroleum-based blend stocks that will increase vehicle efficiency. Engine research will focus on advanced conventional and kinetically controlled engine technologies with advanced fuels that enable maximum engine performance.	• Co-optima research will focus on the eight fuel compounds (of the original 40) that passed initial screening to determine final fuel properties and values needed for spark ignition and multi-mode compression ignition engines as well initial determination of fuel properties needed in medium and heavy-duty advance compression ignition engines. Sub-program will eliminate 18 projects at the National Laboratories in the following research areas: impact of exhaust gas recirculation on high-load operation; reactivity controlled compression ignition engine research; octane on demand; small volume fuel tester; and low-speed pre-ignition research.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• In collaboration with the Bioenergy Technologies Program and Vehicle Technologies Advanced Combustion Engine R&D subprogram, and building on prior-year activities, support the Co-Optimization of Fuels and Engines effort, with a focus on cost-effective, bio-derived, high-octane fuels for high-performance, efficient engines, as well as fuel quality metrics.	• The FY 2018 Budget Request reflects continued funding for the Co-Optimization of Engine and Fuels effort. These activities have been incorporated into the unified line above.	• The FY 2018 Budget Request reflects continued funding for the Co-Optimization of Engine and Fuels effort. These activities have been incorporated into the unified line above.
• Initiate up to three new competitively awarded projects to develop enabling technologies for engine and powertrain systems to support the achievement of breakthrough thermal efficiencies while meeting emissions standards.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
Catalyst R&D for Emission Control/After-Treatment		
• Support National Laboratory development and characterization of 150^{o} C catalysts in combination with hydrocarbon and NOx traps to enable low-temperature combustion engines to meet EPA Tier 3 standards with low energy penalty.	• Continue support for 3 of 4 cost-shared CRADAs with industry to address advanced emission control technologies.	• Eliminate diesel engine related selective catalytic reduction research and focus on emission control for gasoline lean and advanced compression engines.
• Continue to develop emission control systems at the National Laboratories to reduce NOx from lean-burn gasoline and other advanced engines that have low exhaust temperatures.	• Continue support at the National Laboratories for fundamental emission control catalyst characterization research to reduce NOx and hydrocarbons with low-cost materials (to replace expensive platinum group metals) that will be 90 percent effective at low temperatures (150^{o}C) and have low energy penalty to enable efficient lean-burn gasoline and other advanced engines. • Continue development of computer models needed to produce the kinetics and mechanistic information for simulating chemical reactions within and on catalyst surfaces for predicting the performance of lean NOx trap (LNT) and selective catalytic reduction (SCR) catalysts, as	• Eliminate research on the impact of fuels on emission control performance and durability.

	well as advanced multi-functional emission control systems.	
FY 2016 Enacted	**FY 2018 Request**	**Explanation of Changes FY 2018 vs FY 2016**
• Develop and validate performance of gasoline particulate filters at the National Laboratories to enable efficient direct-injection engines to meet future particulate standards.	• No funding is requested.	• Eliminate support for particulate filtration research and development of multi-functional emission control system to reduce volume and weight.
Lubricants and Gaseous Fuels		
• Design prototype system of drivetrain lubricants capable of cost-effectively delivering a three percent fuel economy benefit relative to SAE 10W-20 engine oil in vehicle testing.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
• Conduct RD&D supporting direct injection engines using propane or liquefied petroleum gas.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
U.S. - China Clean Energy Research Center (CERC) - Medium/Heavy Duty		
• The U.S.-China CERC-TRUCK (TRUCK= Truck Research Utilizing Collaborative Knowledge) will focus on potential R&D collaboration for medium and heavy duty vehicles in 6 areas including Engine/Powertrain System, Hybrid Electric Powertrain, Energy Management (System Level Efficiency Improvements), Aerodynamic Drag Reduction, Vehicle Weight Reduction, and Tire Rolling Resistance. The Center facilitates joint research and development on clean energy by teams of scientists and engineers from the U.S. and China.	• Continue research through the U.S. – China Clean Energy Research Center (CERC) at the same funding levels as FY 16 and same research focus.	• Activities continue from FY 2016.

Vehicle Technologies
Materials Technology

Description

The Materials Technology subprogram supports vehicle lightweighting and improved propulsion (powertrain) efficiency through early-stage R&D to discover and further understanding of how to manipulate and use novel materials and enabling technologies for industry to develop and deploy light- and heavy-duty vehicles. The research focus is on activities that have a high degree of scientific or technical uncertainty, or that are too far from market realization to merit sufficient industry focus and critical mass. The Materials Technology subprogram accomplishes its technical objectives through research programs with academia, National Laboratories, and industry.

Subprogram activities focus on the following cost and performance targets:

- Enable a 25 percent weight reduction for light-duty vehicles including body, chassis, and interior as compared to a 2012 baseline at no more than a $5/lb-saved increase in cost;
- Validate a 25 percent improvement in high temperature (300° C) component strength relative to components made with 2010 baseline cast aluminum (AL) alloys (A319 or A356) for improved efficiency light-duty engines.

Lightweight Materials Technology research supports research in advanced, high-strength steels, aluminum (Al) alloys, magnesium (Mg) alloys, carbon fiber composites, and multi-material systems with potential performance and manufacturability characteristics that greatly exceed today's technologies. This focus area supports projects to address materials and manufacturing challenges spanning from extraction to assembly with an emphasis on establishing tools, capabilities, and material standards for light- and heavy-duty vehicles. The sole focus of this activity in FY 2018 will be to support National Laboratory research and joint work with industry through the Lightweight Materials (LightMAT) Consortium established under the Energy Materials Network (EMN), on dissimilar material joining, assembly technologies, and corrosion prevention that enable the use of various lightweight materials as best suited for particular applications. The complex metallurgical, chemical and mechanical behavior associated with the formation of intermetallic compounds, electrochemical reactions and stress-strain states that exist in joining are not well understood and are outside of the core competencies of industry. VTO also has the unique ability to create partnerships between academia, national labs, and all aspects of the industrial supply chain in order to find solutions to these technical challenges that any one entity could not achieve on their own.

Propulsion Materials Technology supports research to develop higher performance materials that can withstand increasingly extreme environments and address the future properties needs of a variety of relevant high efficiency powertrain types, sizes, fueling concepts, and combustion modes. The activity will continue to apply advanced characterization and multi-scale computational materials methods, including high performance computing, to accelerate discovery and early-stage development of cutting-edge structural and high temperature materials for cleaner, more efficient powertrains. In FY 2018, research areas will include (1) Higher Strength Materials for Elevated Temperatures, (2) Lightweight Powertrain Alloys, and (3) Integrated Computational Materials Engineering (ICME) tools that combine high performance computing(HPC) capabilities, multi-length (atoms to components) material models, and boundary layer resolved thermo-kinetic models. Each of these activities require the use of very high-resolution characterization tools and high performance computing facilities, which are beyond the capabilities available to most industry partners.

Materials Technology
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Lightweight Materials Technology		
• Support up to four new competitively awarded projects to develop and demonstrate weight reduction technologies (including materials and manufacturing processes) for SuperTruck II, emphasizing improvements in freight efficiency of heavy-duty vehicles.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
• Initiate up to five competitively awarded projects for advanced materials manufacturing R&D effort that will use high-performance computing and high-throughput experimentation to accelerate the development of high strength, highly formable, corrosion resistant automotive magnesium sheet alloys, in support of the Advanced Materials Crosscut. The goal of this work is to demonstrate significant acceleration in deploying magnesium sheet production, forming, joining, and corrosion protection technologies into the vehicle manufacturing supply chain.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
• National Laboratory work supports vehicle weight reduction across all vehicle classes through development of precursors and processes for low-cost carbon fiber composites.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• National Laboratory work will focus on dissimilar material joining and assembly technologies that enable the use of various lightweight materials as best suited for particular applications. • Initiate up to five new competitively awarded projects to address specific challenges in assembly and galvanic corrosion of multi-material joints.	• Support 3 to 4 National Laboratory research projects addressing durability of joining dissimilar materials including the use of high-performance computing and high-throughput materials experimentation to accelerate the development of novel joining technologies and concepts, including modeling and simulation of multi-material joints and processes. • Maintain industry involvement through 4 to 5 new CRADA projects utilizing the existing Lightweight Materials (LightMAT) Consortium under the Energy Materials Network (EMN).	• Initiate three new projects to address specific early stage scientific challenges limiting the incorporation of Mg alloys and carbon fiber reinforced plastic (CFRP) into multi-material structures, and to develop predictive modelling on aging of adhesives.
Propulsion Materials Technology		
• Develop materials and manufacturing processes for up to four new competitively awarded SuperTruck II projects, targeting cost-effective freight efficiency improvements via materials enabled powertrain efficiency increases and weight reductions through increased power density.	• No funding is requested.	• This activity will be terminated in FY 2018. Some activities related to execution of prior year appropriations will continue until completion.
• Conduct National Laboratory research in High Temperature Engine Materials, with a focus to operate in regimes necessary for the commercialization of engines with increased efficiencies.	• Support one to two National Laboratory research projects in High-Strength, High-Temperature Engine Materials and Integrated Computational Materials Engineering (ICME) tools to accelerate the development of advanced powertrain alloys for next generation high efficiency engines. Projects will build on strengthening high temperature diffusion barrier mechanisms identified through atomic scale characterization and large super cell density functional theory calculations carried out at high performance computing facilities.	• Downselect from eight to one or two National Laboratory projects. Industry lead cast alloy development projects for high efficiency engines and low temperature catalyst materials will be completed using prior year funds. • National Laboratory efforts within Propulsion Materials supporting discovery and characterization of new catalyst materials will be discontinued.

Vehicle Technologies
Outreach

Description

The Outreach subprogram supports only statutory requirements in FY 2018. These include the following activities:

- Alternative Fuels Data Center (AFDC): As required by section 405 of the Energy Policy Act of 1992, Vehicle Technologies maintains a public information program, the AFDC, which provides technically-accurate, objective, and relevant information about the costs and benefits of alternative fuels in motor vehicles. Funds will support minimal annual updates to alternative fuel vehicle, alternative fuel, and infrastructure information, including cost calculators, station locators, and other online tools.
- Fuel Economy Guide: As required by the Energy Policy and Conservation Act of 1975, funds will support the publication and distribution of the Fuel Economy Guide, in partnership with the Environmental Protection Administration. Minimal support for publishing and distributing the Fuel Economy Guide.
- State and Alternative Fuel Provider Fleet Requirements: As mandated by sections 501 and 507 of the Energy Policy Act of 1992, the State and Alternative Fuel Provider Fleet regulatory program requires certain state government and alternative fuel provider fleets to acquire alternative fuel vehicles as part of their annual light-duty vehicle acquisitions. Funds will support work with covered fleets to implement the program, including activities to track compliance, grant exemptions and alternative compliance waivers as necessary, and manage credits that fleets may earn and "bank" for future use.
- Reflecting the shift in focus to early-stage research and development, no funding is requested for Clean Cities-related activities, Alternative Fuel Community Partner Projects, Advanced Vehicle Technology Competitions, and other later-stage development and deployment activities in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

Outreach
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Outreach, Deployment, and Analysis $48,400,000	**$0**	**-$48,400,000**
Outreach $0	**$2,000,000**	**+$2,000,000**
Alternative Fuel Data Center and Fuel Economy Guide		
• In accordance with "Public Information Program" requirements in section 405 of the Energy Policy Act of 1992, update alternative fuel, vehicle, and infrastructure information, including station locator and cost calculator tools, incentives database, and fuel-savings strategy information in the Alternative Fuels Data Center. • In accordance with requirements in the Energy Policy and Conservation Act of 1975, publish and distribute the new model year Fuel Economy Guide, in partnership with the U.S. Environmental Protection Agency, Update data, tools (e.g., Find-a-Car, Fuel Cost & Savings Calculator), and fuel economy information on www.fueleconomy.gov.	• Update alternative fuel vehicle, alternative fuel, and related infrastructure information in the Alternative Fuels Data Center in accordance with "Public Information Program" requirements in section 405 of the Energy Policy Act of 1992. • Publish and distribute the new model year Fuel Economy Guide, in partnership with the U.S. Environmental Protection Agency, in accordance with requirements in the Energy Policy and Conservation Act of 1975.	• Funds supporting the provision of alternative fuel information will be limited to what is necessary for annual updates to alternative fuel, vehicle, and infrastructure information, in accordance with section 405 of the Energy Policy Act of 1992. • Funds supporting vehicle fuel economy information will be limited to the new model year Fuel Economy Guide, in accordance with requirements in the Energy Policy and Conservation Act of 1975.
State and Alternative Fuel Provider Fleet Regulatory Program		
• Review and process petitions to designate new alternative fuels under EPAct 2005. Implement legislative changes to the EPAct 2005 fleet activities, as needed.	• State and Fuel Provider Fleet Requirements: Track covered fleet compliance with annual alternative fuel vehicle acquisition requirements, in accordance with Title V of the Energy Policy Act of 1992.	• Support the State and Fuel Provider Fleet regulatory program (formerly included in the Legislative and Rulemaking key activity) to track covered fleet compliance with requirements established in Title V of the Energy Policy Act of 1992.
Clean Cities Activities and Technical Assistance		
• Document petroleum reduction impact of Clean Cities' activities of at least 1.15 billion gallons per year. • Expand technical and problem solving assistance to key stakeholders to help in overcoming specific market and technical barriers.	• No funding is requested.	• This activity will be terminated in FY 2018 to focus on early stage R&D. Some activities related to execution of prior year appropriations will continue until completion.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Alternative Fuel Community Partner Projects		
• Initiate Alternative Fuel Vehicle Community Partner projects. These projects will accelerate widespread introduction and adoption of commercially available advanced vehicle technologies to reduce U.S. dependence on petroleum, increase local fuel diversification, and catalyze adoption of clean transportation technologies. Up to two projects will be awarded with Federal funding leveraged by a minimum 50 percent cost share from private sector partners.	• No funding is requested.	• This activity will be terminated in FY 2018 to focus on early stage R&D. Some activities related to execution of prior year appropriations will continue until completion.
Advanced Vehicle Technology Competitions		
• Year two of a four-year collegiate engineering competition, EcoCAR 3. In year two, teams integrate their powertrains into vehicles, which must pass a comprehensive safety and technical inspection, and perform an on-road safety evaluation, which tests a baseline level of functionality from all powertrain components.	• No funding is requested.	• This activity will be terminated in FY 2018 to focus on early stage R&D. Some activities related to execution of prior year appropriations will continue until completion.
Analysis		
• Leveraging the unique analytical capabilities of National Laboratories and in cooperation with university partners, this activity supports the planning, execution, and communication of technology, societal, economic, and interdisciplinary analyses to inform program planning and technology investment decisions. FY 2016 Analysis activities also support foundational exploratory and prioritization analyses for Transportation as a System (TAAS).	• No funding is requested.	• Analysis activities are moved to the new Analysis subprogram in FY 2018. TAS funding is moved to the new Energy Efficient Mobility Systems subprogram in FY 2018.

Vehicle Technologies
Analysis

Description

The Analysis subprogram supports the planning and execution of technology, economic, and interdisciplinary analyses to inform and prioritize Vehicle Technologies research portfolio planning, including activities such as research target-setting and benefits estimation. Funds will support vehicle data, modeling and simulation, and integrated and applied analysis activities using the unique capabilities, analytical tools, and expertise resident in the Department's national laboratory system. These activities explore advancements in vehicles and transportation systems and resulting energy impacts to inform early stage R&D and offer analytical direction for potential and future research investments.

Analysis

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Analysis $0	**$2,000,000**	**+$2,000,000**
• Please reference the Outreach subprogram chapter (formerly Outreach, Deployment, and Analysis) for FY 2016 activities.	• Using analytical capabilities and tools unique to DOE national laboratories, funds will support vehicle data, modeling and simulation, and integrated and applied analysis activities to inform and prioritize research portfolio and program planning. Funds will support 5-10 projects with national laboratory partners, leveraging DOE-developed analytical models.	• In FY 2018, Analysis will comprise its own subprogram for greater transparency. • Funds are limited to only mission-critical analyses necessary to inform and prioritize Vehicle Technologies technology investments and research portfolio planning.

Vehicle Technologies
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $3,300,000	**$0**	**-$3,300,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Vehicle Technologies Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Vehicle Technologies
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Vehicles - Batteries - Reduce the cost of batteries for Electric Vehicles (EVs) ($/kWh)**		
Target	$ 250 /kWh	$ 225 /kWh	$ 200 /kWh
Result	Exceeded - 245	TBD	TBD
Endpoint Target	$125/kWh by 2022		

Bioenergy Technologies

Overview

The Bioenergy Technologies Program focuses on early stage applied research and development (R&D) to strengthen the body of knowledge enabling industry to develop and deploy sustainable bioenergy technologies capable of producing price-competative biofuels from non-food sources of biomass[1] such as wastes and agricultural residues, and from energy crops like switchgrass, and algae. The program's primary focus is on R&D to produce "drop-in" biofuels that are compatible with existing fueling infrastructure and vehicles across a range of transportation modes, including renewable-gasoline, -diesel, and -jet fuels. The program also supports early stage R&D on converting biomass into high-value chemicals and products that can enhance the economics of biofuel production and improve energy security by displacing demand for oil imports.

Recent DOE studies found that by 2030, the U.S. has the resource potential to sustainably produce 1 billion dry tons of non-food biomass resources without disrupting agricultural markets for food and animal feed.[2] This could produce approximately 50 billion gallons of biofuels (25% of U.S. transportation fuels), while also producing 50 billion pounds of high-value chemicals and products, 85 billion kWh of electricity (enough to power 7 million homes) and contributing 1.1 million jobs and $259 billion to the U.S. economy by 2030.[3] However, realizing these projections requires industry to develop and transfer novel technologies and approaches to biomass conversion grounded in the knowledge generated through early-stage R&D efforts.

The Bioenergy Technologies Program employs EERE's technology readiness scale (TRL) to prioritize work within a subprogram and across the portfolio. Early stage R&D falls within TRL's 1-3, defined as Basic Principles observed through Proof of Concept with demonstrated technical feasibility at immature or laboratory scale. Aspects of TRL 4-5 are also considered early stage when gathering necessary performance data that will reduce risk to enable industry to scale up the technology. This can mean small integrated piloting of technologies to evaluate the interface between process steps that can highlight issues that require further TRL 1-3 evaluations. BETO is not focused on TRL 6-9, which involves prototype demonstrations through to pre-commerical demonstations in operational environments. For further discussion on TRL levels see EERE's TRL Guide[4]

Highlights of the FY 2018 Budget Request

- The Feedstock Supply and Logistics subprogram will support a consortium of national laboratories and industry experts at the interface between feedstock-conversion-integration, named the Feedstock-Conversion Interface Consortium (FCIC). The consortium is responding to lessons learned in engineering scale up and re-focusing R&D efforts on developing a fundamental understanding of feedstock preprocessing and the molecular deconstruction of polymers within biomass. This highly technical, early-stage R&D will improve downstream conversion efficiency and throughput, and will provide tools for the entire industry to build upon as they develop new markets for biomass. Due to the level of scientific uncertainty and extended commercialization timeline, it is unlikely industry will invest significant resources in the near term.The Advanced Algal Systems subprogram will focus on early-stage applied research focused on new strain development, approaches to culture management, and methods of crop protection to enable industry to improve algae productivity.
- The Conversion Technologies subprogram will support transformative R&D in synthetic biology of engineered organisms through the Agile BioFoundry and explore the potential of new novel catalysts through the Chemical Catalysis for Bioenergy (ChemCatBio) consortium to enable industry to improve yields and selectivity of renewable chemicals and drop-in biofuels.
- The Advanced Development and Optimization subprogram will support collaborative R&D with the Vehicle Technologies program on the Co-Optimization of Fuels and Engines (Co-Optima) to develop bio-based fuels/additives with the potential to enable a 15-20% fuel economy gain when blended with petroleum and used in high-efficiency engines.

[1] As recommended in the Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure, April 2015.
[2] U.S. Billion Ton Update https://energy.gov/sites/prod/files/2016/12/f34/2016_billion_ton_report_12.2.16_0.pdf.
[3] Rogers, J. N.; Stokes, B.; Dunn, J.; Wu, M.; Haq, Z.; Baumes, H. *An assessment of the potential products and economic and environmental impacts resulting from a billion ton bioeconomy.* Biofuels Bioprod Bioref **11***(1):*110–128 *(*2017*).* *http://onlinelibrary.wiley.com/doi/10.1002/bbb.1728/full*

- The Strategic Analysis and Cross-cutting Sustainability subprogram will analyze pathways and R&D strategies capable of achieving an ultimate target of $2 per gallon gasoline-equivalent (gge) and conduct sustainability research to identify and fill knowledge gaps related to increasing bioenergy production without detriment to food security, air, land and water resources.

The Bioenergy Technology Program coordinates its outcome-driven applied R&D activities with the U.S. Department of Agriculture and six other Agencies through the Biomass Research and Development Board to leverage resources and avoid duplication across the federal government.

Bioenergy Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Bioenergy Technologies				
Feedstocks	46,500	—	0	-46,500
Feedstock Supply and Logistics[b]	0	—	6,000	+6,000
Advanced Algal Systems[c]	0	—	5,000	+5,000
Conversion Technologies	85,500	—	34,600	-50,900
Advanced Development and Optimization (formerly Demonstration and Market Transformation)	75,100	—	6,000	-69,100
Strategic Analysis and Cross-cutting Sustainability	11,000	—	5,000	-6,000
NREL Site-Wide Facility Support	6,900	—	0	-6,900
Total, Bioenergy Technologies	**225,000**	**224,571**	**56,600**	**-168,400**

SBIR/STTR:

- FY 2016 Transferred: SBIR $3,761,000; STTR $564,000
- FY 2017 Projected: SBIR $3,754,000; STTR $563,000
- FY 2018 Request: SBIR $1,811,000; STTR $255,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[b]In prior years, the Feedstocks subprogram included Advanced Algal Systems and Feedstock Supply and Logistics activities. The FY 2016 Enacted Budget for just the Feedstock Supply and Logistics activity was $16.5 million. As part of the FY18 request, Bioenergy Technologies is splitting these activities into two separate subprograms. Therefore, the FY18 request of $6M for the Feedstock Supply and Logistics subprogram represents a decrease of $10.5 million in a comparable budget structure.

[c]In prior years, the Advanced Algal Systems activities were included within the Feedstocks subprogram. The FY 2016 Enacted Budget for just the Advanced Algal Systems activities was $30 million, resulting in a $25 million decrease in a comparable structure.

Budget Crosswalk ($K)

FY 2016 Budget Structure	Proposed FY 2018 Budget Structure					
	Feedstock Supply and Logistics	Advanced Algal Systems	Conversion Technologies	Advanced Development and Optimization	Strategic Analysis and Cross-cutting Sustainability	Total
Bioenergy Technologies						
Feedstocks	6,000	5,000	-	-	-	**11,000**
Conversion Technologies	-	-	34,600	-	-	**34,600**
Demonstration and Market Transformation	-	-	-	6,000	-	**6,000**
Strategic Analysis and Cross-cutting Sustainability	-	-	-	-	5,000	**5,000**
NREL Site-Wide Facility Support (Moved to F&I)	-	-	-	-	-	**-**
Total, Bioenergy Technologies	**6,000**	**5,000**	**34,600**	**6,000**	**5,000**	**56,600**

Bioenergy Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Bioenergy Technologies	
Feedstocks: To better align with program management, the Feedstocks subprogram has been separated and replaced by two distinct subprograms on "Feedstock Supply and Logistics" and "Advanced Algal Systems." Existing activities will be managed under the new subprograms, respectively.	**-46,500**
Feedstock Supply and Logistics: The Budget shows an increase of $6 million for the Feedstock Supply and Logistics subprogram when compared to the FY 2016 Enacted Budget due to a structural change. However, this reflects a decrease of $10.5 million for Feedstock Supply and Logistics subprogram activities, under a comparable budget structure. The subprogram will prioritize early stage research on solids handling solutions, such as using particle mechanics research to predict flow behavior of biomass.	**+6,000**
Advanced Algal Systems: The Budget shows an increase of $5 million for Advanced Algal Systems compared to the FY 2016 Enacted. However, this reflects a $25 million decrease for algae R&D under a comparable budget structure. The subprogram will prioritize early-stage research that shows the greatest promise for improving algae productivity, namely strain development and culture management.	**+5,000**
Conversion Technologies: The Budget includes a reduction of $50.9 million to Conversion Technologies, focusing R&D activities on the most promising early-stage R&D opportunities that are too risky or far from commercial application to merit industry investment. In FY 2018, the Conversion Technologies subprogram will focus on early-stage applied research through the Agile BioFoundry, the Chemical Catalysis for Bioenergy (ChemCatBio) multi-laboratory consortium, and enabling modeling and process control methods for biomass conversion processes. Funding will support early stage applied conversion research in the areas of lignin valorization, biological upgrading of intermediates, technologies for separation and purification of fuels and chemicals, and innovative approaches to address wet wastes for the conversion of biomass to fuels and chemicals.	**-50,900**
Advanced Development and Optimization (formerly Demonstration and Market Transformation): No funding is requested in FY 2018 for pilot-scale and demonstration scale projects. Funding is limited to early stage R&D in conjunction with the Vehicle Technologies Program on the Co-optimization of Fuels and Engines (Co-Optima).	**-69,100**
Strategic Analysis and Cross-cutting Sustainability: Less funding is requested to develop and maintain models and tools that have reached a level of maturity and are being used by BETO, industry, and other institutions to analyze market, economic, and environmental aspects of advanced bioenergy technologies. The program will initiate analyses on pathways and R&D strategies capable of enabling industry to achieve a cost target of $2/gge.	**-6,000**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program.	**-6,900**
Total, Bioenergy Technologies	**-168,400**

Description

The primary goal of the Feedstock Supply and Logistics subprogram is to generate the knowledge upon which industry can develop and improve strategies, technologies, and systems to provide consistent-quality feedstock to the biorefinery. The subprogram is currently targeting innovations that have potential to enable a total average delivered cost of $84/dry ton[2] (from $137/dry ton in FY 2014 in 2014 dollars) and modeled potential for 205 million dry tons in FY 2018. This subprogram focuses early-stage R&D on supply and logistics challenges that industry will need to overcome as advanced biofuels are further developed and deployed. Industry R&D develops technology improvements to strengthen their place in current markets. In contrast, the Feedstock Supply and Logistics subprogram is focused on early stage R&D that will enable the formation of new markets. For example, this subprogram has made a significant investment to date in understanding fundamental feedstock characteristics, and will continue conducting early-stage research to develop quality specifications for feedstock, so that industry can build upon that research to develop these new markets. This work is beyond the risk threshold of industry—there is a recognized high risk in shifting from the current industry focus on minimizingpreprocessing costs to advanced preprocessing approaches that enable the efficient movement of biomass solids into the reactor for full conversion to fuels and chemicals. In addition, companies are disincentivized from sharing any solutions they develop with their competitors. Therefore, it is the proper role of government to develop an understanding of the fundamentals of feedstock preprocessing and handling for broad dissemination to enable growth of the entire industry, and the bioeconomy generally.

Past accomplishments for this program include publishing the 2016 *U.S. Billion-Ton Update Volume 1 and Volume 2*,[4] disseminating yield data for energy crops from the Regional Feedstock Partnership [5], and enabling logistics cost reductions through high-tonnage feedstock logistics projects focused on equipment development and demonstration, the results of which are publicly available on the Bioenergy Knowledge Discovery Framework.[6] In FY 2016, the program initiated two new projects from the Advanced Logistics II Funding Opportunity Announcement (FOA) to lower the delivered cost of short rotation woody crops and to study how blending feedstocks at industrial scale could increase the amount of available feedstock within a given delivery radius using newly developed equipment. This equipment development work is later-stage demonstration and will not be continued.

Partners at DOE National Laboratories have continued to make substantial progress toward the subprogram's cost targets. Researchers at Idaho National Laboratory (INL) have achieved $21/dry ton modeled cost reduction in feedstock logistics costs through improvements in harvest and collection, high-moisture pelleting and drying, and dockage associated with meeting the carbohydrate content specification. These efforts have put the subprogram on the trajectory of meeting its 2017 goal of $84/dry ton. Targets beyond 2017 incorporate additional feedstock to conversion pathways, as well as focus on increasing volumes of feedstock available at this cost target. Analyzing both the impacts of preprocessing on feedstock characteristics and the impacts of those characteristics on conversion performance is critical to identifying the most cost-effective ways to deliver high-quality, easily convertible biomass to the biorefinery and address technical and logistical risks for the national supply chain.

In FY 2018, the Feedstock Supply and Logistics subprogram will focus its efforts improving understanding and exploring concepts to overcome challenges at the feedstock-conversion interface. The Program will establish the Feedstock-Conversion Interface Consortium to conduct early-stage research to fill gaps in knowledge of the chemistry and physics of

[2] Verified in 2017. Verification in for a modeled potential of 285 million dry tons accessible at $84/dry ton in 2022 in a national model.

[4] https://energy.gov/sites/prod/files/2016/12/f34/2016_billion_ton_report_12.2.16_0.pdf; https://energy.gov/eere/bioenergy/downloads/2016-billion-ton-report-volume-2-environmental-sustainability-effects

[5] Nationwide Crop Suitability Modeling of Biomass Feedstocks. Michael Halbleib, Chris Daly, David Hannaway. 2012 Sun Grant National Conference. http://sungrant.tennessee.edu/NR/rdonlyres/8CF2F183-8B72-4E48-9E2F-BCAB4E421C7A/3630/46Halbleib_Mike.pdf

[6] http://www.bioenergykdf.net.

the manipulation of biomass during feedstock preprocessing and the molecular deconstruction of polymers within biomass in order to enable the scalability of feedstocks and maximizing robust yields of intermediates. Specifically, models and tools will be developed that use characterization data to inform the proper selection, design, and integration of feedstock and conversion technologies for optimum performance. The subprogram will not fund scale-up activities, but will conduct fundamental research on particle mechanics and novel engineering approaches to reduce the size of biomass material to improve flowability and will evaluate mass transfer of multi-phase systems as is present in conversion unit operations. The subprogram will also conduct advanced characterization and computational tool development to address feedstock variability, and will analyze the tradeoff between quality and affordability in feedstock delivery systems to inform the feasibility of feedstock quality specifications. The subprogram will therefore expand the knowledge base on solids handling as well as develop new bulk solids measuring techniques, and will initiate work to develop control logic and systems to improve the robustness and flexibility of integrated preprocessing and feeding systems.

Feedstock Supply and Logistics (formerly Feedstocks)

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Feedstocks $16,500,000	**$0**	**-$16,500,000**
Feedstock Supply and Logistics $0	**$6,000,0000**	**+$6,000,000**
• Update to the *U.S. Billion Ton Study* (last published in FY 2011). A 5-year resource analysis effort in collaboration with the Regional Feedstock Partnership will be used to update yield projections. • Develop engineered storage practices to reliably handle variable feedstock moisture content; promote drying in storage to improve stability and reduce preprocessing costs by over $4. This research includes demonstration of individual advanced system processing components.	• Standing up consortia among six national laboratories to conduct early-stage research to improve biorefinery operation and reliability towards a 90% time-on-stream (operational reliability) goal. • As part of this consortia, labs will continue early-stage applied research on feedstock characterization, logistics, and handling, and specifically on how to move and handle elastic, compressable solids, such as bioenergy feedstocks. Due to a prioritization on early-stage research, no FY 2018 funding is requested for the process demonstration unit (PDU) within the Biomass Feedstock National User Facility at the Idaho National Laboratory (INL). The DOE support for the PDU will be terminated.	• Discontinue activities related to high-moisture feedstocks, in-field sensors for real-time assessment of biomass quality, and assessment of our nation's biomass resources. • Core feedstock logistics research to inform supply chain analysis and develop innovative solutions to the challenges faced by U.S. biorefineries will shift towards first principles and models, and away from demonstration and scale-up.

Bioenergy Technologies
Advanced Algal Systems

Description

The Advanced Algal Systems subprogram supports early-stage R&D of algal biomass[7] production and logistics systems. Algal biomass warrents consideration as a potential energy resource due to its ability to grow quickly (including in non-potable water), use waste resources, and produce fuel precursors. Algal biofuels could potentially contribute up to 5 billion gallons per year — about 25 percent of the current jet fuel market — to the U.S. domestic production of liquid transportation fuels by 2030.[8] In recent years, knowledge outputs from research by the subprogram has improved capabilities to predict, breed, and select the best-performing algal strains; tools to monitor and control system inputs in a dynamic and integrated fashion; methods to harvest algae at high-throughputs; and processes to extract and convert more algal biomass components into fuels.[9]

In FY 2017, the Advanced Algal Systems subprogram issued a funding opportunity announcement (FOA) focused on increasing the productivity of algae through the use of advanced biological tools to develop enhanced strains and cultivation practices. The program met its 2017 milestone to model the potential of 1,000,000 metric tonnes of algae biomass to be produced annually in the U.S. and is on track to achieve its 2018 milestone to verify biofuel yields of 2,500 gallons of intermediate per acre per year through prior investments. With FY 2018 appropriations, the subprogram will fund work to develop stable algal cultures that produce high yields, resist predators, and are suitable for cultivation in farming operations. "Development of Integrated Screening, Cultivar Optimization, and Validation Research" (DISCOVR) consortium, a partnership among 4 National Laboratories will contribute to subprogram goals by developing an integrated screening platform for the rapid discovery of high productivity strains with potential for year-round outdoor cultivation via crop rotation. At the end of FY 2018, this consortium will deliver a complete pond scale evaluation of predation resistance of four algal strains against eight deleterious species using standard quantitative assay. The goal of this work is to identify resilient algal strains and improve understanding of predation resistance. In addition, the subprogram will initiate work to establish a quantitative framework of algal biomass composition/energy/productivity for all model species to enable industry to identify and isolate viable co-products.

In FY 2018, the subprogram will continue to integrate the latest technological advances into robust state of technology techno-economic analyses. This work allows the subprogram to more effectively target pre-competitive R&D strategies that have the greatest potential to enable businesses to successfully pursue larger-scale integration and demonstration.

These activities are pre-commercial, pre-competitive activities that enhance the state of technology beyond current industry areas of focus. The algae industry remains focused on commercial operations for small scale (100 acres or less) farms producing high value-nutraceuticals. The success of these activites will enable industry to scale up to the next level and begin accessing energy markets when the technology and market conditions are aligned.

[7] The term algae refers to microalgae, cyanobacteria (often referred to as "blue-green algae"), and macroalgae (or seaweed).
[8] Ryan Davis, Daniel Fishman, Edward Frank, et al., "Renewable Diesel from Algal Lipids: An Integrated Baseline for Cost, Emissions, and Resource Potential from a Harmonized Model," Argonne National Laboratory, ANL/ESDA/12-4 (2012), http://greet.es.anl.gov/publication-algae-harmonization-2012.
[9] U.S. Department of Energy. 2016. *National Algal Biofuels Technology Review.* Office of Energy Efficiency and Renewable Energy. Bioenergy Technologies Office. Available at: https://www.energy.gov/eere/bioenergy/downloads/2016-national-algal-biofuels-technology-review

Advanced Algal Systems

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Feedstocks $30,0 00,000	**$0**	**-$30,000,000**
Advanced Algal Systems $0	**$5,000,000**	**+$5,000,000**
• The Advanced Algal Systems subprogram will fund competitive R&D project work to achieve programmatic targets for productivity and yield (up to 3 projects focused on pre-pilot integration of production and pre-processing). • Targeted R&D along the algal biofuels supply and logistics chain will continue through the National Laboratories.	• Early stage and precompetitive applied research to increase algal productivity will be the focus of the portfolio. Activities will take place at 5 national laboratorieswith a goal of identifying and investigating strains that robustly and reliably outperform the FY16 state of technology for algae cultivation.	• Later-stage downstream algae R&D activities, including harvesting, the conversion interface, and integration studies, such as those previously conducted at the Algae Testbeds will be discontinued. • All funding will support early-stage R&D at the National Laboratories.

Bioenergy Technologies
Conversion Technologies

Description

The Conversion Technologies subprogram pursues early-stage applied R&D to generate knowledge that enables industry to develop and deploy technologies for converting biomass feedstocks into transportation fuels and related bioproducts that enable biofuels. Conversion research explores concepts in both biological (using biological organisms) and thermochemical (using heat and chemical processes) routes to convert biomass into "drop-in" hydrocarbon fuels and fuel components. Given the diversity of biomass resources and the range of useful end-products, there is no single, superior conversion process or pathway. Therefore, the program prioritizes research on a portfolio of promising feedstock-flexible conversion technologies capable of producing "drop-in" fuels with the greatest potential to displace gasoline, diesel, and jet fuel.

Because each pathway is at a different level of technical maturity, the subprogram focuses early-stage research on multiple candidate technologies that can potentially meet the goal of cost competitive fuels and coproducts (less than $3/gge), while allowing industry to build on the knowledge generated by the subprogram by developing and deploying novel technology for each market opportunity. Multi-lab consortia have been established to leverage and coordinate the unique capabilities within the national laboratories,and to facilitate active collaboration with industry and/or universities. In order to enable multiple possible process configurations or pathways, the enabling applied research is divided into four main areas: Deconstruction and Fractionation, Synthesis and Upgrading, Enabling technologies, and Integration & Intensification. Due to the emergent nature of the bio-based fuel and products economy, industry is ordinarily focused on immediate barriers facing their individual technology and not willing or able to fund research that is foundational, cross-cutting or that benefits the industry at large e.g. generalized tools and techniques for catalyst or organism development, analytical methods that benefit many processes, etc. These are the areas on which the BETO conversion research focuses as a unique and industry-enabling role of government.

Deconstruction and Fractionation

FY 2018 activities in Deconstruction and Fractionation will primarily support the Feedstock-Conversion Interface Consortium in collaboration with the Feedstock Supply and Logistics subprogram. Efforts will be focused on understanding how feedstock properties and pretreatment operations affect the ability to reliably feed a wide variety biomass into conversion processes of all types. This has been a significant barrier encountered by several pioneer commercial-scale biorefinery projects. There is a recognized high risk in shifting from the current industry standard of minimal preprocessing to an advanced preprocessing of biomass feedstock to enable the efficient movement of biomass solids into the reactor for full conversion to fuels and chemicals. Although these projects, in some cases, are approaching solutions to their specific challenges, they are not likely to research the underlying phenomena to ensure robustness of solutions and enable many or all future biorefineries. Addressing and understanding these issues will enable industry writ-large to develop and deploy a wide variety of potential processes to convert biomass to fuels and chemicals.

Synthesis and Upgrading

Conversion Technologies subprogram has established the Chemical Catalysis for Bioenergy Consortium (ChemCatBio; www.chemcatbio.org). ChemCatBio was designed to increase industry access to the unique capabilities of DOE National Laboratories and tackle fundamental catalyst research problems related to production of biofuels. The goal of ChemCatBio is to reduce the time and cost required to develop novel catalytic materials by targeting both pathway-specific and overarching catalysis challenges. ChemCatBio has produced more than 50 innovative, peer-reviewed publications since its inception. It conducts early-stage applied research around challenge areas identified through consultation with U.S. industry and through public listening days. A high impact example is a recent study that uses computational modeling and *operando* X-ray absorption (expensive resources not readily available to industry) to elucidate the active site of a copper catalyst used for making jet fuel. The published results can be used by industry to facilitate development of their own catalysts. In addition to industrially relevant publications, ChemCatBio facilitates collaboration with industry through its website. Chemcatbio.org showcases National Laboratory capabilities and establishes a single point of contact to simplify industry access to National Laboratory catalysis expertise and other essential infrastructure.

Applied research efforts on the conversion of lignin (lignin utilization) to fuels and products will be expanded in FY 2018. Lignin makes up almost a third of biomass by weight but due to its chemical complexity, it is generally burned for heat and power rather than being converted into valuable fuels or products. Applied research on producing higher-value products

or "valorizing" (creating higher value from) lignin is essential to improve the economics of fuel production. Recent progress on this long-standing scientific grand challenge has set the stage for very rapid progress toward economic viability as more fundamental issues continue to be addressed.

Enabling Technologies

The development of an Agile BioFoundry continues to be a key activity in the Enabling Technologies area in FY 2018. The effort leverages recently developed synthetic biology tools (ways to engineer organisms) to improve efficiencies in the conversion of biomass to fuels and products. Currently, the industrial biotechnology sector scales up processes on a case-by-case basis, without tools that can be extrapolated to multiple host organisms, pathways, and applications. The Agile BioFoundry connects distributed capabilities across multiple National Laboratories to develop processes for engineering biology enabling predictable-design by establishing a robust biomanufacturing set of principles, which use standardized DNA elements and commercially relevant and optimized host organisms. The BioFoundry will produce a set of tools and organism development packages that would be easily transferred to the biotechnology industry, enabling the scaling of multiple, high-impact chemicals in multiple, industrially-relevant host organisms at half the time and cost while significantly improving conversion efficiency. In FY 2016-2017, a seed project demonstrated production of a strategically important precursor to nylon at 30 g/L (300x the original target, 1000.1 mg/L), in an industrially-relevant organism. In addition to the biological engineering success, the seed project demonstrated the functionality of the National Laboratory Design-Build-Test-Learn framework which will enable efforts toward future target products to proceed more rapidly through machine learning. FY 2018 funds will continue to develop these unique, publically accessible R&D tools, data and robust organisms, to enable the pursuit of additional R&D in support of the bioeconomy.

Additional key elements in the Enabling Technologies area include the Consortium for Computational Physics and Chemistry (CCPC) and the Bioprocessing Separations (BioSep) consortium. CCPC is an element of the larger ChemCatBio consortium. It will continue to work with catalyst scientists and biologists to understand the fundamental mechanisms underlying catalyst and enzyme behavior. Specifically the new knowledge developed with CCPC and incorporated into models that will accelerate R&D, help target new applied research, and aid in design of advanced catalysts, enzyme systems, and reactors. BioSep focuses on separations which are often expensive, energy intensive and complex aspects of processes. BioSep will coordinate with separations activities in the Advance Manufacturing Office to leverage common resources and approaches; however, BioSep will focus on separation problems unique to biofuel and bioproducts processes.

Enabling Technologies also includes continued work on pre-competitive applied research challenges in areas such as analytical methods, process measurement and control, computational modeling, and technical analysis to provide an invaluable informational resource for industry and lay the foundation for a successful domestic bioeconomy. These areas were all identified in the 2017 Bioenergy Technologies Program Peer Review as being of key interest and value to industy, and as adding significant value and efficiency to both existing and future biomass conversion processes.

A small number of innovative on-ramps to the portfolio will be examined as part of Enabling Technologies in FY 2018. Early stage research will be conducted at the national labs on production of advantaged bioproducts that take advantage of the unique structure of biomass to enable more efficient and less-costly manufacture of better-performing chemicals and materials. This will be a collaborative effort which will ultimately require diverse expertise and likely partnerships between National Laboratories, academia, and industry. Other subprogram research activities will include the continued development of technologies that enable industry to accelerate the economic and innovative conversion of wet waste feedstocks, including biosolids which are a significant environmental issue in many areas, to biofuels and bioproducts. Applied research in converting wet waste to energy will focus on modifications to anaerobic digestion processes to produce useful intermediates that can be converted to fuels and chemicals. Preliminary investigations to develop Carbon Advanced Research fuels and materials will also befunded at the national laboratories examining the potential for renewable energy to convert waste CO_2, CO, or other useful intermediates. Carbon advanced research would potentially increase the range of gaseous feedstocks considered capable of making renewable-fuels and –chemicals reducing risk and driving rincreased conversion efficiency.

Integration and Intensification

In FY 2018, critical applied research will also focus on several pre-competitive areas. These include thermochemical, biological, and hybrid approaches to convert biomass into fuels and chemicals. Specifically, applied research hurdles for the integration of bio-oils and other intermediates into existing petroleumrefineries and petrochemical plants such as characterization methods for bio-based oils and analysis of the fate of such oils in the refinery will be addressed. This effort will enable biofuels to

leverage the existing petroleum infrastructure by inserting biofuel intermediate directly into existing refineries, rather than creating separate production and distribution channels for biofuels. Prior work between national laboratories and industry has indicated that there are economic and overall fuel yield benefits to pursing this approach. In addition, a focused number of pathways for biological deconstruction and upgrading of biomass to cost-competitive fuels and higher value co-products will continue to be explored.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Conversion Technologies $85,500,000	**$34,600,000**	**-50,900,000**
• Finalize facility modification for conversion pathways verification in FY 2017. Possible modifications are for pyrolysis and upgrading, biological upgrading or indirect liquefaction. • Continue to advance the integration of bio-oils into petroleum refineries (a conversion topic in the FY 2016 Demonstration and Market Transformation FOA that builds on the FY 2013 BOSC FOA), clean sugar production, and other issues identified in FY 2014 workshops. • Continued R&D on issues such as catalyst lifetime, separations, and carbon efficiency to demonstrate technical performance corresponding to a mature, modeled thermochemical conversion cost $3/GGE of combined blendstock (this does not include a $1/GGE feedstock contribution to the total fuel cost). • Continued R&D on low-temperature conversion routes producing biobased hydrocarbon fuels and chemicals (such as biological and chemical catalyst development) will demonstrate technical performance corresponding to a modeled, mature conversion cost contribution of $5.30/GGE in 2017 on a pathway to a $3/GGE cost in 2022. • Initiate R&D in a diverse set of pathways (MEGA-BIO FOA) that produce renewable chemicals derived from biomass that enable more competitive biofuels and support the DOE Clean Energy Manufacturing Initiative.	• Fund the 9-Lab Agile BioFoundry consortium which will leverage the tools of synthetic biology (ways to engineer organisms) to enable the biotechnology industry to ultimately bring new of biologically-derived molcules to market at half the current time and cost. [d]In FY18 this will include reaching titers of 500 mg/L in industrially-relevant conditions. • Fund the 5-Lab ChemCatBio consortium, which leverages unique U.S. DOE national lab capabilities to address technical risks associated with accelerating the development of catalysts and substantially improving conversion efficiencies of biomass-derived fuels and chemicals with the goal of reducing time and cost of catalyst development by 2x . *In FY18, demonstrate accelerated materials design cycle through integration of experiments, computation, and theory. • Fund national lab projects to develop analytical methods to address critical process control, analytical standards, and materials issues for application in the bioindustry. • Fund national laboratory early stage re applied research on lignin valorization which can reduce effective biofuel cost by nearly $2/gge. In FY18, an initial target product/methodology will be identified for further development. • Fund innovative technology seed projects at national laboratories in the areas of wet wastes use, performance advantaged bioproducts, and to develop carbon advanced research fuels to increase conversion efficiencies.	• Due to the successful verification of fast pyrolysis and upgrading technology in FY 2017 funding for pilot scale work, no funding is requested in FY 2018 for this particular technology area. • Due to advances in the integration of bio-oils into petroleum refineries, funding and activity in biomass pyrolysis has been reduced. • No funding is requested in FY 2018 for later stage process integration and intensification work (TRL 4-5). • While applied research for catalyst lifetime, separations, and carbon efficiency are important to bio-based processes, funding for applied bioenergy separations research will be scaled back to allow focus on higher priority areas. This will increase the time required to realize the benefits of these technologies. • Routes to biobased hydrocarbon fuels and products - certain research areas will be eliminated, such as aerobic upgrading strategies and cellulase development. • All funding will support early-stage R&D conducted by the National Laboratories including targeted “CRADA” partnerships.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	• A lab call will also be issued to begin development of modular reactors for constructive use of liquid or gaseous wastes.	

*Will include use of Cooperative Research and Development Agreements (CRADAs) or similar agreements in calls for innovative concepts and a channel for DOE National Laboratories to work with industry and/or universities to amplify these applied research consortia.

Bioenergy Technologies
Advanced Development and Optimization
(Formerly Demonstration and Market Transformation)

Description

The Advanced Development and Optimization (ADO) subprogram will continue collaboration with the Vehicle Technologies program on the Co-Optimization of Fuels and Engines (Co-Optima) in FY 2018 to strengthen the knowledge-base upon which industry can develop and deploy the next generation of fuels and engines that are co-optimized to enable higher efficiency and performance. Through a collaborative R&D effort at the National Laboratories including industry stakeholders the project explores phenomena related to fuel chemistry – fuel property – engine performance relationships and investigate preferential fuel options that have potential to maximize domestic fuel sourcing. The effort leverages unique properties available from domestic biofuels, such as high octane and sensitivity, that enable higher engine efficiency. Accomplishments in FY 2016 and FY 2017 include the development and application of a rigorous fuel property selection process to identify eight high-potential fuel candidates, from an initial list of 470, that have the properties to maximize the efficiency and performance of advanced spark ignition engines and could be produced from domestic biomass resources. In addition, eight university FOA selections supporting the project goals were initiated in FY 2017. Activities in FY 2018 will focus on the investigation of novel bio-based fuel molecules and mixtures that provide properties that maximize the efficiency and performance of advanced compression ignition (ACI) engines and will result in a list of high-potential fuel candidates for ACI engines that provide desirable fuel properties.

The ADO portfolio also includes pilot, demonstration, and pioneer integrated biorefinary projects fully funded by prior appropriations. The subprogram will continue to manage these existing projects through to completion. Reflecting the shift in focus to early-stage R&D, no new projects will be solicited or award in FY 2018.

Advanced Development and Optimization

Formerly Demonstration and Market Transformation

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Demonstration and Market Transformation $75,100,000	**$6,000,000**	**-69,100,000**
• Fund three integrated pilot-scale facilities to enter into Phase 2 to build, commission and test their performance which will result in direct feedback to related applied research programs. • Continue managing commercial biofuel manufacturing facilities under the Defense Production Act (DPA) interagency effort between DOE, the U.S. Department of Agriculture, and U.S. Department of Defense. • Conduct fuel characterization of cellulosic ethanol and/or other hydrocarbon biofuel blends and work with the Vehicle Technologies Program on the co-development of engine technology components. These biofuel blends will also be tested for compatibility with existing infrastructure systems, for impacts on engine efficiency and tailpipe emissions, and for the development of various codes and standards for certification. • A leading DOE national laboratory will work with industry partners to develop and refine codes and standards to ensure the safety of people and assets involved in biomass handling, processing, and storage; as well as to meet market expectations for sustainability.	• Collaborate with the Vehicle Technologies Program on the Fuel and Vehicle Systems Co-Optimization of Fuels and Engines effort. Fund the consortium of nine National Laboratories to conduct early stage R&D and related analysis to identify and evaluate the most promising biofuel candidates to enable fuel economy and efficiency targets for advanced diesel and multi-mode spark iginition engines. • Contiune early stage R&D at four universities focused on fuel characterization and performance prediction, which were fully funded through prior year appropriations.	• Co-Optimization of Fuels and Engines activities will have reduced emphasis on fuels to enable spark ignition engines, which have nearer term market introduction potential and are better understood by industry. • No new integrated biorefinery pilot, demonstration, or pioneer projects will be solicited or awarded. Management of existing projects will continue to completion. • In FY 2016, the Bioenergy Technologies Office completed its funding obligations under the DPA initiative. • National Laboratory-led work with industry partners to develop and refine industry safety and sustainability codes and standards will conclude in FY 2017.

Bioenergy Technologies
Strategic Analysis and Cross-cutting Sustainability

Description

Strategic Analysis activities provide quantitative analysis to inform the Bioenergy Technologies Program's decisions regarding the future direction and scope of its early-stage research and development (R&D) portfolio. Activities include techno-economic, resource, market, impact, and risk assessments that provide the analytical basis for planning and assessing progress against program goals and cost targets. System-level analyses identify the key gaps in existing knowledge and help identify areas where additional research could have the greatest impact. Decision support, data management, and analytical tools allow the program to identify and validate performance goals, and measure progress toward these goals.

Through the Cross-cutting Sustainability activities the subprogram works with National Laboratories, industry, and academic partners to improve understanding of and focus the research portfolio on potential win-win solutions that maximize both economic and environmental value. For example focusing research on underproductive aspects of agricultural and forestry systems and leveraging the ability of biomass to improve degraded soil and water resources.

Key accomplishments of the Strategic Analysis and Cross-cutting Sustainability subprogram include the creation of state-of-the art tools and analyses to answer critical questions about the potential economic and environmental benefits of bioenergy. For example, the Water Analysis Tool for Energy Resources (WATER) evaluates the use and quality of water in the production of biofuels and could ultimately help improve efforts to use water more efficiently if utilized by industry. The Jobs and Economic Development Impact (JEDI) models estimate the economic impacts of constructing and operating biofuel plants at the local and state levels. Additional models developed through the subprogram include the Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation Model (GREET), the Biomass Scenario Model (BSM), and the Landscape Environmental Assessment Framework (LEAF). In FY 2018, Cross-cutting Sustainability and Strategic Analysis activities will make necessary improvements to critical models and tools (including GREET, BSM, WATER, and LEAF) and apply these tools to conduct high-priority analyses focused on understanding the potential economic and environmental effects of novel bioenergy technologies and processes if developed and deployed by industry. Tasks in FY 2018 will include analyzing pathways and R&D strategies capable of enabling industry to achieve an ultimate cost target of $2/gge and sustainability research to identify and fill knowledge gaps related to improved yields and sustained, year-after-year productivity of agricultural land and forests without detriment to food security, air, land and water resources.

Strategic Analysis and Cross-cutting Sustainability

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Strategic Analysis and Cross-cutting Sustainability $11,000,000	**$5,000,000**	**-6,000,000**
• Maintain and enhance key models and tools for internal and external use (including GREET, Biomass Scenario Model (BSM), WATER footprint tool, and LEAF). • Assess economic, environmental, social, and industry impacts of a significantly larger bioeconomy concept. Identify conditions under which at least one technology pathway for hydrocarbon biofuel production will meet BETO's GHG emissions performance goals.	• Make necessary improvements to critical models and tools (including GREET, BSM, WATER, JEDI and LEAF) and apply models to conduct high-priority analyses—expected to result in at least 10 peer reviewed publications and technical reports—focused on understanding the potential economic and environmental effects of novel bioenergy technologies and processes. • Analyze pathways and R&D strategies capable of enabling industry to achieve an ultimate cost target of $2/gge. • Conduct sustainability research to identify and fill knowledge gaps related to increasing bioenergy production without detriment to food security, air, land and water resources.	• Less funding is requested to develop and maintain models and tools that have reached a level of maturity and are being used by BETO, industry, and other institutions to analyze market, economic, and environmental aspects of bioenergy scenarios.

Bioenergy Technologies
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $6,900,000	**$0**	**-$6,900,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Bioenergy Technologies Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Bioenergy Technologies
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Biomass - Thermochemical** - Reduce modeled thermochemical conversion cost of a combined gasoline and diesel production ($/gallons of gasoline equivalent)		
Target	$3/gge	$2.47/gge	N/A
Result	Met -3	TBD	TBD
Endpoint Target	$2.47/gge by 2017 ($2011)	Measure is being discontinued in FY18 as overarching verification goal is scheduled to be met by the end of FY17.	

Hydrogen and Fuel Cell Technologies

Overview

Hydrogen can be produced from diverse domestic resources, such as natural gas, oil, coal, and biomass, as well as from water splitting using any form of electricity. Fuel cell electric vehicles using hydrogen can achieve significantly higher efficiencies than combustion engines, and domestically produced hydrogen enables energy independence. Stationary hydrogen and fuel cell technologies can also improve energy security and reliability providing responsive back-up power and other electric and fuel distribution services. However, the highly specialized hydrogen and fuel cell industry is still nascent, and lacks the capabilities and critical mass to address technology challenges that have the potential for high return on investment, but which present a significant degree of scientific or technical uncertainty across a relatively lengthy time span.

The Hydrogen and Fuel Cell Technologies Program's focus is on early-stage R&D to investigate novel hydrogen and fuel cell technology concepts that could enable American energy independence and domestic job growth through industry development and deployment. To be cost competitive with gasoline on a cents-per-mile driven basis, the cost of hydrogen from domestic resources needs to be less than $4/gge and the cost of a durable fuel cell system needs to be less than $40/kW. While the focus is on transportation, the research concurrently benefits stationary fuel cells – such as backup power, reversible fuel cells, or small-scale tri-generation of fuel, heat and power that provide resiliency and impact multiple sectors. In all cases, the key issue is the need for significant reductions in cost and improvements in performance and durability. The scope is technology-neutral and feedstock-flexible, emphasizing low- and medium-temperature fuel cells applicable to transportation, as well as enabling electricity and fuel distribution reliability and flexibility through cost-competitive hydrogen production, delivery and storage technologies.

Highlights of the FY 2018 Budget Request

The Fuel Cell R&D subprogram will focus on early-stage fuel cell component R&D with potential for transportation and cross-cutting applications. Early-stage research areas will include catalysts, membranes, and fuel cell performance and durability (including R&D to address electrode, mass transport and degradation issues). In addition, the program will conduct proof-of-concept testing, technical analysis and high-throughput combinatorial R&D, coupled with high-performance modeling to enable the development of platinum group metal (PGM) free catalysts and electrodes. Funding will focus on research that industry either does not have the technical capability to undertake or is too far from market realization to merit sufficient industry focus and critical mass.

The Hydrogen Fuel R&D subprogram's efforts will emphasize applied materials research and early-stage component and process development to enable industry to develop and deploy novel hydrogen production, delivery, and storage technologies capable of utilizing a diversity of domestic energy resources. The subprogram's hydrogen production and delivery efforts will emphasize longer-term renewable options that can completely revolutionize the energy sector, such as advanced water splitting. Activities will include exploring innovative liquefaction and dispensing technologies, as well as low-cost station and vehicle storage of hydrogen. The subprogram's onboard hydrogen storage efforts will continue to focus on applied early-stage R&D for advanced storage technologies offering high-energy density at lower pressures compared to today's systems.

The highlights in FY 2018 are National Laboratory-led efforts, offering state-of-the-art multi-lab core capabilities that leverage university and industry partners to dramatically accelerate materials breakthroughs and innovations in early-stage R&D. These efforts are aligned with the DOE Energy Materials Network (EMN) which serves as an effective model for organizing national lab capabilities around specific technology challenges with the potential to increase industry engagement such as through Cooperative Research and Development Agreements (CRADAs) and Strategic Partnership Projects (SPPs, also known as Work for Others). Focus areas through 'virtual' lab-led consortia, are:

- ElectroCat for PGM-free catalysts,
- HydroGEN for advanced water-splitting, and
- HyMARC for hydrogen storage materials research.

In addition, the program will include early-stage R&D activities to support the H2@Scale concept, which lays a framework for the potential wide-scale production and utilization of hydrogen to address key issues such as grid resiliency and energy

security. By generating hydrogen when power generation exceeds load, electrolyzers can prevent curtailment of renewables and enable grid stability (providing marketable services to the grid), while also producing a feedstock for end users across a variety of sectors. The FY2018 Budget will invest in fundamental and transformational materials R&D to enable industry to develop and deploy viable and safe technologies, including advanced liquefaction and delivery technologies.

The Program will discontinue market transformation activities in FY 2018, reflecting the shift in focus to early-stage transformative science and technology solutions and increased reliance on the private sector to fund later stage efforts related to market transformation.

Hydrogen and Fuel Cell Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Hydrogen and Fuel Cell Technologies				
Fuel Cell R&D	35,000	—	15,000	-20,000
Hydrogen Fuel R&D	41,050	—	29,000	-12,050
Manufacturing R&D	3,000	—	0	-3,000
Systems Analysis	3,000	—	1,000	-2,000
Technology Validation	7,000	—	0	-7,000
Safety, Codes and Standards	7,000	—	0	-7,000
Market Transformation	3,000	—	0	-3,000
Technology Acceleration	0	—	0	0
NREL Site-Wide Facility Support	1,900	—	0	-1,900
Total, Hydrogen and Fuel Cell Technologies	**100,950**	**100,758**	**45,000**	**-55,950**

SBIR/STTR:

- FY 2016 Transferred: SBIR $2,149,000; STTR $322,000
- FY 2017 Projected: SBIR $2,145,000; STTR $322,000
- FY 2018 Request: SBIR $1,440,000; STTR $203,000

[a]FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Hydrogen and Fuel Cell Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Hydrogen and Fuel Cell Technologies	
Fuel Cell R&D: In FY 2018, the subprogram will discontinue or significantly reduce later-stage and lower priority research on low PGM catalysts, balance of plant R&D, and system related operation and performance validation, and focus funding on early-stage innovations too far from market realization to merit sufficient industry investment such as identifying and testing PGM-free catalysts.	**-20,000**
Hydrogen Fuel R&D: In FY 2018, the subprogram will focus on early-stage applied materials R&D for hydrogen production, delivery and storage. The program will discontinue later-stage and lower priority research on development of low cost 700 bar composite tanks, storage balance of plant components, and cryo-compressed on-board hydrogen storage work. Work on near-commercial technology development for production and delivery of hydrogen is also discontinued as this type of work is more appropriately funded by industry.	**-12,050**
Manufacturing R&D: No funding is requested for this subprogram due to prioritization of early-stage R&D in Hydrogen Fuel and Fuel Cells subprograms.	**-3,000**
Systems Analysis: In FY 2018, the subprogram will focus on providing analysis to identify key areas in which to strategically prioritize early-stage R&D efforts and discontinue work to measure the program impacts, return on investment, infrastructure financing analysis, and state partnership support.	**-2,000**
Technology Validation: No funding is requested for this subprogram due to shift in focus to early-stage R&D.	**-7,000**
Safety, Codes and Standards: No funding is requested for this subprogram due to shift in focus to early-stage R&D on hydrogen fuel and fuel cells. Codes and standards support is discontinued as this type of work is more appropriately funded by industry. Safety considerations will continue to be an important parameter integrated into early-stage R&D projects and activities funded through the Hydrogen Fuel and Fuel Cell subprograms.	**-7,000**
Market Transformation: No funding is requested for this subprogram due to shift in focus to early stage R&D.	**-3,000**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-1,900**
Total, Hydrogen and Fuel Cell Technologies	**-55,950**

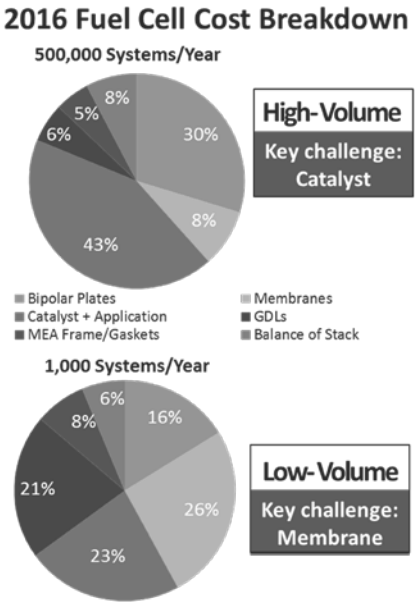
Description

The Fuel Cell R&D subprogram supports early-stage applied R&D to strengthen the body of knowledge upon which industry can develop and deploy technologies that improve the durability, reduce the cost, and improve the performance (e.g., power, efficiency, start-up time, transient response, etc.) of fuel cells. Key goals include validating concepts that reduce the modeled high-volume cost of automotive fuel cells to $40/kW and improve fuel cell durability to 5,000 hours (approximately 150,000 miles of driving) for automotive systems as an interim step towards the ultimate goal of enabling direct cost competitiveness with internal combustion engine light duty vehicles at $30/kW and 8,000 hours. Innovations resulting from subprogram activities have facilitated a more than 50 percent cost reduction in fuel cells developed and deployed by industry over the last decade. However, the current modeled automotive fuel cell cost is roughly $60/kW using state-of-the-art fuel cell technology projected to high manufacturing volumes (100,000 units/year) and the low-volume cost based on input from OEMs is estimated at roughly $230/kW, significantly higher than the $40/kW target. Similarly, the subprogram has enabled a four-fold increase in durability, now at over 4,000 hours, but an additional doubling is necessary to be comparable to incumbent technologies. These differences represent the potential for knowledge generated through early-stage R&D to foster substantial technology advances by industry. Funding is focused on scientifically challenging areas in which the potential return on investment is high but the time to commercialization is long and industry lacks the critical mass in expertise and the required specialized tools and facilities to make the necessary advances.

The planned early-stage R&D will focus on automotive applications with high potential for knowledge spillover benefits relevant to other uses such as distributed power (primary and backup), Auxiliary Power Units (APUs), and specialty vehicles While the focus is on polymer exchange membrane (PEM) fuel cells, the portfolio is technology neutral and projects may include exploration of alkaline membrane fuel cells, medium-temperature fuel cells such as phosphoric acid fuel cells, and higher-temperature fuel cells like molten carbonate fuel cells, as long as they are expected to contribute to the Program goals.

In FY 2018 the Fuel Cell R&D subprogram ($14 million) will focus R&D in the key areas of fuel cell components and materials, as well as fuel cell performance and durability. Figure 1 shows the primary contributors to cost based on state-of-the-art technology both at high volume and low volume, emphasizing the importance of catalysts, as well as other components such as membranes, bipolar plates, and gas diffusion layers (GDLs).[1] Today, the fuel cell industry relies entirely on platinum based catalysts and automakers have focused on commercializing vehicles rather than on game-changing early-stage research to displace platinum. Discovery and development of PGM-free catalysts and electrodes could reduce fuel cell stack cost by approximately 40 percent and mitigate U.S. dependence on South Africa, Russia, China and other countries for precious metal imports. Therefore, the subprogram will place particular emphasis on expediting the development of PGM-free catalysts and electrodes by streamlining private industry and university access to National Laboratory capabilities through a lab-led consortium, ElectroCat ($6 million), and further developing advanced high-performance computing, unique synthesis and characterization tools, and high-throughput combinatorial approaches focused on the development, processing, component integration, qualification and end-use of PGM-free catalysts and electrodes into membrane electrode

Figure 1 R&D Focuses on High Cost Areas



[1] Program Record, https://www.hydrogen.energy.gov/pdfs/16020_fuel_cell_system_cost_2016.pdf

assemblies (MEAs). These approaches will capture the effects of materials processing and end-use performance and will accelerate advanced materials R&D.

In addition, the subprogram will focus on low-technology readiness level (TRL)[1] component R&D such as alkaline and non-water dependent membranes, electrodes and component innovations (such as gas diffusion layers, bipolar plates, etc.) and MEA fabrication research innovations ($4 million). The remaining funds will focus on performance and durability, including the lab-led consortium FC-PAD (Fuel Cell Performance and Durability) which brings together National Laboratory capabilities with university and industry partners to develop a better foundational mechanistic understanding, and risk mitigation strategies to improve fuel cell mass transport and mitigate degradation (such as membrane and electrode-layer stabilization), as well as fuel cell modeling, proof of concept testing, safety research, and cost analysis to guide R&D prioritization ($4 million).

To maximize the impact of government funding and avoid duplication, R&D efforts will leverage outside activities, through coordination with other offices and agencies, such as the Office of Science, the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Defense (DoD). The subprogram will also continue to support peer reviews and relevant activities under the Energy Policy Act of 2005 (EPACT), including analyses supporting the Federal advisory committee (the Hydrogen and Fuel Cell Technical Advisory Committee) and the interagency working group. Consistent with rigorous peer review processes, competitive selection of projects in topic areas will be determined based on the relative merit, applicability, and potential for R&D progress, including lab calls and calls for CRADAs with industry and academia.

[1] https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04/@@images/file, p. 9

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Fuel Cell R&D $35,000,000	**$15,000,000**	**-$20,000,000**
• Develop innovative catalyst and electrode technologies and integrate state-of-the-art components in advanced MEAs to achieve 6.9 kW/g platinum group metal (PGM).		• No solicitations for new R&D projects. Cut efforts to increase catalyst activity per gram PGM in order to focus on early-stage research for PGM-free catalysts.
	• Develop cutting edge PGM-free catalysts to achieve a catalyst activity of at least 25 mA/cm^2, a 50 percent improvement to the 2016 value (16 mA/cm^2).	• Shift efforts to PGM-free catalyst research to enable breakthroughs in catalyst activity without the need for platinum.
• Accelerate PGM-free catalyst, electrode and MEA development through the application of high-performance computing, high-throughput combinatorial based approaches and advanced modeling, capturing the effects of processing and end-use performance, to facilitate meeting the fuel cell cost target of $40/kW.	• Continue research through a consortium approach to bring together expertise from National Laboratories, industry, and universities to accelerate PGM-free catalyst, electrode, and MEA development. High-throughput combinatorial experimental and advanced modeling tools will be implemented and coupled to baseline PGM-free catalyst research and development. Effort will enable meeting fuel cell cost targets of $40/kW.	• Down-select to approximately 60 percent of FY 2016 National Laboratory efforts to sustain state-of-the art core capabilities enabling future innovations. Focus on high throughput combinatorial and computational tools to enable accelerated materials development and discovery.
• Continue development of higher temperature fuel cell stack components, as well as system and subsystem components and system integration to extend fuel cell operational life beyond 50,000 hours.	• Investigate early-stage concepts for membranes and sub-stack components that are too far from market realization to merit sufficient industry focus.	• Investigate early-stage concepts for membranes and sub-stack components and reduce stack component development for improved performance and durability. • Cut FC-PAD lab consortium work and rely on industry funding for testing of component innovations, performance and durability. • Cut balance of plant (BOP) work which comprises roughly half of the fuel cell system cost in order to focus on fuel cell stack innovations and rely on industry for BOP work. • Based on the success of perfluorosulfonic acid based membrane R&D, transition this work to industry for ownership of further optimization efforts.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
		• Cut catalyst support R&D for low-PGM catalysts addressing degradation under fuel cell transient operating conditions.
• Issue Fuel Cell R&D solicitation and select three to six projects that will help achieve the fuel cell system cost ($40/kW) and durability (5,000 hours) metrics.	Use existing lab-led consortia and engage university and/or industry partners through CRADA calls.	• Focus will shift to long-term lab-led early-stage R&D. No industry funding solicitations will be issued. Industry and academia may partner with labs through the consortia mechanism or CRADA calls.

Description

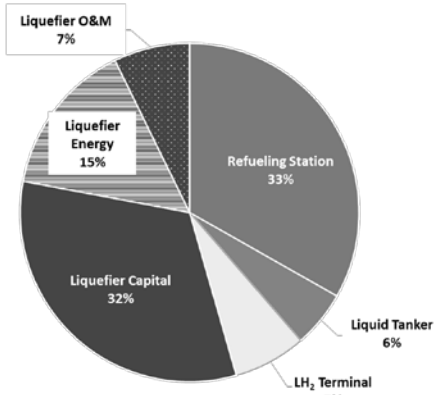
The Hydrogen Fuel R&D subprogram supports the program's mission through applied materials research and early-stage technology development to enable industry to develop and deploy novel hydrogen production, delivery, and storage technologies capable of utilizing a diversity of domestic energy resources. The overarching goal of the Hydrogen Fuel R&D subprogram is to enable viable options for hydrogen production, storage and delivery which would ultimately lead to industry development and commercialization, thereby enabling energy security, economic growth and environmental benefits.

A key subprogram goal to guide early R&D is the production of hydrogen from diverse domestic resources at a cost of less than $4/gge (dispensed and untaxed, at high volumes). This target represents the threshold at which hydrogen for FCEVs will be competitive on a cent-per-mile basis with conventional vehicles due to the inherently higher fuel efficiency of fuel cell electric vehicles. There are technical challenges associated with compression, storage, and dispensing (CSD) at the station that affect the final cost of hydrogen produced at both central and local point-of-use hydrogen production sites. The subprogram is pursuing advances in innovative and safe technologies for hydrogen delivery and station CSD that can enable industry to reduce costs, with the ultimate goal of reducing the delivery portion of the total hydrogen cost to less than $2/gge (at high volumes). High-level techno-economic and life-cycle analyses will continue to provide important guidance on subprogram priorities in foundational and applied research needs for maximizing the energy security, economic growth and environmental benefits offered by hydrogen fuel. The FY 2018 hydrogen fuels research scope will also include R&D to help address gaps in the body of knowledge identified in the H2@Scale initiative developed in FY 2017.

The hydrogen production component of the Hydrogen Fuel R&D subprogram will address applied materials research and early-stage technology development in the following key areas: (1) high temperature thermochemical hydrogen production, (2) direct photoelectrochemical (PEC) hydrogen production, and (3) low and high temperature electrolysis. By leveraging the DOE Energy Materials Network (EMN), the subprogram will emphasize R&D associated with the HydroGEN EMN consortium, including advanced high throughput/combinatorial approaches to enable rapid identification and development of promising materials essential for dramatic advances in water-splitting pathways. Specific research areas include new catalysts, membranes, electrode structures, energy conversion materials, and materials compatible with hydrogen at a broad range of temperatures and pressures. The HydroGEN EMN will include 6 core National Laboratories and CRADA calls to encourage partnerships with industry and academia ($10 million).

The subprogram's hydrogen delivery component will focus on R&D of innovative materials for emerging technologies in hydrogen compression, liquefaction, transport, storage & dispensing. Figure 2 shows the major cost contributors to liquid hydrogen delivery and key focus areas guiding R&D. In support of the H2@Scale initiative ($7 million), the subprogram will leverage National Laboratory capabilities in early-stage R&D of steel and polymeric materials for hydrogen delivery technologies (e.g. seals, valves, hose materials, sensors, self-healing materials, high throughput hydrogen-compatible compressors, etc.); and continue R&D of innovative materials systems for viable, highly efficient hydrogen liquefaction (e.g., magnetocaloric materials that completely eliminate the need for conventional mechanical liquefaction). The Hydrogen Fuels R&D subprogram primarily focuses on early TRL (3 or below) activities with minimal activities ($2 million) planned at TRL 4 for verifying components and subsystems to guide future early R&D efforts.

Figure 2 Liquid Hydrogen Cost Contribution to the $/kg Dispensed Cost



The Hydrogen Fuel R&D subprogram is also developing advanced technologies to enable efficient and cost-effective hydrogen storage systems, such as materials-based storage, with potential for significantly improved energy density and performance. The overarching goal of the program's hydrogen storage efforts is to enable a driving range of more than 300 miles (~500 km), while meeting the cost and performance requirements of current and future vehicle markets. Automakers

have recently started to lease and sell vehicles that can achieve a driving range of more than 300 miles with 700 bar compressed hydrogen. However, industry will need to develop and deploy advanced storage approaches to achieve this driving range across all platforms without compromising passenger and cargo space or performance, and at a cost that will be commercially viable. Through collaboration with industry, the subprogram has established onboard automotive storage density goals (for gravimetric and volumetric density) along with a long-term system cost target of $8/kWh. While some promising storage materials have been identified, no single material has been identified that meets all storage targets simultaneously, reinforcing the long-term nature of this materials R&D challenge. In FY 2018, the Program will focus on unique National Laboratory capabilities to advance hydrogen storage materials R&D, maintain U.S. scientific leadership, and enable industry to double the energy density compared to today's 700 bar systems.

To maximize the impact of government funding and avoid duplication, R&D efforts will leverage outside activities, through coordination with other offices and agencies, such as the Office of Science, NSF, NASA, and DoD. The subprogram will also continue to support peer reviews, safety R&D relevant to hydrogen production, delivery and storage, and relevant activities under EPACT, including analyses supporting the Federal advisory committee (the Hydrogen and Fuel Cell Technical Advisory Committee) and the interagency working group. Consistent with rigorous peer review processes, competitive selection of projects in key topic areas will be determined based on the relative merit, applicability, and potential for R&D progress, including lab calls and calls for CRADAs with industry and academia.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Hydrogen Fuel R&D $41,050,000	**$29,000,000**	**-$12,050,000**
• Continue support for approximately nine direct-funded National Laboratory projects and plan to initiate approximately 13 new projects (TRL level 2 to 5) to achieve the outcomes below. • Relative to the 2011 baseline of $8.00/gge, reduce the hydrogen cost (dispensed and untaxed) to $6.70/gge.	• Continue support for approximately nine direct-funded National Laboratory projects on early-stage R&D to achieve hydrogen fuel cost goals. Relative to the 2011 baseline of $8.00/gge, identify at least one early-stage R&D pathway with potential to meet the $5/gge target.	• FY 2018 emphasis will be on smaller, early TRL projects on innovative approaches and materials R&D, rather than development and system level integration.
	• Identify the foundational and applied research needs for large-scale hydrogen production and delivery in support of the H2@Scale initiative and complete a roadmap for early-stage R&D.	• FY 2018 scope will include support of the H2@Scale cross-cutting initiative developed in FY 2017.
• Demonstrate at least 80 percent isentropic efficiency for forecourt compression, compared to the 2011 baseline of 65 percent, to meet or exceed the 2020 target.	• In support of H2@Scale, complete research and modeling to establish feasibility of first-of-a-kind hydrogen liquefaction from room temperature using innovative magnetocaloric materials.	• FY 2018 will focus on innovative materials & emerging technologies for hydrogen delivery and dispensing in support of H2@Scale, and terminate funding of later stage component and system development.
• Demonstrate > 500 hours of H_2 production from bio-derived liquids with in-situ CO_2 capture and >90 percent pure H_2.	• No funding is requested.	• Shift away from higher TRL demonstrations and in-situ CO_2 capture.
• Design a mega-watt scale solar thermochemical hydrogen production plant for 100,000 kg/day, and show through modeled performance analysis the capability to meet the $2/gge cost target. • Develop PV-grade wide-band gap thin-film absorbers with photo electrochemical (PEC) solar photocurrent densities ≥13 mA/cm^2 to enable 16 percent solar to hydrogen conversion efficiency.	• Through early-stage R&D and computational studies within the HydroGEN EMN, identify 10 promising materials that meet at least 3 criteria to enable $4/gge.	• Shift away from development and demonstration related to mega-watt scale hydrogen production plant and PEC system-level efficiency improvements. Focus instead on materials research to enable improvements in performance and durability.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	• Based on lab consortia capabilities, identify at least 2 new industry partners that leverage early-stage research at the National Laboratories.	
• Demonstrate the pilot production of a new high strength (750 KSI), low cost ($6/lb.) glass fiber with the potential to replace traditional carbon fiber at half the cost, for 700 bar hydrogen storage systems. • Develop technologies to enable a 25 percent cost reduction of 700 bar compressed hydrogen storage systems from the 2013 baseline projection of $17/kWh, on track towards meeting the target of $10/kWh.	• Focus critical mass efforts on HyMARC using computational materials design to identify and prioritize research strategies that will enable the synthesis of hydrogen sorbent materials with record adsorption capacities of at least 25 percent higher than current materials.	• In FY 2018, efforts will focus on materials research for advanced low pressure storage and discontinue efforts on carbon fiber tanks, balance of plant for 700 bar storage, and cryo-compressed storagesystems.

Hydrogen and Fuel Cell Technologies
Manufacturing R&D

Description

The Manufacturing R&D subprogram supports the program's mission through the development of advanced fabrication technologies and processes to meet the cost targets of the Hydrogen and Fuel Cell Technologies Program. These activities will help reduce fuel cell and hydrogen system costs to be competitive with those of current technologies. The Manufacturing R&D subprogram also supports outreach activities to facilitate development and expansion of the domestic supply chain of hydrogen and fuel cell-related components. A nimble supply chain can help reduce cycle time in production and ensure a constant flow of raw materials, and enable American leadership in clean energy technologies.

Reflecting the shift in focus to early-stage research and development in hydrogen fuel and fuel cells, no funding is requested for the Manufacturing R&D subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

Manufacturing R&D

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Manufacturing R&D $3,000,000	**$0**	**-$3,000,000**
• Support at least three direct-funded National Laboratory projects and about five projects awarded from a solicitation to: o Demonstrate continuous in-line quality control methods for detecting pinholes in fuel cell membranes <150 micrometers in diameter. o Report on development of outreach activities that facilitate the development of a robust domestic hydrogen and fuel cell supply chain. • Deliver comprehensive global manufacturing competiveness analysis to guide early-stage R&D on both polymer electrolyte membrane fuel cell systems (automotive and stationary) and high-pressure (700 bar) hydrogen storage systems. The report will describe: o The current industry structure both domestically and internationally to benchmark markets; o The value stream from raw materials (or component parts where more relevant) to consumer products; o Areas where the U.S. has (or may have) viable manufacturing opportunities and identify potential vulnerabilities to U.S. competitiveness; and o Segments identified as having particularly well suited to U.S. strengths (e.g. requiring a highly skilled, innovative workforce). • Initiate one to two project(s) from FY 2015 FOA to develop high-volume, fiber reinforced pipeline-manufacturing methods with the ultimate goal to help achieve the DOE target of hydrogen delivery at < $2/gge from the point of production to the point of use.	• No funding is requested	• In FY 2018 the Hydrogen and Fuel Cell Technologies Program is prioritizing resources on hydrogen fuel and fuel cell innovation and is deferring Manufacturing R&D activities.

Hydrogen and Fuel Cell Technologies
Systems Analysis

Description

The Systems Analysis subprogram performs the analytical research that provides a technical basis for informed decision making for the program's R&D direction and prioritization. These efforts assess R&D gaps, planning, and budgeting, as well as synergies and interactions with other energy sectors such as natural gas. The subprogram assesses the requirements of potential end-users to determine metrics for processes, components, and subsystems. Results also support annual updates to key planning documents that provide direction and milestones for the program, including peer reviews.

The Systems Analysis subprogram ($1 million) will continue to develop, refine, and use analytical models and tools, as well as develop program milestones and technology readiness goals. The subprogram will perform techno-economic analysis of hydrogen production and infrastructure to identify research and technology gaps, as well as risks, to guide targeted applied early-stage R&D that will enable the sustainability and domestic competitiveness of hydrogen and fuel cell technologies. Underlying technical analysis is included for technology-related go/no-go decisions and modeling and analysis of synergies between hydrogen and fuel cells with other emerging technologies and fuels such as natural gas/biogas, and nuclear energy (e.g. related to H2@Scale), and energy systems to identify and understand potential opportunities/system trade-offs. The subprogram will support approximately three direct funded National Laboratory projects for these activities.

The subprogram will no longer assess strategies for near-term hydrogen infrastructure scenarios or perform infrastructure financing evaluations. The program will not assess the benefits of achieving economies of scale, or market impacts which are inconsistent with the shift in focus to early-stage research. Also in FY 2018, the subprogram will no longer assess the return on investment of DOE R&D funding to quantify impact, such as the number of technologies commercialized by industry as a result of early R&D advances funded by the program. Analysis efforts will leverage outside activities, through coordination with other offices and agencies and will support peer reviews and relevant activities under EPACT, including analyses supporting the Federal advisory committee (the Hydrogen and Fuel Cell Technical Advisory Committee) and the interagency working group.

Systems Analysis

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Systems Analysis $3,000,000	**$1,000,000**	**-$2,000,000**
• Continue to assess the market impacts of DOE R&D funding in advancing fuel cell and hydrogen technologies that will be used to assess the program's progress and technology advances.	• No funding is requested.	• Market impacts and return on investment will not be assessed in FY 2018.
• Assess impact of fuel cell performance on the life cycle cost on a cost per mile for FCEVs that will identify the benefits for continued fuel cell R&D.	• Assess impact of fuel cell performance, including on the life cycle cost for FCEVs that will identify potential R&D priorities for hydrogen or fuel cell breakthroughs.	• Support only analysis that will help prioritize R&D.
• Assess program milestones and technology readiness goals, including risk and environmental analyses, and financial evaluations.	• Assess program milestones and technology readiness goals, including risk analysis to identify opportunities that prioritize R&D.	• In FY 2018 continue to assess readiness goals and risk analysis but will not include financial evaluations.
• Complete life cycle analysis for water use of at least three hydrogen production pathways, with emphasis on renewables that will be used to identify hydrogen production technologies within regional water constraints.	• Initiate analysis to identify early R&D that can maximize energy independence and increase fuel diversity, including regional impacts.	• In FY 2018, reduce work on life cycle water use for hydrogen production pathways.
• Continue to support approximately six direct-funded National Laboratory project to achieve these outcomes.	• Continue to support approximately three direct-funded National Laboratory projects to achieve these outcomes.	• Three of the six direct funded laboratory projects will be downselected for continued support
• Assess natural gas and hydrogen infrastructures to determine potential synergies and opportunities to reduce cost through economies of scale applicable to hydrogen.		• Project completed in FY 2016.

Hydrogen and Fuel Cell Technologies
Technology Validation

Description

The Technology Validation subprogram provides accurate assessments of the state of hydrogen and fuel cell technologies—providing valuable feedback to R&D efforts, and validating the performance of pre-commercial technologies to enable informed decisions for public and private investment in continued R&D. The validation of pre-commercial technologies ensures the technologies are ready for the demonstration and deployment phase by industry. To enable the automotive, energy, and utility industries to determine whether technology readiness has been achieved, systems are validated against their technical targets under a range of operating conditions and provide a critical feedback mechanism for future R&D strategies. It also can signify a point at which R&D has been successfully completed with verified results. The Technology Validation subprogram has supported the program's mission by providing data from later-stage R&D project to predict whether FCEVs can meet the targets of 60 percent peak efficiency, 5,000-hour fuel cell durability, a range greater than 300 miles, 5-minute fill time, and hydrogen fuel costs of less than $4/gge.

Reflecting the shift in focus to early-stage research and development, no funding is requested for the Technology Validation subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

Technology Validation

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Technology Validation $7,000,000	**$0**	**-$7,000,000**
• Demonstrate a medium-duty fuel cell hybrid electric parcel delivery truck with a projected driving range of 120 miles on a single hydrogen fill. • Demonstrate hydrogen delivery trailer capable of delivering hydrogen at >8500 psig to validate the effect of higher delivery pressure on the cost of dispensed hydrogen for fuel cell vehicles. • Evaluate performance, cost, operation and maintenance of hydrogen contamination detector technologies installed in hydrogen stations to mitigate potential damage to fuel cell systems in vehicles from fuel contamination. • Benchmark meter accuracy for measuring the mass of hydrogen dispensed into vehicles to support regulatory bodies responsible for regulating the sale of hydrogen and inform R&D programs of technical status. • Evaluate durability, range and fuel economy of light-duty vehicles in real operation against the R&D targets (5,000 hours, 300 miles, 60 miles per gge).	• No funding is requested	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.

Hydrogen and Fuel Cell Technologies
Safety, Codes and Standards

Description

The Safety, Codes and Standards subprogram conducts critical early-stage applied research and development to enable the safe rollout of hydrogen and fuel cell technologies. Examples include the development of models for quantitative risk assessment and research related to hydrogen releases that can apply across the industry, and materials compatibility studies. The subprogram has also conducted extensive collaborative efforts among government, industry, standards development organizations, universities, and National Laboratories in an effort to harmonize regulations, codes, and standards (RCSs) both domestically and internationally to enable domestic competitiveness and mass market penetration of safe hydrogen and fuel cell technologies. Efforts have involved valuable stakeholder input from automobile manufacturers and the energy, insurance, and aerospace sectors, as well as the fire protection community and academia, to enhance and create safety knowledge tools for emergency responders and relevant authorities. The subprogram has also supported the development and implementation of best practices and procedures to ensure safety in the operation, handling, and use of hydrogen and fuel cell technologies in program-funded projects. Continual availability of safety knowledge tools, distributed via an array of media outlets to reach the largest number of safety personnel possible, will be transitioned to industry so that critical mass activities can focus on safety research.

Reflecting the shift in focus to early-stage research and development in hydrogen fuel and fuel cells, no funding is requested for the Safety, Codes and Standards subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion. Safety considerations will continue to be an important parameter integrated into early-stage R&D projects and activities funded through the Hydrogen Fuel and Fuel Cell subprograms.

Safety, Codes and Standards

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Safety, Codes and Standards $7,000,000	**$0**	**-$7,000,000**
• Continue to support approximately six National Laboratory core and enabling capabilities to achieve these outcomes. • Decrease the hydrogen refueling station physical footprint for gaseous or liquid hydrogen delivery using a performance-based risk mitigation approach. • Develop the initial liquid hydrogen release models to inform the risk assessment for separation distances that will be used for revising the current codes. • Implement quantitative risk assessment models to address restricted structures such as tunnels, parking garages (e.g. semi-enclosed), maintenance repair facilities, bridges, and limited access highways. • Train at least 150 first responders and code officials regarding hydrogen and fuel technologies in the Northeast U.S. corridor. • Support coordination of state rollouts and public-private partnerships (e.g. H2USA) to leverage deployment of hydrogen infrastructure.	• No funding is requested.	• Reflects shift in focus to early-stage R&D in hydrogen and fuel cells. Existing projects will be continued to close and safety consideration will continue to be integrated into early-stage R&D projects and activities funded through the Hydrogen Fuel and Fuel Cell subprograms.

Hydrogen and Fuel Cell Technologies
Market Transformation

Description

The Market Transformation subprogram activities focus on moving technologies from the laboratory to the commercial marketplace. This market-acceleration strategy verifies advanced and innovative technologies from the R&D portfolio at the pilot scale in a range of operating environments. Efforts are primarily focused on industry-cost shared projects operating and testing fuel cells in emerging markets such as specialty vehicles, backup/remote power, hydrogen storage with renewables, auxiliary power for transportation (e.g., truck auxiliary power units), continuous recharging for batteries, distributed stationary power generation, and renewable hydrogen applications. The subprogram coordinates with Federal and state agencies as well as other regional entities and industry to most effectively foster early market adoption, increase economies of scale and enable domestic leadership in hydrogen and fuel cell technologies.

Reflecting the shift in focus to early-stage research and development, no funding is requested for the Market Transformation subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

Technology Acceleration

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Market Transformation $3,000,000	**$0**	**-$3,000,000**
• In collaboration with the U.S. Maritime Administration, complete the development and deployment of a maritime fuel cell power generator including energy savings and business value proposition evaluations. • In collaboration with other Federal agencies, such as DOD and U.S. Postal Service, state and local governments, co-fund and provide technical support for strategic deployments of fuel cell fleet vehicles by siting at Federal properties and expanding existing early market fleet refueling equipment. • Complete the development and deployment of refrigerated truck auxiliary power technology and document the petroleum savings and business value propositions. • In collaboration with General Services Administration and other Federal agencies, conduct a pilot program for demonstrating the use of fuel cell vehicles in Federal fleets. • Initiate operations of a 100 kW maritime power system; select and award projects to deploy a fleet of Class 1/2/3 hybrid vans for passenger or cargo transportation; and fund at least three direct-funded National Laboratory projects to achieve the outcomes.	• No funding is requested	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.

Hydrogen and Fuel Cell Technologies
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $1,900,000	**$0**	**-$1,900,000**
• Directly fund NREL Site-wide Facility Support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Hydrogen and Fuel Cell Technologies Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Hydrogen and Fuel Cell Technologies

Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Hydrogen and Fuel Cell Technology - Fuel Cell Power - Improve the catalyst specific power of fuel cells (kW/gram of platinum group metal)**		
Target	6.9 kW/g	7.1 kW/g	N/A
Result	Met - 6.9	TBD	N/A
Endpoint Target	Measure discontinued in FY18 due to the strategic decision to shift towards earlier stage research. Industry will continue to improve the kW/gram of PGM catalysts without additional government investment.		

Solar Energy

Overview

EERE's Solar Energy Program funds early stage research and development (R&D) to build the knowledge base upon which industry can achieve dramatic reductions in the cost of solar electricity and address challenges related to integrating high penetrations of solar energy into the nation's electricity grid. Through its work, the Solar Energy Program supports the DOE SunShot Initiative, which is a collaborative national effort to maintain U.S. leadership in solar energy innovation. The Solar Energy Program embraces two complementary technology approaches; direct conversion of solar photons to electricity by a semiconductor (i.e., photovoltaics - PV) and conversion of photons to thermal energy that may be stored before it is used to generate electricity (i.e., concentrating solar power-CSP), while also advancing the state of knowledge on grid integration of solar generation. These approaches and objectives will invigorate American technological leadership in solar energy, diversify the Nation's electricity supply, enhance grid resiliency and reliability, catalyze domestic economic growth, and reduce the air and water impacts of electricity generation.

The Solar Energy Program works to achieve the SunShot 2030 target of $0.03/kWh without subsidies for utility-scale PV systems, which will make solar electricity one of the most affordable forms of electricity in the U.S. Achieving these 2030 goals requires cost reductions of 50-75 percent from 2016 benchmarks for utility-scale, commercial and residential PV[1]. The Solar Energy Program has a history of success in enabling solar energy cost reduction: the original SunShot goal for unsubsidized, utility-scale solar electricity of $0.06/kWh by 2020 is expected to be achieved ahead of schedule.

Deployment of PV across the U.S. has been growing at a rapid rate, with a record 14.8 GW installed in 2016 — a nearly 20-fold increase from the 2010 level.[2] Today there is over 40 GW of solar power across the U.S., and solar is supplying an average of about one percent of U.S. electricity on an annual basis[3], and several times more during peak hours. The solar industry has also shown significant job growth. By the end of 2016, approximately 260,000 people in the U.S. were employed in the solar sector with nearly 1,000 new high paying jobs being added every week in 2016.[4] Rapid declines in solar costs have made these market and job growth increases possible. Nevertheless, significant work remains before solar realizes its full potential. In addition to further aggressive cost reductions, grid integration challenges also impede deployment.

Highlights of the FY 2018 Budget Request

The Solar Energy Program will support focused activities in FY 2018:

- With solar contributing approximately 4 percent of the Nation's peak electricity generating capacity—and as high as 15 percent in some regions of the U.S. — the challenges of even higher levels of grid integration need to be researched today to enable industry to develop and deploy cost-effective solutions in the future that improve the resiliency, security and reliability of the grid. As part of DOE's grid modernization efforts, the Solar Energy Program will focus on the tools and technologies to measure, analyze, predict, protect and manage the impacts of solar generation on the grid of the future. The Program supports early-stage research and development activities at the National Laboratories in solar integration studies, solar power forecasting, power system planning and operation, power electronics, sensing and communication integrity, and data analytics. National Laboratory research also supports industry's development of test and evaluation standards.
- To facilitate the development of the next generation of CSP systems with thermal energy storage, research is aimed at expanding the body of knowledge related to high temperature component design that can enable higher efficiencies. FY 2018 funding includes investigation of advanced diffusion-bonded heat exchangers, a manufacturing technique currently available only to U.S. companies, and new concepts for collecting and harvesting light, while accelerating cost reduction.
- Research on emerging photovoltaic technologies at the National Laboratories and universities will focus on improving the efficiency and reliability of PV devices with the potential to achieve the 2030 Sunshot target. FY 2018 work focuses

[1] R. Fu et al., "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2016," NREL Technical Report, September 2016.
[2] "U.S. Solar Market Insight Report: 2016 Year in Review," GTM Research and SEIA, March 2016.
[3] EIA Electricity Monthly, February 2017.
[4] "National Solar Jobs Census 2016," The Solar Foundation, January 2017 and "2017 U.S. Energy and Employment Report," U.S. Department of Energy, January 2017.

on understanding reliability physics and materials science to better predict performance, improve performance, and increase durability. These topics will continue to support U.S. leadership in PV innovation, which has led to more than 50 percent of the world records in solar power conversion efficiency over the past 35 years.

Through the DOE SunShot Initiative, the Solar Energy Program closely coordinates activities with the Office of Science and the Office of Electricity Delivery and Energy Reliability to ensure the most efficient use of taxpayer dollars, while maximizing the department-wide impact on solar energy.

Solar Energy
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Solar Energy				
Concentrating Solar Power	48,400	—	8,000	-40,400
Photovoltaic R&D	53,152	—	43,700	-9,452
Systems Integration	52,447	—	18,000	-34,447
Balance of Systems Soft Cost Reduction	34,913	—	0	-34,913
Innovations in Manufacturing Competitiveness	43,488	—	0	-43,488
NREL Site-Wide Facility Support	9,200	—	0	-9,200
Total, Solar Energy	**241,600**	**241,141**	**69,700**	**-171,900**

SBIR/STTR:

- FY 2016 Transferred: SBIR $1,774,000; STTR $266,000
- FY 2017 Projected: SBIR $1,771,000; STTR $266,000
- FY 2018 Request: SBIR $2,230,000; STTR $314,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Solar Energy
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Concentrating Solar Power: Funding focuses efforts at the National Laboratories on developing high temperature components for next generation CSP systems with thermal energy storage.	**-40,400**
Photovoltaic R&D: Funding focuses on continuation of efforts at the National Laboratories.	**-9,452**
Systems Integration: Funding focuses on efforts at the National Laboratories and runs one targeted competitive funding solicitation.	**-34,447**
Balance of Systems Soft Cost Reduction: No funding is requested for this subprogram due to shift in focus to early stage R&D.	**-34,913**
Innovations in Manufacturing Competitiveness: No funding is requested for this subprogram due to shift in focus to early stage R&D.	**-43,488**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-9,200**
Total, Solar Energy	**-171,900**

Solar Energy
Concentrating Solar Power

Description

The Concentrating Solar Power (CSP) subprogram supports early-stage R&D of CSP with thermal energy storage as a unique path to achieving the DOE SunShot Initiative cost targets with technologies that can supply solar power on demand.

The goal of the CSP subprogram is to generate the scientific and technological knowledge necessary to reduce the cost of CSP electricity at utility scale to $0.06/kWh, from a baseline of $0.21/kWh in FY 2010. [1] Government funding for early-stage R&D provides an innovation pipeline that enables industry to drive down costs toward this goal, which would make CSP electricity cost competitive with electricity from other sources. An additional benefit is that, CSP, as well as PV, technologies utilize sunlight to generate electricity, and are therefore not subject to fuel-price uncertainties over the lifetime of the plants.

Funding in FY 2016 and FY 2017 leveraged promising component-level CSP research developed in prior fiscal years to integrate best-in-class components at the megawatt scale. That effort will inform further component level research in the major CSP focus areas (i.e., solar collection, receivers and heat transfer fluids, power conversion, and thermal energy storage). Moreover, significant challenges exist in understanding the integration of the subcomponent technologies of the solar field, thermal receivers, thermal storage, and power block.

The CSP subprogram funds the DOE National Laboratories, in partnership with academia, non-profit research institutes and industry, in advanced R&D topics including solar field design, high-temperature receiver development, thermal energy storage allowing turbine operation beyond the daytime hours, advanced power cycles, and systems integration. The FY 2018 request continues the efforts at the National Laboratories with a focus on advanced power cycles, heat exchangers that take advantage of manufacturing techniques only available to U.S. companies, and new designs for collecting and harvesting light. Funding will focus on early-stage research with a periodic feedback loop of early subsystem integration and testing to verify theory and potential while informing the next iteration of research cycles. Funding will also support the National Solar Thermal Test Facility (NSTTF) at Sandia National Laboratories.

[1] Key additional details of this target include:

- Cost target is unsubsidized;
- Due to costs varying across geographic regions, the target is averaged across the U.S.;
- Includes the value of storing energy into the evening hours as CSP thermal storage technologies improve;
- Long-term goal: $3.50/W including 16 hours storage (equivalent to $0.06/kWh) – thermal storage allows a much higher capacity factor, enabling $0.06/kWh to be met with $3.50/W installed capacity; and
- NREL runs this LCOE analysis annually based on best-known industry data.

Concentrating Solar Power

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Concentrating Solar Power $48,400,000	**$8,000,000**	**-$40,400,000**
• Continue the efforts at the National Laboratories in the areas of solar field cost reduction, high temperature receiver development, advanced R&D of thermal energy storage, advanced power cycles, and systems integration. The funding will also support the core capabilities at NREL on System Advisor Modeling and the NSTTF at Sandia National Laboratory.	• Continue approximately 10 R&D projects at the National Laboratories, in partnership with academia and industry, to build upon the state of knowledge in the areas of solar field design, high temperature receiver development, thermal energy storage, advanced power cycles, and systems integration.	• No Significant Change.
• Issue a solicitation and competitively select 2 to 4 projects focused on integrating best-in-class sub-system technologies at the 1-10MW scale with the greatest potential toward achieving the 2020 DOE SunShot Initiative goal. The effort will refine and optimize subcomponent technologies toward an integrated solution.	• No funding requested.	• Projects funded from the FY 2016/2017 solicitation will continue through to close. No new solicitations or awards are planned for FY 2018.
• Award 1 to 3 emerging research leaders who will pursue breakthrough CSP technologies with 2-year awards to conduct applied research at universities, National Laboratories, and other research facilities.	• No funding requested.	• Funding will not be provided separately for this purpose, but the National Laboratories will be encouraged to hire promising emerging leaders using available funding.

Solar Energy
Photovoltaic R&D

Description

The Photovoltaic (PV) subprogram funds early-stage R&D to generate the scientific and technological knowledge necessary to achieve the SunShot target of $0.03/kWh by 2030 for unsubsidized, utility-scale systems. While the PV industry has had great success in the reduction of upfront hardware costs, government funded research is appropriate to advance the state of knowledge of novel PV technology performance and reliability, enabling industry to develop and deploy new PV technologies needed to reach the 2030 goal.

The PV R&D subprogram advances state-of-the-art PV, with National Laboratory, industry, and academic partners. Specifically, the subprogram funds early-stage research to enable higher PV performance (including improved efficiency and durability), reduced cost, and better understanding of long-term reliability. FY 2018 projects will, as an example, build upon the state of knowledge in the areas of advanced silicon processes and multi-junction solar cells' efficiency potential, advanced materials science models for cadmium-telluride solar cells to probe fundamental performance limits, and the impacts of outdoor soiling, temperature cycling, ultra-violet light and humidity on PV performance.

In FY 2018, the PV R&D subprogram will support ongoing merit-reviewed research activities at the National Renewable Energy Laboratory (NREL), Sandia National Laboratories (SNL) and Lawrence Berkeley National Laboratory (LBNL), performed in partnership with academia and industry through cooperative research and development agreements. This work covers foundational analytical research on the potential cost and value of PV technologies to inform research directions, advancement of existing and emerging technologies, understanding of reliability physics to improve module durability and performance prediction, and development of new measurement and characterization techniques. The PV subprogram also funds the Regional Test Centers (RTCs), which are located in Denver, Colorado; Albuquerque, New Mexico; Orlando, Florida; Las Vegas, Nevada, and Williston, Vermont. The RTCs provide facilities to study and validate the performance of PV technology pathways, including semiconductor materials, packaging and power electronics. These data elements deliver essential feedback to early stage R&D. During FY 2018, the Nevada, Vermont and Florida sites will begin a transition to a self sustainable business model that is not reliant on federal funding, and the Colorado site will be decommissioned and folded into an existing, smaller, outdoor test facility on the NREL campus, which is also used to maintain reference standards necessary for benchmark tests.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Photovoltaic R&D $53,152,000	**$43,700,000**	**-$9,452,000**
• Initiate 15 to 25 merit-reviewed research projects at the National Laboratories, primarily at the National Center for Photovoltaics (NCPV). This work advances existing and emerging photovoltaic technologies, develops new measurement and characterization techniques, and develops novel module components and architectures. NREL also works in collaboration with industry through unique capabilities, such as specialized equipment that simultaneously allows the creation and analysis of PV devices. (PV module reliability efforts moved from the Systems Integration subprogram to the PV R&D subprogram).	• Continue approximately 30 merit-reviewed research projects at the National Laboratories (NREL, SNL, and LBNL). This work advances the performance of emerging and existing photovoltaic technologies, develops new measurement and characterization techniques, and employs materials science and reliability physics to improve module durability. Most projects have industry and/or academic partners. LBNL tracks worldwide developments to provide feedback to the early-stage technology efforts at NREL and SNL.	• No significant change.
• Issue Next Generation PV IV solicitation and competitively select 10 to 12 projects focused on investigating new concepts for PV cells and modules that have the potential to disrupt the PV market beyond the DOE SunShot Initiative goals.	• Continue the collaboration (year 7 of 10) with the National Science Foundation to support the Quantum Energy and Sustainable Solar Technologies Engineering Research Center at Arizona State University.	• Maintain a minimum level of support for academic R&D developing future leaders in solar energy technology while emphasizing research activities at the National Laboratories.
• Issue Foundational Program to Advance Cell Efficiency III solicitation and competitively select 4 to 7 projects focused on increasing efficiency and overcoming technological challenges with established PV technologies.	• No funding is requested.	• Existing projects will be continued to close.
• Fund 4 to 6 emerging research leaders through SunShot Postdoctoral Research Awards who will pursue breakthrough PV technologies and publish impactful peer-reviewed articles.	• No funding is requested.	• Funding will not be provided separately for this purpose, but the National Laboratories will be encouraged to hire promising emerging leaders using available funding.
• [From the FY 2016 Innovations in Manufacturing subprogram] Initiate a durable materials (DuraMat) lab call to rapidly screen and optimize manufacturing processes to reduce the cost of modules to $0.50/W and the development cycle of a new material in ½ the time.	• Continue the DuraMat National Laboratory Consortium, part of the Energy Materials Network, initiated in FY 2016 under the Innovations in Manufacturing subprogram, which is dedicated to modeling, discovering, and measuring durable coatings and packaging	• No significant change. Moved from the Innovations in Manufacturing subprogram due to better alignment with early-stage research in the PV R&D subprogram.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	materials for photovoltaic modules including advanced anti-reflective coatings, anti-soiling solutions, encapsulants, flexible packaging, and glass or polymer alternatives.	

Solar Energy
Systems Integration

Description

The Systems Integration (SI) subprogram, in coordination with the DOE Grid Modernization Initiative, funds early-stage research and development to generate the scientific and technological knowledge necessary to enable the seamless integration of hundreds of gigawatts of solar power into the electricity grid in a secure, reliable, safe and cost-effective manner. As the deployment of photovoltaic systems in electric distribution systems has rapidly accelerated over the past few years, utilities, regulatory agencies, and developers face a significant set of new challenges for which early-stage research can provide fundamental understanding to drive innovative solutions. Key technical challenges related to the grid integration of solar power include power variability, voltage regulation, frequency control, unintentional islanding, protection coordination (planning for fault currents), and two-way power flow. There is a need for early-stage R&D to provide comprehensive models and innovative technology that can inform industry as they solve these current and future challenges, ensuring standardization and adoption of most efficient practices across the grid.

The anticipated expansion of solar power at centralized and distributed scales underscores the need to strengthen the body of knowledge to enable industry and regulatory agencies to develop technologies and best practices for timely and cost-effective interconnection procedures, accurate prediction of sunlight and solar power generation, as well as monitoring and control of solar power. The SI subprogram will address these challenges by supporting early-stage research and development of solar integration models and technologies that have the potential to improve system performance, reliability, resiliency and security. Early-stage research will focus on long-term solutions that are beyond the timeframe that industry is addressing, to create a pipeline of ideas and technologies.

Funding in FY 2018 will support early-stage research and development activities at the National Laboratories (the Grid Modernization Laboratory Consortium-GMLC), in partnership with academia and industry, in foundational analysis and evaluation of solar integration challenges, solar power forecasting, power system planning and operation, power electronics, sensing and communication integrity, and data analytics. This early stage research is beyond the horizon of utilities and regulatory agencies and provides a critical knowledge base for industry to use in solving grid integration challenges. National Laboratory research also supports industry's development of test and evaluation standards by providing objective data and modeling that can be trusted by all involved parties to inform standard development.

FY 2018 funding will also support a $2M competitive solicitation aimed at developing innovative microgrid concepts with the greatest potential to improve resiliency and cyber-security, while increasing consumer power supply choices. Current work at the National Laboratories is focused on developing the proper metrics to use in this funding opportunity announcement. The solicitation will focus on early-stage research and development of models for cooperative control technologies for advanced microgrid structures. This work leverages FY 2017 funding for advanced power electronics technologies that enhance cyber-security and resiliency.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Systems Integration $52,447,000	**$18,000,000**	**-$34,447,000**
• Competitively select project proposals from DOE National Laboratories and coordinate expertise among a greater number of the National Laboratories with industry (utilities as well as equipment and service providers) to more rapidly address systems integration challenges.	• Continue approximately 20 merit-reviewed R&D projects with the National Laboratories, including through the GMLC, to address foundational analysis and evaluation of solar integration challenges, solar power forecasting, power system planning and operation, power electronics, sensing and communication integrity, and data analytics. National Laboratory research also supports industry's development of test and evaluation standards by providing objective data and modeling to inform standard processes.	• No significant change.
• Issue Solar Dispatchability solicitation and competitively select 5 to 10 projects focused on technologies that will enable utilities to integrate high levels (>100 percent of peak load on a line segment as defined by FERC SGIP) of solar energy into the electric grid in a dispatchable manner. Dispatchability research aims to mitigate the impact of intermittency of PV by leveraging the integration of building/home energy management systems with energy storage and intelligently using the combination of all energy generation and load assets to maximize the value of the integrated system while minimizing grid impact. This effort will build off the efforts on Solar Forecasting, the National Laboratories R&D, and HiPen funding programs, and bridge the gap between the outcomes of the programs and the SunShot Systems Integration targets.	• No funding is requested.	• Projects underway to address this topic will be continued to their close, but no further funding is required, reflecting the shift in focus to early-stage R&D.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Issue Solar HiPen (High PENetration) solicitation and competitively fund 5 to 10 projects focused on technologies that will enable utilities to integrate high levels (>100 percent of peak load on a line segment as defined by FERC SGIP) of solar energy into the electric grid in a safe, reliable, and cost-effective manner. As penetration of solar increases, the challenges of reliability, safety, and communications complexity increase tremendously. Improved communications and power electronics hardware and software tools are necessary to produce transformative solutions that address the challenges and enable the utilities to seamlessly interconnect and integrate solar into the grid. This effort will build off the developments from the HiPen and SEGIS-AC funding programs that are winding down in FY 2015, and bridge the gap between the outcomes of the programs and the SunShot Systems Integration targets.	• No funding is requested.	• Projects underway to address this topic will be continued to their close.
• Fund 2 to 3 emerging research leaders through the DOE SunShot Initiative Postdoctoral Research Awards who will pursue breakthrough solar integration technologies.	• No funding is requested.	• Funding will not be provided separately for this purpose, but the National Laboratories will be encouraged to hire promising emerging leaders using available funding.
• N/A	• Issue a competitive solicitation to fund 1 to 3 projects developing innovative microgrid concepts that improve resiliency and cyber-security while increasing consumer power supply choices	• Funding to address next set of opportunities in grid integration of solar electricity that also leverages FY 2017 funding for advanced power electronics capabilities to enhance cyber-security and resiliency.

Solar Energy
Balance of Systems Soft Cost Reduction

Description

The Balance of Systems Soft Cost Reduction (BOS) subprogram supports the development of innovative and scalable solar energy solutions, enabling economic growth, creating economically sustainable market conditions, and establishing clean energy initiatives to meet evolving needs. Soft costs include financing, customer acquisition, permitting, installation, labor, inspection, and other non-hardware costs. Taken together, soft costs constitute over half the cost of total system prices for residential, commercial and community PV systems.

The BOS subprogram works with a broad range of stakeholders, typically through later-stage development and deployment activities, to quantify cost reduction opportunities, highlight best practices and expand access to solar energy to every home, business, and community. The subprogram funds workforce training for veterans, the next generation of power systems engineers, real estate professionals, first responders, code officials and others, to address workforce gaps. It also develops a new generation of powerful data and information technology tools to increase market transparency, improve consumer protection, and improve access to low-cost financing for a growing number of consumers.

As overall solar prices have dropped, the U.S. has enjoyed unprecedented growth in both solar installations and jobs through the development of successful business and deployment models across the country. Between 2008 and 2016, the U.S. saw a rapid increase in renewable energy generation from solar. The solar sector of the economy now employs over 260,000 people and continues to add more than 1,000 high paying jobs per week. As the industry continues to mature, there is no longer a strong role for the Federal government to fund balance of systems cost reduction activities. Instead, industry is better positioned to fund these later-stage development and deployment activities.

Reflecting the shift in focus to early-stage research and development, no funding is requested for the BOS subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

Balance of Systems Soft Cost Reduction

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Balance of Systems Soft Cost Reduction $34,913,000	**$0**	**-$34,913,000**
• Conduct new and ongoing research and analysis on key areas in reducing the balance of systems costs at the National Laboratories, including: financing costs through the NREL Solar Access to Public Capital team which, in FY 2016 will help financial institutions expand solar loan portfolios; leveraging big data assets through SEEDs II and upcoming rounds of Catalyst to reduce customer acquisition costs and improve local program design. Funding at the National Laboratories also supports research to mitigate environmental, wildlife, and visual impacts.	• No funding is requested.	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.
• Launch a Commercial/Mid-Scale Solar Program to accelerate growth in this high-potential U.S. solar market segment through development of new business models and standardization of practices for utility, commercial, multi-family, municipal and community partners.	• No funding is requested.	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.
• Launch a second round of the successful SEEDS Program combining big data with real-world practice and cutting edge analysis to improve solar technology development and market diffusion.	• No funding is requested.	• Existing projects will be continued to close.
• Installation, Quality Assurance and Utility/Manufacturing Standards Effort will comprehensively address best practices for products and installation to reduce costs and ensure consumer protection.	• No funding is requested.	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.
• Solar Analysis and Outreach Partnerships II Program will provide actionable resources and facilitate peer-to-peer learning for utilities and local stakeholders to support the growth of stable local solar markets.	• No funding is requested.	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.

Solar Energy
Innovations in Manufacturing Competitiveness

Description

The Innovations in Manufacturing Competitiveness (IM) subprogram was established to increase U.S. competitiveness in clean energy manufacturing while advancing progress toward the Nation's energy goals. The focus for the IM subprogram has been to increase America's market share for added-value manufacturing by helping companies with promising solar technology survive the funding gaps that often emerge in the development cycle of new technologies.

Focused research in the Technology to Market portfolio has supported innovation at the earliest stages of commercial research and development. The flagship program in the Technology to Market portfolio is the DOE SunShot Initiative Incubator program, currently in its twelfth round. The DOE SunShot Initiative Incubator Program has supported businesses seeking to develop innovations in hardware installation, grid conversion technologies, and novel business models as well as software platforms for reducing soft costs. Past recipients have attracted more than $22 in follow-on funding for every $1 in Federal investment. The Solar Manufacturing Technologies (SolarMAT) Program has funded the development and demonstration of innovative, but commercially and technically viable, manufacturing technology that can achieve a significant market or manufacturing impact within several years of project completion. As the industry continues to mature, there is no longer a strong role for the Federal government to fund commercialization and manufacturing development and demonstration activities. Instead, industry is better positioned to fund these later-stage activities.

Reflecting the shift in focus to early-stage research and development, no funding is requested for the IM subprogram in FY 2018. Some management activities related to execution of prior year appropriations will continue until close.

Innovations in Manufacturing Competitiveness

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Innovations in Manufacturing Competitiveness $43,488,000	**$0**	**-$43,488,000**
• Issue SolarMAT IV solicitation and competitively select 5 to 10 projects focused on developing solar manufacturing technologies with the greatest potential to reduce cost in manufacturing and supply chain to reduce the trade imbalance in the solar industry.	• No funding requested.	• Reflects shift in focus to early stage R&D. Existing projects will be continued to close.
• Implement Incubator round 11 to provide early stage assistance to help 10 to 20 small businesses commercialize innovative solar technologies.	• No funding requested.	• Reflects shift in focus to early stage R&D. Existing projects will be continued to close.
• Initiate the durable materials lab call to rapidly screen and optimize manufacturing processes to reduce the cost of modules to $0.50/W and the development cycle of a new material by 50 percent in time.	• Funding requested in the PV R&D subprogram to continue the DuraMat Consortium established in FY 2016.	• Moved to the PV subprogram, due to alignment with associated early-stage R&D.

Solar Energy
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $9,200,000	**$0**	**-$9,200,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Solar Energy Program Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Program Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Solar Energy
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Solar - Photovoltaic (PV) - Reduce the levelized cost of Solar PV energy at utility scale (cents / kilowatt hour, kWh)**		
Target	9 cents/kWh	7 cents/kWh	6 cents/kWh
Result	Exceeded - 8.2	TBD	TBD
Endpoint Target	6 cents /kWh by 2020, cost competitive with traditional electricity sources		

Wind Energy

Overview

The U.S. has abundant land-based and offshore wind resources across the nation, and wind power has confirmed its credibility as a scalable, reliable, and environmentally sound domestic energy technology. Wind power is affordable, safe, secure, and clean, making it a valuable component in the national portfolio of domestic power generation solutions, and promoting clean air and clean water for the American people. Wind has rapidly become a mainstream power source in the U.S. electricity portfolio, with 82 gigawatts (GW) of installed capacity[1] across 41 states[2], supplying 5.5 percent of the Nation's electricity end-use demand in 2016[3], and representing 30 percent of all newly installed U.S. generation capacity from 2012-2016[4]. Strong market demand, coupled with the increasing size of wind turbine components, has spurred the growth of a robust domestic manufacturing sector. The U.S. wind industry supports over 100,000 U.S. jobs in installation, manufacturing, and operations, with more than 500 U.S. wind-manufacturing facilities in 43 states.

As the industry continues to mature, early-stage technology innovations are critical to strengthen the body of knowledge upon which industry can develop and deploy new technologies that significantly reduce costs and enable continued growth of U.S. wind power. A 2015 analysis of U.S. wind energy potential, entitled "*Wind Vision, A New Era for Wind Power in the United States,*" was performed by a collaboration between DOE and over 250 experts from industry, electric power system operators, environmental stewardship organizations, state and Federal Governmental agencies, research institutions and laboratories, and siting and permitting stakeholder groups. This report concluded that increasing the penetration of wind power is technically feasible; generates long-term economic savings; creates good-paying, long-standing jobs; and provides substantial local community and environmental benefits.

EERE's Wind Energy Program funds early stage research and development (R&D), and related testing, to build the knowledge base upon which industry can develop and deploy technologies that enable continued growth of the U.S. wind industry, enhance U.S. competitiveness, increase U.S. energy security and independence, strengthen domestic manufacturing, and provide local economic opportunity across the entire United States. The Wind Energy Program has unique roles in conducting high risk, transformational R&D that are typically not being undertaken by individual U.S. wind industry participants due to real or perceived cost, risk, the need to focus on near-term investment returns, or the proprietary and competitive nature of their business. Federally-funded activities can also address different time-scales and/or engage comprehensive competencies that industry alone cannot tackle, such as the application of DOE's high-performance computing capabilities to high-fidelity tools for wind plant design and optimization, and facilities such as the National Wind Technology Center at the National Renewable Energy Laboratory (NREL). The early-stage R&D funded by the Program informs regulatory and interagency processes to address issues related to wind energy deployment.

Land-based wind, in high wind resource areas with access to transmission capacity, is cost competitive with other electricity generation technologies today. DOE's Wind Energy Program activities therefore target innovations applicable to the remaining balance of land, offshore, and distributed wind opportunities to expand the geographic potential for directly cost-competitive wind power (without subsidy) to complement traditional electricity sources and enable a diverse energy portfolio across the Nation. Program activities focused on taller towers, larger rotors, lower weight components, and increased energy capture through overall wind plant optimization, aim to strengthen the body of knowledge which industry can utilize to broaden the number of available sites for economic wind deployment. Several specific core challenges for

[1] Federal Energy Regulatory Commission, Energy Infrastructure Update, December 2016, https://www.ferc.gov/legal/staff-reports/2016/dec-energy-infrastructure.pdf
[2] U.S. Energy Information Administration, Electric Power Monthly for February 2017, April 2017, https://www.eia.gov/electricity/monthly/pdf/epm.pdf
[3] U.S. Energy Information Administration, Electric Power Monthly for December 2016, February 2017, https://www.eia.gov/electricity/monthly/current_year/february2017.pdf
[4] Federal Energy Regulatory Commission, Energy Infrastructure Update, December 2012-2016
https://www.ferc.gov/legal/staff-reports/2013/dec-2012-energy-infrastructure.pdf
https://www.ferc.gov/legal/staff-reports/2013/dec-energy-infrastructure.pdf
https://www.ferc.gov/legal/staff-reports/2014/dec-infrastructure.pdf
https://www.ferc.gov/legal/staff-reports/2015/dec-infrastructure.pdf
https://www.ferc.gov/legal/staff-reports/2016/dec-energy-infrastructure.pdf

wind power include improvement to wind turbine design, reliability, wind plant optimization, cost reduction, and grid integration.

Highlights of the FY 2018 Budget Request

In FY 2018, through its Atmosphere to electrons (A2e) initiative—a consortium among DOE, industry, academia, and other stakeholders—the Program will fund fundamental, early-stage R&D to improve the performance and reliability of next-generation "SMART" (System Management of the Atmospheric Resource by Turbines) wind plants by investigating systems-level interactions influenced by atmospheric conditions, variable terrain, and machine-to-machine wake interactions. The Program will conduct field experiments to validate high-fidelity computational models, leveraging DOE's high-performance computing (HPC) capabilities, and establish the performance improvements from innovative wake controls in realistic atmospheric operating conditions. This activity will engage comprehensive competencies that industry alone does not possess, including the application of DOE's high-performance computing capabilities to develop high-fidelity tools for better understanding atmospheric phenomenon in complex terrain, high fidelity simulations coupling the large- scale physics of the atmosphere to the smaller-scale physics of wind plant and wind turbine inflow, to enable wind plant design and optimization. DOE investment in the national wind energy test facilities maintains unique, state-of-the-art capabilities to provide U.S. industry and academia a resource for research, development, testing and validation of their innovations. For example, research-quality data collected in field experiments at both the National Wind Technology Center at NREL and the Scaled Wind Farm Test Facility (SWiFT) at SNL is used to validate high-fidelity models.

In FY 2018, the Program will characterize the potential cost, grid and deployment impacts of innovations related to A2e "SMART" wind plant technologies such as wake steering, predictive wind plant control strategies, and low specific power rotors. The Program will also evaluate potential innovations in offshore wind installation and operations, and fund R&D on early-stage technologies such as instrumentation and control algorithms to enhance wind farm operations and asset management.

In FY 2018, the Program will initiate a new R&D effort focused on the scientific challenges associated with the design and manufacturing of low-specific power rotors for tall wind applications. This effort will strengthen the body of knowledge necessary for industry to mitigate aerodynamic loads, deploy new materials and approaches to structural design, and apply novel methods of fabrication and transportation, resulting in up to a 10% improvement in wind plant capacity factor.

In FY 2018, the Program will fund early-stage R&D on wind energy grid integration and grid infrastructure modernization challenges in collaboration with electric grid operators, utilities, regulators, and industry to enable incorporation of increasing amounts of wind energy into the power system, while maintaining economic and reliable operation of the national transmission grid. As part of the DOE's grid modernization efforts, the Wind Energy Program will focus on the tools and technologies to measure, analyze, predict, protect, and control the impacts of wind generation on the grid of the future. The Program will continue supporting only the early-stage R&D activities outlined in the Grid Modernization Multi-Year Program Plan. The Program will work with DOD, FAA, DHS, and other agencies to address the impacts of wind development on critical radar missions, including completion of a suite of wind-turbine radar-interference mitigation algorithms for long-range and terminal radar systems.

Wind Energy
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Wind Energy				
Technology Research, Development & Testing (RD&T) and Resource Characterization (Land, Offshore, Distributed)	24,789	—	26,693	+1,904
Technology Validation and Market Transformation	47,650	—	0	-47,650
Mitigate Market Barriers	12,395	—	3,822	-8,573
Modeling and Analysis	8,166	—	1,185	-6,981
NREL Site-Wide Facility Support	2,450	—	0	-2,450
Total, Wind Energy	**95,450**	**95,269**	**31,700**	**-63,750**

SBIR/STTR:

- FY 2016 Transferred: SBIR $652,000; STTR $98,000
- FY 2017 Projected: SBIR $650,000; STTR $98,000
- FY 2018 Request: SBIR $844,000; STTR $119,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Wind Energy
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Wind Energy	
Technology RD&T and Resource Characterization (Land, Offshore, Distributed): Increased funding due to increased effort in the Atmosphere to Electrons (A2e) initiative to develop modeling and simulation capabilities that can enable performance optimization of an entire wind plant comprised of an array of turbines, and a shift to fundamental research in the areas of controls, sensors, algorithms, materials, manufacturing, and reliability. Specifically, a new effort will be initiated focused on R&D challenges to the design and manufacturing of low-specific power rotors for tall wind applications.	**+1,904**
Technology Validation and Market Transformation: No funding is requested for this subprogram due to shift in focus to early stage R&D.	**-47,650**
Mitigate Market Barriers: Decrease reflects the shift in focus to early-stage transformative science and technology research. The subprogram will continue to strengthen the body of knowledge necessary to improve wind energy grid integration and develop and evaluate technology solutions to inform regulatory and interagency processes to address issues related to wind energy deployment such as wind turbine radar interference.	**-8,573**
Modeling and Analysis: Decrease reflects the elimination of the wind plant performance benchmarking and improvement initiative, the completion of several pieces of analysis related to the National Offshore Wind Strategy, and refocusing of the modeling and analysis program on the evaluation of potential early-stage transformative science and technology R&D opportunities in wind technology.	**-6,981**
N**REL Site-Wide Facility Support**: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-2,450**
Total, Wind Energy	**-63,750**

Wind Energy
Technology RD&T and Resource Characterization (Land, Offshore, Distributed)

Description

The primary objective of the Technology Research, Development and Testing (RD&T) and Resource Characterization (Land, Offshore, Distributed) subprogram is to generate scientific and engineering knowledge that enables industry to reduce the U.S. wind power levelized cost of energy (LCOE) for land, offshore and distributed wind systems to complement traditional electricity sources for the nation. The subprogram's strategy is to explore concepts and improve modeling and simulation capabilities that enable the wind plant optimization as an integrated system, rather than focusing solely on components. To enable industry to address key cost drivers—capital costs, O&M costs, annual energy production (AEP), and financing rates—and improve the performance and reliability of the wind plant overall, the subprogram invests in a range of parallel and complementary basic and applied R&D activities. These activities inform wind turbine technology innovations—including those that enable higher hub heights, larger rotors, and improved wind plant energy capture—to provide the opportunity for significant growth in U.S. wind power and U.S. industry competitiveness through 2030 and beyond.

The Program's applied research portfolio ($26.7 million), informed through collaborative activities with industry and reinforced by independent peer review, takes an integrated approach to improving wind plant performance through early-stage R&D focused on complex aerodynamics, advanced component manufacturing, wind plant reliability, resource characterization, controls, sensors, modeling. In addition, the subprogram manages wind-specific test facilities that enable validation of R&D results that can ultimately inform industry development and deployment of novel technologies to reduced wind plant LCOE for land and offshore applications. The Atmosphere to Electrons (A2e) initiative—a consortium of scientists from national laboratories, academia, and industry—is a major component of the subprogram, examining the performance of an entire wind plant comprised of an array of turbines. This complete system approach enables the design of low-cost "SMART" (System Management of the Atmospheric Resource by Turbines) wind power plants by improving current predictive capability of wind plant flow and performance. A2e is conducting R&D for next-generation wind plants to reduce wind plant underperformance due to turbine-turbine wake interaction (20-30 percent observed in current operational wind plants). Ultimately, the goal is to develop the modeling, simulation, sensors, and control capabilities that enable industry to improve wind plant reliability over 20-25 year lifetimes and demonstrate a "SMART" wind plant through real-time plant-flow control strategies capable of increased energy capture and mitigating stress loading in both existing and next-generation wind plants, and to lower the integrated plant systems LCOE by 20 percent.

Other long-term objectives also include using and maintaining unique testing facilities to support, validate, and inform research of wind turbine technologies at the component, turbine, and wind plant levels for land, offshore and distributed wind systems, while developing increased capability and capacity of existing facilities in support of new research requirements. The Program pursues fundamental scientific research in resource characterization, remote sensor measurement and development, and forecasting that are essential for the development of offshore wind and for the United States to remain competitive in the global market of offshore wind technologies. Trends toward larger wind turbine blades and the drive for global competitiveness call for exploration of technologically challenging, long horizon investment in transformative manufacturing technologies. Technology R&D in wind manufacturing is aimed at exploring novel concepts of materials and process applications that can enable the competitiveness of U.S. manufacturers to develop advanced blade designs, improve fabrication techniques, automate processes, and increase reliability while lowering production costs. The goal of the program is knowledge generation that enables industry to advance U.S. manufacturing competitiveness.

In FY 2018, the A2e initiative will build upon the Wind Forecasting Improvement Project phase 2 (WFIP 2) field campaign and conduct research to improve the wind forecasting high fidelity models and transition them to the industry. The initiative includes comprehensive field experiments to develop and validate high-fidelity wind inflow and wake models, and to develop and test innovative wind-plant flow control strategies for land and offshore wind applications. A2e will leverage DOE high-performance computing (HPC) capabilities at the National Laboratories to develop wind application-focused, high-fidelity, and computational simulations to model the physical processes critical to predicting wind plant performance and turbine loads.

Funding in FY 2018 will continue to support the Exascale Predictive Wind Plant Flow Physics Modeling project initiated under the A2e High Fidelity Model (HFM) development effort in collaboration with the Office of Science and NNSA's

Exascale Computing Project (ECP). The Program will continue to examine the most appropriate methods for incorporating future exascale computing capability for a coupled atmosphere to turbine integrated analysis capability that resolves the atmosphere/wind plant coupled interactions. This effort will provide an integrated analysis method to assess new wind-plant technology options and predict actual installation cost and performance with a high degree of certainty, using a virtual digital environment.

In FY 2018, a new research initiative will focus on the early-stage R&D challenges associated with low-specific power rotors for tall wind applications. Technically known as a low-specific power rotor, it sweeps a larger area of the available wind, improving the capacity factor of a wind turbine. The rotors of today have reached the limit for exploiting the current body of knowledge in this area. The Big Adaptive Rotor (BAR) initiative is an integrated program aiming to achieve an improvement in capacity factor of up to 10% as a result of changing the specific power from current technology of greater than 200 watts per meter squared (W/m2) to the 150 W/m2 rotor systems envisioned for tall wind applications. Several technical challenges, including addressing adaptive load control via passive and active aerodynamic devices, innovative blade materials, and new design concepts, require development of fundamentally different architectures. The investment required to develop these architectures is high risk and will require a new multidisciplinary approach to modeling and validation.

Funding in FY 2018 will continue to support R&D, performed in collaboration with industry, aimed at increasing U.S. manufacturing competitiveness in wind energy, leveraging previous success in a project that produced several prototype blade molds using additive manufacturing. Strengthening the body of knowledge necessary for reliable and cost-effective materials for use in additive, or 3-D, manufacturing that could remove limitations on tooling, configuration, component design and variations, or production time, lowering costs and transforming the wind manufacturing industry. Prototype additive manufacturing technology, developed through industry-lab collaboration, and located at the national labs, will enable completely new ways of fabricating components. This technology is still in early-stage development, and the investment required to develop this technology is high risk and explores new manufacturing methods which could be transferred to industry. For this effort, the National Laboratories provide a collection of experts with the knowledge, expertise, and experience of decades of wind energy development that no single company could duplicate on its own, refining the knowledge base, and ultimately contributing to U.S. leadership in materials and manufacturing.

Funding in FY 2018 will continue to support operation and enhancement of DOE's world-class testing infrastructure, including NREL's National Wind Technology Center (NWTC) in Colorado, and Sandia's Scaled Wind Farm Test Facility (SWiFT) in Texas. DOE investment in test facilities provides unique, state-of-the-art capabilities to U.S. industry and academia as a resource for research, development, testing and validation of their innovations. National Laboratories actively engage industry and academia to encourage use of government facilities in support of later stage R&D. The testing infrastructure provides a wide breadth of testing and research capabilities critical for supporting basic laboratory research and inform future research priorities, which will lead to U.S. wind energy innovation and cost of energy reductions for all market segments, including development of improved test methods which better reflect field conditions wind turbines are likely to experience.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Technology RD&T and Resource Characterization $24,789,000	**$26,693,000**	**+$1,904,000**
• Conduct joint computational-experimental campaigns, including the following core activities: ▪ High fidelity simulations coupling the large-scale physics of the atmosphere to the smaller- scale physics of wind plant and wind turbine inflow in conjunction with validation data collected in field experiments. ▪ High-fidelity simulations in conjunction with scaled experiments to study turbulent inflow and near-wake development.	• The Program seeks to overcome issues associated with moving from large-scale weather forecasting to smaller wind plant time and space scales, and to quantify remaining forecast uncertainties for land and offshore wind applications. • The Program will continue to execute the joint computational-experimental program for new research rotors at the Sandia SWiFT Facility and leveraging previous activities will focus on high-quality measurements to understand the development of wind turbine wake and its impact on the power production and loads of a downstream turbine under realistic atmospheric inflow conditions.	• Complex terrain field data campaigns finished in FY 2017. FY 2018 efforts transition to data analysis and incorporating new understanding of physical phenomena into high fidelity meteorological models to improve forecasting of wind energy production and higher resolution wind plant inflow and turbulence. • The A2e experimental campaigns will obtain unique datasets that will be used for verification and validation of high fidelity models (HFM) developed to advance understanding of rotor wakes and innovative control paradigms that can be used to minimize the adverse impacts that the wakes have on rotor performance and turbine loads.
• Initiate a new aeroacoustics experimental testing program at the Scaled Wind Farm Test facility (SWiFT). The objective of this AOP task is to experimentally quantify noise reductions of promising technologies.	• No funding requested for this activity.	• Aeroacoustics program has been deferred.
• Use the SWiFT facility to test experimental wind plant controls that may be capable of optimizing wind plant performance and reducing wake losses, which currently account for 6-10 percent energy losses in operating wind plants. Experiments will investigate the extent to which novel plant-level control strategies may be able to reduce wake losses in existing and future wind plants.	• Begin wake steering experiments using the new National Rotor Testbed (NRT) blades specifically designed to replicate the wake characteristics of full-scale turbines.	• The design validation of the NRT blades will be completed in FY 2017, allowing the start of the formal verification and validation experimental and simulation campaign for A2e. The HFM code simulations will begin comparisons to wake data acquired at SWiFT.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Develop turbine component and wind plant system design tools that integrate cost models with system dynamics models for land-based and offshore applications.	• FY 2018 activities will build upon the capabilities developed in prior years to investigate the potential of co-designing controls and turbine layout to improve the performance of wind plants, and will begin to expand the capability to offshore floating wind plants.	• This project ties the high-fidelity modeling and experimental efforts under A2e to a completely new systems approach to the design and analysis of wind plants. The effort is focused on three inter-related tasks: systems engineering and optimization; multi-physics model validation and uncertainty quantification; and informing design procedures and methodologies. In FY 2018 the subprogram will begin the verification of floating offshore foundation and mooring, engineering physics-based simulation tools modeling the coupled dynamic response of turbine and substructures under a full-range of operating conditions.
• Correlate the uncertainty and underperformance of wind plants and associated financial risk to identify technology improvement opportunities.	• No funding requested for this activity.	• A preliminary benchmarking effort to help quantify the risk and uncertainties associated with pre-production estimates was completed in FY 2017.
• Analyze and continue to collect meteorological and oceanographic data using offshore buoys. • Investigate the impacts of hurricane wind and wave conditions on offshore wind turbines.	• FY 2018 activities focus on analysis of prior year meteorological and oceanographic data from offshore buoys.	• The Program is redeploying the offshore wind buoys in FY 2018 to new locations in order to obtain high fidelity data on a different set of unique offshore wind and wave conditions.
• The objectives of this task are to improve turbine availability, reliability and reduce O&M cost. Specific objectives include evaluation of oil sampling systems ability to indicate gear and bearing damage; evaluation of novel diagnostic and prognostic methods based on turbine SCADA data; and continuing to populate and analyze the gearbox failure database.	• FY 2018 activities include investigation of basic science in the main bearing and high-speed shaft bearing root cause failures, lightning damage characterization in carbon fiber material, and electrical collection and power electronics reliability analysis.	• Root cause failure analysis activities will build on information gathered from the ongoing industry-lab gearbox reliability collaborative (GRC). Based on industry input, a new activity for FY 2018 is assessment of the damage to rotors from lightning strikes to carbon spurs on wind turbine blades affecting both land based and offshore wind turbines.
• The Wind Forecasting Improvement Project (WFIP) Phase 2.0 is a three-year project targeted at better understanding atmospheric phenomenon in complex terrain. WFIP II will begin to analyze data gathered in FY 2015 and continue in FY 2016. The FY 2016 objective is to gather field data over an 18-month period	• Analysis and model development in coordination with wind industry partners will continue in FY 2018.	• The WFIP II field campaign ended in FY 2017. FY 2018 activities will build upon the analysis and model improvements developed in prior years.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
starting in Q4 of FY 2015. In FY 2017, the field data was used to improve forecasting models.		
• Site, capital equipment, and testing facility maintenance, upkeep, and safety support for NREL's research and test facilities at the NWTC, including the existing blade structural test facility, 225kW, 2.5MW and 5.0MW dynamometers, 7.0MVA Grid Simulator, and the Controls Advanced Research Turbines. The NWTC will continue to complete all scheduled and unscheduled maintenance and repair activities, as required, on all DOE turbines, test sites, met towers and site infrastructure to ensure safe and reliable operation of DOE-owned turbines, infrastructure, and test sites, as needed, to support field-testing activities by DOE or outside partners.	• Purchase equipment, instrumentation and materials to upgrade and support key personnel for state-of-the-art facilities to include best practices in maintenance, and safety support for facilities at the National Wind Technology Center (NWTC), and the Scaled Wind Farm Test Facility (SWiFT). NWTC facilities include the blade structural test facility, 225kW, 2.5MW and 5.0MW dynamometers, 7.0MVA Controllable Grid Interface (CGI), Controls Advanced Research Turbines and the DOE 1.5MW wind turbine. The SWiFT facility includes an array of test turbines, meteorological towers, wake measuring systems, and instrumentation.	• Continued support for the improvement of capabilities, equipment, safety, operations and maintenance of wind turbine test facilities provides the U.S. with a world-class suite of test capabilities for R&D of innovative designs. The facilities are integrated into important research initiatives such as A2e, providing researchers with a scientific experimentation capability, where high fidelity data can be collected under controlled circumstances. SWiFT verification and validation campaign for A2e will be initiated with the NRT blade set to test turbine-turbine wake interaction effects. The CGI, DOE 1.5MW turbine and dynamometer facilities will be used in conjunction with one another to test the effect of short-term energy storage on ancillary grid services.
• Support the development of blade and drive train test procedures and methods through partnerships with the Massachusetts blade test facility and the Clemson drive train facility.	• No funding requested for this activity.	• These facilities are now self-sustaining and federal support for them has ended.
• Support distributed wind LCOE reduction to be competitive with other distributed generation technologies and retail electricity rates, and increase the number of certified turbine models.	• National Laboratory technical support to Competiveness Improvement Project (CIP) awardees.	• The Competitiveness Improvement Program (CIP) addresses research, development and manufacturing improvements that directly reduce LCOE and facilitate turbine certification goals.
• Produce an annual Distributed Wind Market Report covering U.S. wind power in distributed applications — including small, mid-size, and utility-scale installations.	• Annual Distributed Wind Market Report and data portal management.	• There is no change in strategy or scope of work in FY 2018 for the Annual Distributed Wind Market Report and associated activities.
	• A new research activity entitled the Big Adaptive Rotor (BAR) initiative is focused on the design and manufacturing challenges associated with low-specific power rotors (150W/m2 vs. today's technology of >200W/m2) for tall wind	• New activity in FY 2018

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	applications. This integrated program will address the fundamental science challenges in adaptive load control via passive and active aerodynamic devices, innovative blade materials and new design concepts that will achieve an improvement in capacity factor of up to 10% as a result of changing the specific power from current technology.	
	• Funding in FY 2018 will support research on technologies to optimize wind farm operations and accelerate wind farm development, such as improvements in instrumentation and control algorithms address industry needs for versatile operations strategies at existing and future wind plants. With increased wind energy deployment nationally and the increasing useful life of wind plants, there is a growing need for early-stage R&D aimed at minimizing operational costs and issues that may hamper future LCOE reductions or deployment. Addressing these operational concerns will help enable continuing U.S. wind industry growth.	• New activity in FY 2018
	• Funding in FY 2018 will support R&D on wind-specific optimized carbon fiber composites. Carbon fiber offers significantly enhanced mechanical properties compared to fiberglass, however, the high cost of carbon fiber limits its use in wind turbine blades. Two national laboratories and one university will be engaged in an initiative to design, fabricate and test new carbon fiber material systems designed specifically to meet strength and cost targets for wind turbine application to low-specific power rotors.	• New activity in FY 2018

Wind Energy
Technology Validation and Market Transformation

Description

The primary objective of the Technology Validation and Market Transformation subprogram is to conduct high-risk testing and validation of new technologies at relevant scale. In addition to validating through testing, the subprogram collects performance and environmental data from these projects and produces public datasets that researchers and private industry may use. Reflecting the shift in focus to early-stage R&D, no funds are requested for this subprogram in FY 2018. Industry is better positioned to fund these later-stage development and deployment activities. Some management activities related to the execution of prior year appropriations will continue until completion.

Technology Validation and Market Transformation

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Technology Validation and Market Transformation $47,650,000	**$0**	**-$47,650,000**
• Continue fabrication and installation of three Offshore Wind Technology Demonstration projects. The three projects will continue to be evaluated and monitored by an independent third party for validation and verification of cost, schedule, and milestones to minimize risk and ensure a 2017 project commissioning.	• No funding requested for this activity.	• Reflects shift in focus to early-stage R&D. Past appropriations fully funded the two remaining Offshore Wind Technology Demonstration projects to completion. The two projects will continue to be evaluated and monitored by an independent third party for validation and verification of cost, schedule, and milestones.
• Fund the two alternate Offshore Wind Technology Demonstration projects to further substantiate the design and economic value proposition of alternate project designs for offshore wind power. These include concrete semi-submersible foundations as well as monopile foundations designed to reduce ice loading.	• No funding requested for this activity.	• Reflects shift in focus to early-stage R&D. There are no alternate Offshore Wind Technology Demonstration projects remaining. The two alternate demonstration projects transitioned into the full program.

Wind Energy
Mitigate Market Barriers

Description

The Mitigate Market Barriers subprogram funds early-stage R&D activities to strengthen the body of knowledge necessary to inform key grid integration and regulatory decisions associated with the deployment of wind energy. The subprogram evaluates technology solutions to address wind turbine radar interference, and funds early-stage R&D on wind energy grid integration and grid infrastructure modernization challenges as part of coordinated grid modernization efforts across the Department through the National Laboratories and the Grid Modernization Laboratory Consortium (GMLC). The GMLC is a strategic partnership that brings together leading experts and resources across thirteen National Laboratories to collaborate on grid modernization projects.

This subprogram conducts early-stage wind energy grid integration R&D with the purpose of generating knowledge relevant for electric grid operators, utilities, regulators, and industry to develop and deploy novel technologies that enable reliable incorporation of increasing amounts of wind energy into the power system. With four states having wind electrical generating capacity greater than 25 percent of their total installed capacity, and some utilities seeing instantaneous wind generation production of up to 60 percent, the U.S. continues to move closer to wind penetration levels that 10 years ago were purely theoretical. While these penetration levels are still lower than scenarios studied in reports such as the Western Wind and Solar Integration Study (Phase 1-3) and the Eastern Renewable Generation Integration Study, these studies have framed the groundwork for utilities to understand how to effectively operate the power grid under high penetrations of wind energy and identify technical innovations, such as forecasting and dynamic line rating, that are critical for further successful grid integration.

In FY 2018, the subprogram will validate tools and prove novel concepts that enable industry to measure, analyze, predict, and control the grid of the future with ever increasing amounts of wind energy. This effort is needed as regulatory oversight limits the ability of industry to invest in early-stage R&D to improve the fidelity, accuracy, and speed of production cost models because these activities are not seen as providing direct and immediate benefit to utility customers. For example, the Program will complete efforts to improve the fundamental algorithms used in production cost models to improve model solve time and fidelity; allowing increased scenario analysis to evaluate the impact of various wind deployment levels on power system operations. This will inform follow-on early-stage grid research, while simultaneously improving tools and technologies available to industry as they pursue near-term targets.

In FY 2018, in partnership with the Canadian and Mexican governments, the subprogram will complete a three-year North American Renewable Integration Study (NARIS). Recent changes in the utility industry, coupled with a rapidly changing energy source and grid landscape, provide an opportunity for North American countries to conduct an in-depth study of changing energy futures in the region. The tri-national study focuses on the operational and planning impacts of higher penetration levels of wind power, hydropower, and possibly solar power between the U.S., Canada, and Mexico.

In FY 2018, collaboration will continue with DOD, FAA, DHS, NOAA, and other agencies through the interagency Wind Turbine Radar Interference Mitigation MOU to address the impacts of wind development on critical radar missions. The objectives include completion of a suite of wind-turbine radar-interference mitigation techniques for DoD, FAA, and DHS long-range and terminal radar systems, and deployment of those and other mitigation measures in operational environments to ensure their availability to radar operators.

Mitigate Market Barriers

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Mitigate Market Barriers $12,395,000	**$3,822,000**	**-$8,573,000**
• Fund Eagle Impact Mitigation Technologies research solicitation and competitively select 5 to 7 research projects to support the development and validation of technologies that reduce potential impacts of wind energy facilities on Bald and Golden Eagles. A field-testing and validation component will independently test the performance of high-technology readiness level (TRL) measures such as eagle detection and deterrence devices, while an R&D focus component will be aimed at the development of lower-TRL concepts to improve the efficacy and reduce the cost of and need for detect-and-deter or other mitigation technologies.	• No funding requested for this activity.	• DOE issued a FY 2016 FOA and issued 6 awards to address these research needs. Projects are currently on-going and funded with prior-year funds.
• Continue laboratory efforts to address the effects of wind development on sensitive bird and bat species.	• No funding requested for this activity.	• Activities to address the effects of wind development on sensitive bird and bat species is discontinued.
• Initiate a National Public Acceptance Baseline Study to provide the first quantitative assessment of the factors associated with public acceptance of wind energy development across the country.	• No funding requested for this activity.	• Project will be completed in FY 2017.
• With interagency partners, continue to develop measures to mitigate wind turbine-radar interactions.	• Continue co-funded interagency R&D collaboration with DOD, FAA, DHS, NOAA and other agencies under the MOU. Complete work on at-the-radar software mitigation measures, increase focus on command-and-control system and radar tracker improvements, and facilitate multiple demonstrations of these and other mitigation technologies at existing National Airspace System (NAS) radars.	• Reduced emphasis on development of novel at-the-radar software mitigation methods for existing radar systems and increased support for command-and-control and tracking improvements. Increased support to transition these mitigations to operational settings and make them available to radar operators.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Continue support to WINDExchange and Wind Energy Regional Resource Centers to ensure decision-makers are using the best available science to support decisions around wind energy policies and projects.	• No funding requested for this activity.	• Support for this activity discontinued.
• Continue level support to the Collegiate Wind Competition to challenge students to solve key engineering and business challenges facing wind energy technologies by engaging 150-180 students from 12 universities across the country, including Alaska to Puerto Rico.	• No funding requested for this activity.	• Support for this activity discontinued.
• Conduct next generation integration studies using newly developed 10-year wind data sets, including a North American renewable integration study.	• Complete the North American Renewable Integration Study (NARIS) that analyzes scenarios of wind, solar, and hydro deployment, operational considerations and possible grid infrastructure and energy transaction planning options between the U.S., Canada, and Mexico. These efforts are centered on facilitating the wind energy centric portions of the study, while investments from the DOE Solar and Water Power Programs will support the analysis pertaining to those technologies.	• The strategy for supporting analysis of renewable integration across North America is unchanged. This analysis is a first of its kind look at the energy future of the three countries related to new renewable development and understanding the operational impacts of future energy transactions between the countries. This effort is supported by past year funding from the DOE Solar and Water Power Programs, which funds the analysis related to each of those technologies respectively.
• Further develop the wind-based transmission line planning tool architecture and improve integration of wind forecast information into grid operational tools.	• Continue the development of a wind-based transmission line routing tool with new capabilities to evaluate exclusion zones and further develop forecasting into dynamic line rating development.	• Transition focus on dynamic line rating methodology development, and increase focus on dynamic line rating forecasting capability development to allow generator dispatch to use the new line capacity.
• Continue the development of integrated Energy/Distribution/Building Management Systems (EMS/DMS/BMS) to allow control across each operational area and continue the evaluation of the analysis impacts of geographic and temporal decomposition for use in production cost modeling.	• Finalize efforts related to the development of an integrated EMS/DMS/BMS controls system and complete evaluation of new decomposition efforts in production cost modeling.	• Reduced and refocused efforts to improve power grid analysis tools and the development of operational tools that combine EMS/DMS/BMS tools.

Wind Energy
Modeling and Analysis

Description

The Modeling and Analysis subprogram provides objective analysis to evaluate and prioritize wind energy technology innovation opportunities for land and offshore applications, based on a solid understanding of current technology and market conditions as well as state-of-the art systems engineering, cost and deployment models and tools. The subprogram also provides regular reporting and analysis of costs and market trends to ensure transparency in its analytical basis and methods; performs fundamental analysis of wind's impacts on economic factors such as land use and jobs; and provides the analytical basis for Program development of annual and multi-year plans and technology roadmaps and investments. Using state of the art modeling and accessing the most detailed wind data available, the subprogram is constantly improving insights and providing detailed data analysis to enable informed policy and investment decisions.

In FY 2018, the subprogram will invest in techno-economic and life-cycle assessments to help the Program focus its research and technology development priorities and identify key drivers and hurdles for wind-energy technology development, with a particular focus on "SMART" wind plant technologies developed through the Technology Research, Development & Testing (RD&T) and Resource Characterization (Land, Offshore, Distributed) subprogram Atmosphere to electrons (A2e) initiative, and innovations in offshore wind energy installation and operations, and floating offshore wind substructures. These analyses will assist the Program in identifying and prioritizing early-stage, transformative science and technology opportunities that will have a significant impact on the wind industry and maximize return on taxpayer investments in wind energy R&D.

Modeling and Analysis

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Modeling and Analysis $8,166,000	**$1,185,000**	**-$6,981,000**
• Conduct technology characterization data gathering, system cost analyses using laboratory generated analysis tools and evaluate the impact of new and emerging technologies on system cost (sensitivity analyses), and provide unbiased information to stakeholders on the status of the domestic wind market in the U.S.	• Collect high-fidelity wind technology trend and sensitivity data to provide the foundation to the Atmosphere to electrons (A2e) initiative necessary for rigorous analysis of technology innovation investment opportunities for land-based and offshore wind.	• Several pieces of analysis related to the National Offshore Wind Strategy were completed in FY 2016. The program will focus on data collection to feed systems engineering and other analysis necessary to determine remaining cost reduction opportunities in wind and identify opportunities where DOE investment has a unique role in driving innovation.
• Complete development and validation of integrated wind-plant system model, which couples state of the art dynamics (blades, drivetrain, floating platform etc.) and cost models for the purposes of understanding how specific innovation opportunities will impact LCOE.	• Utilize systems engineering and levelized cost of energy (LCOE) analysis modes to support evaluation of transformative "SMART" wind plant technologies developed under the A2e initiative and offshore wind-specific substructure and operational innovations.	• The Performance, Risk Uncertainty and Finance (PRUF) wind plant performance benchmarking and improvement initiative is deferred. The subprogram will conduct activities on offshore-wind specific impacts as well as plant or system level impacts.
• Apply and improve core-capacity expansion models — including ReEDS, Plexos and NEMS — to identify and leverage opportunities for accelerated wind deployment and understand variable wind generation's actual costs and benefits with the five Power Markets within the U.S.	• Improve programmatic capacity expansion, transmission and cost modeling functionality for continued identification of opportunities to decrease wind energy costs and identify opportunities for wind energy to provide additional grid services.	• Activities will emphasize characterizing the electricity system costs and benefits associated with wind on the grid to utilities and ratepayers, and on providing analysis and tools that researchers and stakeholders can use to evaluate wind energy opportunities.
• Continued to implement processes to gather, evaluate, verify, and analyze data and information regarding technical and project management performance and progress relative to the Program's cost and performance goals.	• Review an impact analysis of Program research, multi-year program plan (MYPP) and technology roadmap updates.	• Continued improvement of detailed impact analysis. Continue to conduct Program external/industry project reviews. Continue to update wind technology roadmap to identify the status and progress of all of the critical actions identified to support transformative wind technology development.

Wind Energy
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $2,450,000	**$0**	**-$2,450,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Wind Energy Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Wind Energy
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Wind - Offshore - Cost of off-shore wind energy (cents/kWh)**		
Target	18.1 cents/kwh	17.2 cents/kWh	16.2 cents/kWh
Result	Met - 18.1	TBD	TBD
Endpoint Target	14.9 cents/kWh by 2020, 9.3 cents/kWh by 2030		
Performance Goal (Measure)	**Wind - Onshore - Cost of land-based wind energy (cents/kWh)**		
Target	5.6 cents/kWh	5.5 cents/kWh	5.4 cents/kWh
Result	Met - 5.6	TBD	TBD
Endpoint Target	5.2 cents/kWh by 2020, 3.1 cents/kWh by 2030		

Energy Efficiency and Renewable Energy
Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. The Facilities Maintenance and Repair activities funded by this budget and displayed below are intended to halt asset condition degradation.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
National Renewable Energy Laboratory	10,884	10,180	10,839	10,353
Total, Direct-Funded Maintenance and Repair	**10,884**	**10,180**	**10,839**	**10,353**

Costs for Indirect-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
National Renewable Energy Laboratory	1,500	2000	1,100	2,038
Total, Indirect-Funded Maintenance and Repair	**1,500**	**2000**	**1,100**	**2,038**

Report on FY 2016 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2016 to the amount planned for FY 2016, including Congressionally-directed changes.

Energy Efficiency and Renewable Energy
Total Costs for Maintenance and Repair ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost
National Renewable Energy Laboratory	12,384	12,180
Total, Maintenance and Repair	**12,384**	**12,180**

The Planned Cost is an estimate developed at the beginning of the year and is a minimum target amount. Final FY 2016 actual costs show that NREL was able to invest approximately the planned amount on the repair and maintenance of real property assets on the South Table Mountain site and remain within funding limits.

Energy Efficiency and Renewable Energy Research and Development
Research and Development ($K)

	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request	FY 2018 vs FY 2016
Basic	0	0	0	0
Applied	640,428	639,211	480,732	-159,696
Development	765,705[1]	764,249	89,508	-676,197
Subtotal, R&D	1,406,133	1,403,460	570,240	-835,893
Equipment	3,600	6,593	3,600	0
Construction	0	0	0	0
Total, R&D	**1,409,733**	**1,407,053**	**573,840**	**-835,893**

[1] The Budget Appendix erroneously reports $790 million in FY 2016 Enacted BA for Development. The correct total should be $766 million.

Energy Efficiency and Renewable Energy Research and Development
Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR) ($K)

	FY 2016 Transferred	FY 2017 Annualized CR Projected Transfers	FY 2018 Request Projected Transfers[1]	FY 2018 vs FY 2016
Vehicles Technologies				
SBIR	7,244	7,230	2,560	-4,684
STTR	1,087	1,085	360	-727
Bioenergy Technologies				
SBIR	3,761	3,754	1,811	-1,950
STTR	564	563	255	-309
Hydrogen and Fuel Cell Technologies				
SBIR	2,149	2,145	1,440	-709
STTR	322	322	203	-119
Solar Energy				
SBIR	1,774	1,771	2,230	+456
STTR	266	266	314	+48
Wind Energy				
SBIR	652	650	844	+192
STTR	98	98	119	+21
Water Power				
SBIR	1,123	1,121	653	-470
STTR	168	168	92	-76
Geothermal Technologies				
SBIR	885	883	400	-485
STTR	133	132	56	-77
Advanced Manufacturing				
SBIR	6,000	5,989	2,624	-3,376
STTR	900	898	369	-531

[1] Initial assessment is planned against the programmatic funding level of $695M, rather than the request for new BA of $636M, which will result in an assessment above the statutory minimum.

	FY 2016 Transferred	FY 2017 Annualized CR Projected Transfers	FY 2018 Request Projected Transfers[1]	FY 2018 vs FY 2016
Building Technologies				
SBIR	2,652	2,647	1,232	-1,420
STTR	398	397	173	-225
Total, SBIR	**26,240**	**26,190**	**13,794**	**-12,446**
Total, STTR	**3,936**	**3,929**	**1,941**	**-1,995**

Energy Efficiency and Renewable Energy
Safeguards and Security ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Protective Forces	5,200	3,100	3,100	-2,100
Physical Security Systems	0	750	750	750
Information Security	200	500	500	300
Cybersecurity	2,190	3,680	3,680	1,490
Personnel Security	720	200	200	-520
Material Control and Accountability	0	0	0	0
Program Management	490	800	800	310
Security Investigations	400	170	170	-230
Transportation Security	0	0	0	0
Construction	0	0	0	0
Total, Safeguards and Security	**9,200**	**9,200**	**9,200**	**0**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Water Power

Overview

Water power technologies, which include hydropower and marine and hydrokinetic (MHK) energy, generate renewable electricity that supports domestic economic growth and energy security while supporting the reliability of the U.S. power grid. The Water Power Program conducts early-stage research and development to strength the body of scientific and engineering knowledge enabling industry to develop and deploy new technologies with the potential to increase hydropower and MHK generation.

U.S. hydropower has provided reliable and affordable power for over a century. In 2016, hydropower supplied 6.5 percent of the Nation's electricity end-use demand -- more electricity generation than any other renewable energy source. Today, over 100 GW of installed hydropower and pumped storage capacity supports 87,000 U.S. jobs and powers the equivalent of 21 million homes. Pumped-storage hydropower alone accounts for 97% of U.S. utility-scale energy storage. Hydropower also provides a greater range of flexibility and ancillary services than any other renewable energy technology, important to ensure grid reliability and balance variable generation.

Even though many technologies used in hydropower today are well-understood and commercially available, there is still opportunity for innovation and growth. In 2016, the DOE's *Hydropower Vision* found that an additional 50-65 GW of new hydropower and pumped storage could be added to the U.S. generation mix by 2050 through a combination of upgrades to existing plants, new hydropower at existing unpowered dams and in new stream-reaches, and new pumped storage hydropower (PSH) capacity. DOE developed these future hydropower growth scenarios in coordination with both the hydropower industry and environmental organizations alike. However, in order to realize this potential, new technologies must be developed that optimize existing facilities and reduce the costs and environmental impacts of new projects.

The Water Power Program supports National Laboratories, universities, and industry partners in conducting research and development (R&D) into advancing novel hydropower designs. Federal support for early-stage hydropower R&D addresses fundamental science and technology gaps required to realize necessary cost reductions and gains in environmental performance for new modular hydropower designs. This includes research on the interactions between design elements and site characteristics that occurs far before commercialization of any given system, providing a basis for understanding the viability and tradeoffs of different design choices and enabling future industry-led R&D. The Program also invests in research of new technologies that enable hydropower to provide increased flexibility and grid-reliability services. The Program leads efforts to model and quantify the cost and value of services that hydropower and PSH projects provide to the grid; a computationally-intensive and interdisciplinary research challenge that is beyond the capability of any single hydropower developer, operator, or regulator. These efforts constitute part of DOE's grid modernization efforts which focus on enabling industry to develop and deploy the tools and technologies to measure, analyze, predict, protect, and control the grid of the future. The Program will support only the early-stage research and development outlined in the Grid Modernization Multi-Year Program Plan, leaving later stage development and deployment related activities to the private sector.

The Water Power Program also supports fundamental research to better understand the relationships between energy generation, water flow and important indicators of environmental health, enabling industry to develop novel technologies and operational models that can increase both power generation and environmental performance at existing facilities. Whereas existing industry tools are designed to optimize for fluid flow and structural loading, the Program's early-stage R&D combines experience across biological sciences, hydrology, and engineering as well as the computing resources at the National Laboratories, to provide quantitatively-resolved interactions between hydropower components and site-specific environmental conditions. The resulting design codes and models enable industry innovation in turbine design and inform scheduling and dispatch models that are more effective at optimizing across multiple mandates (e.g. energy generation, irrigation, recreation). This research is designed in close collaboration with industry and the Federal hydropower operating agencies, with the Water Power Program research focusing on knowledge generation that feeds future industry innovation and commercialization.

Marine and hydrokinetic (MHK) technologies convert the energy of waves, tides, and river and ocean currents into electricity. MHK resources have the potential to provide tens of millions of Americans with locally sourced, reliable and clean energy. In addition, developing MHK resources that are close to load centers can reduce transmission needs and ease

integration with the grid. MHK is a predictable, forecastable resource with a generation profile that is complimentary to other resources such as onshore wind and solar, which can enhance grid performance and stability. Finally, there are unique opportunities for MHK to provide power for a number of distributed applications.

MHK technologies are at an early stage of development due to the fundamental scientific and engineering challenges of generating power from complex, low-velocity and high-density dynamics in a corrosive ocean environment. These challenges are intensified by the high cost and lengthy permitting processes associated with in-water testing. To address these challenges, the Program invests in early-stage R&D specific to MHK applications to generate knowledge relevant for industry to develop and deploy innovative components, structures, materials, systems, and approaches to manufacturing. As a key part of this process, the Program develops, improves, and validates computer modeling tools and methodologies needed to optimize device and array performance and reliability across operational and extreme conditions. In addition, the Program supports testing infrastructure to enable systematic technology development testing by industry at multiple scales. The Program works to aggregate, analyze and disseminate data enabling industry-led development of cheaper and more effective monitoring instrumentation that ultimately increase efficiencies of permitting and regulatory processes.

Highlights of the FY 2018 Budget Request

The Water Power Program will pursue the following major activities in FY 2018:

- Modular hydropower systems: early-stage R&D into new approaches to hydropower designs that enable industry to lower the cost of installation and environmental impacts of new development. This work will includes computational design tools developed by the National Laboratories and the validation of designs through competitively-awarded industry-led projects.
- Hydropower grid reliability: Research and analysis to strengthen the body of knowledge necessary for the hydropower industry to provide grid reliability services. A key focus will be early-stage research to model and simulate how multiple run-of-river hydro plants could operate as a single dispatchable system.
- Novel hydropower turbines: early-stage R&D to develop design tools capable of evaluating power potential and environmental impacts of novel turbine designs. Evaluate the potential cost and performance impact of advanced turbine technologies such as embedded sensors for turbine condition monitoring and turbine manufacturing techniques.
- Advanced MHK system: Building on recent advances in controls, develop tools to model and evaluate device-neutral control strategies, and test full sensor-based control algorithms in a wave tank setting. Continue research to define the requirements of tidal and wave systems to achieve the cost reductions necessary for eventual cost-competitiveness, as well as preliminary research to structure a competition likely targeted at R&D needs specific to high-priority remote and sensor applications.
- MHK monitoring instrumentation: Early-stage R&D at National Laboratories to conduct proof of concept and technical feasibility testing of environmental monitoring instruments designed to operate in harsh marine environments as part of industry-led projects previously competitively awarded.

Water Power
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Water Power				
Hydropower Technologies	24,750	—	11,650	-13,100
Marine and Hydrokinetic Technologies	44,250	—	8,750	-35,500
NREL Site-Wide Facility Support	1,000	—	0	-1,000
Total, Water Power	**70,000**	**69,867**	**20,400**	**-49,600**

SBIR/STTR:

- FY 2016 Transferred: SBIR $1,123,000; STTR $168,000
- FY 2017 Projected: SBIR $1,121,000; STTR $168,000
- FY 2018 Request: SBIR $653,000; STTR $92,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Water Power
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Water Power	
Hydropower Technologies: Decreased funding for later-stage development of new hydropower technologies through competitive solicitations for industry-led projects, such as turbines and civil works structures for powering non-powered dams or low-impact pumped storage designs. In FY 2018, the subprogram will focus on earlier-stage research at the National Laboratories to develop design codes and modeling tools, and competitively-selected awards will be limited to the modeling and testing of early-stage designs.	**-13,100**
Marine and Hydrokinetic Technologies: Eliminated funding for new competitive solicitations focused on later-stage development and testing of specific marine energy systems and components, such as power take-off, controls, or structural designs, as well as a decreased funding for research on the environmental impacts of marine energy and the physical characterization of different wave and tidal resource climates. In FY 2018, the subprogram will focus on earlier-stage technology research, design codes, and modeling tools to improve understanding of promising energy conversion concepts.	**-35,500**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-1,000**
Total, Water Power	**-49,600**

Water Power
Hydropower Technologies

Description

Hydropower is the oldest and largest installed renewable energy resource in the U.S.. While hydroelectricity has been in use for over a century, there is still opportunity for additional generating capacity and grid reliability services realized through novel design and operations innovations. The 2016 DOE *Hydropower Vision* report, which represented views regarding hydropower development across industry, environmental organizations, and all levels of government, verified this potential. The *Vision* identified a number of credible scenarios where industry could realize up to 50 GW of new hydropower capacity from upgrading and modernizing the existing fleet, installing generation on non-powered dams, and developing new small hydropower and pumped storage technologies.

The Program's hydropower strategy is aligned to the roadmap in the *Hydropower Vision*, which set forth priority pathways identified by industry, environmental groups, and other hydropower stakeholders as the necessary steps to realize the full potential benefits of hydropower in the U.S. These pathways involve strengthening the body of knowledge that enables industry to develop and deploy new technologies, quantify the value of grid reliability services, address regulatory requirements, and maintain and improve the sustainability of U.S. hydropower assets. While DOE is not engaged in every activity suggested in the roadmap, it leads in areas where government R&D is appropriate and most effective.

The Water Power Program targets both critical technology development challenges currently limiting hydropower generation, as well as research and analysis to improve understanding of how hydropower can contribute to the reliability of the grid. Examples of important technology challenges include reducing the site-specific costs of construction, powerhouse design/installation, and environmental mitigation for new hydropower at non-powered dams and greenfield sites; turbine designs that generate more power at given water flows or increase operational ranges with reduced impacts for existing hydropower facilities; reducing the operations and maintenance costs associated with more impactful modes of operation for grid stabilization; and novel closed-loop pumped storage designs that can be deployed at a wider range of sites and minimize or eliminate environmental impacts.

The subprogram's technology research and development efforts focus on areas where hydropower turbine manufacturers and hydropower-owning utilities are unlikely or unable to spend private capital. This typically includes the initial conceptual design, and numerical modeling and validation of technologies that can subsequently be adopted by industry for further development and commercialization. For entirely new and unproven approaches to hydropower development, such as modular hydropower or closed-loop pumped storage designs, the subprogram partners with competitively-selected technology developers to optimize designs, prove the viability of concepts, and collect and disseminate data that transfers knowledge of performance improvements across the entire industry. The subprogram also conducts early-stage research that identifies vulnerabilities or opportunities across the entire hydropower fleet (or specific subsets that share relevant characteristics) and therefore beyond the purview of any single operator. This research is essential to the prioritization of hydropower R&D and is unique to hydropower, where each plant and turbine is designed for a specific site and the operations of multiple plants in the same river basin can be closely interrelated. All hydropower R&D efforts are closely coordinated with the Federal agencies that own and operate half of the hydropower capacity in the U.S. While a small portion of these agencies' own budgets also go toward R&D, such efforts are typically targeted more to solve specific pressing O&M challenges associated with their own fleets as opposed to generating knowledge benefits relevant to the hydropower industry at-large.

Hydropower and pumped storage projects provide critical services that help maintain the reliability and resiliency of the nation's power grid. Services include quick response dispatchable power that can be used to meet peak demand and balance variable renewables like wind and solar, as well as a discrete set of technical capabilities unique among renewable energy technologies. These capabilities range from sub-second frequency response to black-start capabilities that can help the grid quickly recover from an outage. Pumped storage provides many of these same services, in addition to the ability to absorb excess generation during the pumping mode and save power for when it is needed most. However, while these capabilities are understood to be critical to the grid, hydropower developers, operators, and regulators lack the capability or incentives to better quantify their precise value which leads to potential inefficiencies in how existing power and ancillary services are procured and compensated. Working with the National Laboratories and the Grid Modernization Laboratory Consortium, the value of hydropower services to the grid will be placed in context with other technologies

providing similar services. This information can inform decisions on future R&D requirements, and also be used by policymakers or market operators to provide appropriate incentives for the flexibility and grid services each requires.

Efforts to improve sustainability and environmental performance of the nation's hydropower systems are inherently linked to the development of new hydropower technologies and modernization of the existing fleet. Scientific advances that allow for developers and operators to more effectively identify and mitigate potential impacts ultimately allows for more new hydropower development, more effective utilization of existing hydropower, and reduced regulatory costs. For example, the subprogram supports research to incorporate environmental performance criteria into turbine design and evaluation tools, enabling both lower environmental impacts and improved efficiency and flexibility at new and existing projects.

In FY 2018, the Water Power Program will continue R&D efforts to specify design requirements for standardized, modular hydropower technologies, and define these new approaches to hydropower design, manufacturing and construction to enable industry to lower the cost of installation while minimizing the environmental impacts of new hydropower. The work will also include competitively selected, industry-led projects to validate and optimize the design of novel generation, foundation, and fish passage proof of concept modules while collecting high-fidelity data to improve the performance of National Laboratory design specifications and computational modeling tools.

In FY 2018, the subprogram will conduct early-stage research into novel turbine design and evaluation tools that can enable industry to improve the performance and efficiency of existing hydropower facilities. This research provides turbine design tools to allow hydropower operators to generate more power while minimizing impacts and meeting regulatory requirements. The subprogram will continue to actively engage with turbine manufacturers to ensure their input into tool design.

In FY 2018, in coordination with operators and other government agencies, the subprogram will continue to collect and analyze data on existing hydropower assets to inform future program R&D. In addition, the subprogram will evaluate the potential cost and performance impact of advanced turbine technologies such as embedded sensors for turbine condition monitoring and advanced turbine manufacturing techniques.

In FY 2018, the subprogram will continue R&D efforts that can enable multiple run-of-river hydropower plants, which traditionally have less operational flexibility, to operate as an interconnected, dispatchable system. This effort, utilizing National Laboratory and industry partnerships, will generate valuable knowledge upon which operators of both new and existing hydropower can provide additional value to the stability of the power grid.

In FY 2018, the subprogram will finalize a 4-year research project with the U.S. Army Corps of Engineers, under the interagency Hydropower MOU that completes the development of a miniaturized cost-effective injectable acoustic fish tag through testing and validation to inform future early-stage R&D into design considerations. This effort, which has received significant in-kind support from industry, will allow the Corps and many other hydropower operators to better understand the behavior of sensitive aquatic species in and around hydropower turbines and optimize power generation while reducing impacts.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Hydropower Technologies $24,750,000	**$11,650,000**	**-$13,100,000**
• Under the HydroNEXT initiative, solicit and competitively select up to four projects focusing on new hydropower technology for non-powered dams. This effort will identify and demonstrate new technologies associated with powertrain and civil works that will minimize construction costs and environmental impacts.	• This element is not funded in FY 2018.	• Projects under the FY 2016 competitive solicitation were selected in FY 2017 and will continue into FY 2018.
• Issue a solicitation and competitively select up to four projects that will assess the commercial viability of new and advanced pumped storage hydropower (PSH) technologies.	• Research into control systems to enable multiple run-of-river hydro plants to operate as single dispatchable system.	• Projects selected under the FY 2016 competitive solicitation were finalized and awarded in FY 2017. FY 2018 activities will build on previous program work to focus on thoroughly understanding the value of individual ancillary services provided by PSH and hydropower technologies, the costs of operating PSH and hydropower more flexibly, and new technologies that can reduce such costs and more efficiently contribute to grid reliability.
• Identify and leverage existing Federal, university, or industry hydro-mechanical test facilities for full-scale performance and reliability testing of low-impact powertrain and components testing.	• This element is not funded in FY 2018.	• Activities undertaken since FY 2016 to identify and define testing needs will end in FY 2017.
• Support hydraulic, structural, materials, and construction design innovations that reduce the cost, footprint, and environmental disturbance of siting, supporting, installing, and operating promising powertrain technologies through a low-impact, low cost balance of plant design initiative.	• R&D and competitively-selected industry awards for standardized, modular designs for novel turbines/powertrain, foundations, and fish-passage that enable industry to lower the cost of installation and minimize environmental impacts of greenfield hydro projects.	• FY 2018 work is based on the development of an exemplary design specification in FY2016. This design specification will be used to inform the further research and competitive selection process for applicable designs.
• Validate the environmental performance and sustainability of new hydropower technologies.	• Continue the development of design tools that evaluate environmental impacts of fish passage through turbines and allow for more efficient, low impact designs, as well as conclude the final year of a 4-year partnership with the U.S. Army	• FY 2018 represents the continuation of projects initiated in prior years.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
	Corps of Engineers on the design of acoustic fish tags for American Eel and Pacific Lamprey.	
• Energy-Water Nexus Crosscut: initiate work to expand the number and diversity of hydropower systems represented in integrated assessment models, with the aim of identifying their potential effects and benefits to other water and energy systems (such as thermal generation units).	• U.S. – China Clean Energy Research Center (CERC): the five-year Water-Energy Technology track, initiated in 2016, facilitates joint research by teams of scientists and engineers from the U.S. and China to better understand and reduce vulnerabilities inherent in the interlinkages of national and regional energy and water systems.	• FY 2018 Request supports continuation of one of the activities initiated in FY 2016, support of the U.S. – China Clean Energy Research Center's work to improve accurate representation of hydropower systems in integrated energy assessment models to identify future significant water and energy systems risks. Comparable National Laboratory work as part of the Energy-Water Nexus is eliminated in FY 2018.

Water Power
Marine and Hydrokinetic Technologies

Description

Marine and hydrokinetic (MHK) technologies convert the energy of waves, tides, and river and ocean currents into electricity. National resource assessments have found that the U.S. has 1,250–1,850 terawatt-hours per year (TWh/yr) of untapped, technically extractable MHK resource potential[1], equivalent to nearly 30% of total electricity generation in the U.S. MHK is a predictable, forecastable resource with generation patterns typically complimentary to other renewable resources such as onshore wind and solar, enhancing its potential to enhance grid stability. Industry deployment of MHK technologies for bulk power generation is nascent, and far from cost-competitiveness at the utility scale for MHK technologies. However, niche applications such as serving remote coastal communities with high electricity costs, charging for ocean-based sensors and underwater vehicles, and non-electric uses like desalination could provide industry with opportunities to develop and deploy MHK technologies in the near-term.

The subprogram's strategy to help catalyze the development of MHK focuses primarily on technology research and design tools to enable industry to reduce cost and improve performance of MHK technology concepts. This research involves testing new proof of concept systems in laboratory and ocean settings to understand performance characteristics, identify and mitigate reliability risks, and provide data to inform future R&D to improve early-stage designs across the industry. The subprogram also evaluates the potential environmental impacts of novel energy conversion technologies, generating data useful to developers and regulators in addressing regulatory requirements for in-water testing and commercial adoption.

The MHK subprogram is committed to investment in R&D that allows the domestic MHK industry to advance and achieve cost competitiveness with local hurdle rates in high-cost markets, while working towards the long-term goal of cost competitiveness at the utility scale. This will be accomplished by focusing early-stage research on design concepts that have potential to increase energy capture and annual energy production of devices, improve reliability and availability, and reduce capital and operating/maintenance costs if further developed and deployed by industry. A major programmatic focus is on controls research, where studies have shown that advances can provide significant increases (on the order of 200-300%) in energy capture. Controls strategies and technologies are also being leveraged from other industries (e.g. aerospace, defense) that can maximize power production over a range of ocean conditions. Other priorities include improving and validating modeling tools and methodologies needed to optimize device and array performance and reliability across operational and extreme conditions, and investigating new approaches for safe and cost efficient installation, grid integration, operations, maintenance, and decommissioning of MHK projects. The Program's efforts in each area create a knowledge base and design tools that enable industry to develop solutions for their own systems, and focus on areas where the existing industry does not have the computational tools, expertise or budget to perform on their own. These are priority areas where targeted government support at early-stages in the research and development process can generate knowledge benefits applicable to MHK technology development and deployment by industry, as well as broader knowledge spillover benefits from innovations in materials, sensors, and modeling capabilities.

For industry to move MHK technologies beyond small-scale prototypes requires in-water tests of performance and efficiency, and the validation of reliability and the ability to survive extreme weather. Due to the complexity of the wave physics of high-energy sea states and the fluid dynamics of sub-sea currents, even simple MHK prototypes must be tested in realistic (i.e. ocean) settings in order to get data that accurately reflects system performance. This testing is highly expensive and time consuming due to the unique challenges of the marine environment, and it is generally beyond the capacity of the relatively early-stage technology companies that comprise the industry. The subprogram partners with industry members to support the development and testing of early-stage prototypes, as well as to make available dedicated testing infrastructure to reduce the inefficiency associated with each developer investing in its own separate testing cables and permits. The results of in-water tests are collected and aggregated by DOE and made broadly available to ensure knowledge generated through public funding is widely available.

[1] Technical resource potential refers to the portion of a theoretical resource (annual average amount of physical energy that is available) that can be captured and converted to electricity.

The subprogram also supports efforts to model and predict the environmental effects of marine energy devices, through research that simulates device-ecosystem interactions and enables new technologies that more accurately monitor devices in the water. Subprogram research generates new data and synthesizes and disseminates existing data that would not otherwise be available to resource agencies and regulators.

In FY 2018, the MHK subprogram will continue to support advanced controls research for MHK devices. This work builds upon successes of the DOE 2016 Wave Energy Prize Competition, which catalyzed industry-led teams to realize the largest single leap in potential wave energy device technology with a five-fold performance increase and a potential reduction in projected energy costs of 50% by 2030. The work will use numerical modeling to quantitatively compare control strategies and systems and develop tools to evaluate device-neutral control systems and test sensor-based algorithms in the Naval Surface Warfare Center Carderock Division's Maneuvering and Seakeeping Basin, a national testing asset for scale model testing.

In FY 2018, the MHK subprogram will also continue research to quantify the system requirements of wave energy devices to achieve necessary cost reductions, develop numerical design models that will enable industry to incorporate those requirements into future designs, and assess the cost-reduction potential for system designs at an earlier stage of development in order to reduce costly later-stage device development and testing. The research includes validation of recently developed Technology Performance Levels (TPLs) as a metric to quantify techno-economic performance potential of WEC technologies. Technology developers will continue to be engaged in the development of functional requirements.

In FY 2018, the MHK subprogram will continue to collect data from ongoing laboratory and in-water device tests (funded in prior fiscal years), analyze and aggregate that data to further guide future early-stage R&D investments, and broadly disseminate results.

In FY 2018, the MHK subprogram will continue efforts in modeling and validation of instrumentation developed under competitively-selected industry-led projects. These projects will reduce costs and improve performance for special-purpose instruments designed to operate in harsh marine environments, helping reduce the time and cost associated with siting and permitting MHK projects.

In FY 2018, the MHK subprogram will also begin preliminary research to identify specific design requirements for future systems targeted toward a range of applications including high-cost electric or remote and/or off-grid communities as well as non-grid applications such as underwater sensors. This effort builds on analysis completed in FY 2017 to identify promising early-market opportunities for MHK technologies, and is planned to culminate in the establishment of a research, design and test competition.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Marine and Hydrokinetic Technologies $44,250,000	**$8,750,000**	**-$35,500,000**
• Complete detailed front-end engineering and design of a multi-berth, full-scale grid-connected open water wave test facility. The results of this completed engineering and design phase will be used to support a programmatic go/no-go decision on further facility construction funding.	• This element is not funded in FY 2018.	• A competitive solicitation for the construction of the test facility was released in FY 2017, based on the initial preliminary design competition. No funding is requested in FY 2018.
• Award up to three competitive MHK subprogram demonstration projects that will integrate advanced components into MHK systems.	• This element is not funded in FY 2018, however performance data collected though ongoing projects will continue to be validated by DOE and disseminated to improve future designs.	• Projects under the FY 2016 competitive solicitation were selected and awarded. In FY 2018, the Program's focus shifts to earlier-stage research and development that can apply across a wide range of marine energy designs.
• Continue structured innovation R&D to define the requirements for wave energy devices to become cost-competitive, and continue a competition began in FY 2015 to develop and test next-generation wave devices to quantify and demonstrate improved performance.	• Continued research to quantify the system requirements of wave energy devices to enable cost reductions, develop numerical design models, and assess the cost-reduction potential for system designs, as well as preliminary research to structure a competition, likely targeted at high-priority remote and sensor applications.	• Initial Wave Energy Prize competition was completed in FY 2016. Research to define cost-competitiveness requirements proceeding according to project plan.
• Coordinate with relevant Federal agencies to continue environmental research and aggregate, analyze, and disseminate environmental research data. Award up to five competitive projects for the development and testing of new sets of instruments for environmental monitoring. These efforts will help reduce the time and cost associated with siting and permitting MHK projects, currently a critical barrier in the technology development cycle.	• National Laboratory support for the modeling and validation of instrumentation developed under the competitively-selected awards.	• No change. This represents planned laboratory activities in the awarded projects.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Validate open source advanced design tools for extreme conditions modeling, greatly reducing engineering time required to obtain confidence in robust system design.	• This element is not funded in FY 2018.	• Project will be completed in FY 2017. The extreme conditions modeling methodology and associated tools will be completed and made available to industry in FY 2017.
• Validate two-fold improvement of absorbed power of wave energy capture devices in the laboratory with controls technology.	• Building on recent advances in controls, develop tools to model and evaluate device-neutral control strategies and test full sensor-based control algorithms in wave tank setting.	• Previous research validated a five-fold improvement and confirmed advanced controls as key cost reduction pathway; FY 2018 focus is on device-neutral tools to evaluate and further optimize controls for increased power capture.
• Complete and release a wave classification scheme to enable design of technology products for resource classes rather than individual designs for specific sites.	• This element is not funded in FY 2018.	• National Laboratory projects funded since FY 2016 to research and develop improvements to wave classification schemes and site-specific wave energy characterization are terminated under the FY 2018 Request.

Water Power
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $1,000,000	**$0**	**- $1,000,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Water Power Program Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Program Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Water Power
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Water - Dams - Cost of hydropower from dams (cents/kWh)**		
Target	9.8 cents/kWh	9.7 cents/kWh	9.6 cents/kWh
Result	Met - 9.8	TBD	TBD
Endpoint Target	9.2 cents/kWh by 2020, 7.5 cents/kWh by 2030		
Performance Goal (Measure)	**Water - Marine & Hydrokinetic (MHK) - Cost of energy from Marine & Hydrokinetic technologies (cents/kWh)** **2016: Double energy capture per cost (meters per million dollars)**		
Target	3 m/$M	66 cents/kWh	64 cents/kWh
Result	Met - 3	TBD	TBD
Endpoint Target	27 cents/kWh by 2030		
Performance Goal (Measure)	**Water - Streams - Cost of energy from new stream developments (cents/kWh)**		
Target	11.7 cents/kWh	11.5 cents/kWh	11.4 cents/kWh
Result	Met - 11.7	TBD	TBD
Endpoint Target	10.9 cents/kWh by 2020, 8.9 cents/kWh by 2030		

Geothermal Technologies

Overview

Geothermal energy is a domestic energy resource from the heat of the earth, which represents a clean, efficient, and nearly inexhaustible baseload energy source. The current domestic installed capacity is over 3.8 gigawatts (GW). Current estimates of technically recoverable resource potential include a mean estimated 30 GW of new undiscovered hydrothermal resources (compared to the current 3.8 GW of geothermal energy connected to the electric grid) and 100+ GW of new geothermal energy accessible through Enhanced Geothermal Systems (EGS) (compared to the current 6.2 MW). However, technological innovation is required for industry to convert these resources into useful energy services. The mission of the Geothermal Technologies Program is to support early-stage research and development (R&D) to strengthen the body of knowledge upon which industry can accelerate the development and deployment of innovative geothermal energy technologies.

The Program's technology portfolio prioritizes early-stage R&D in two closely related geothermal categories: hydrothermal and EGS.[1] This research addresses the high risk in early stage R&D that industry does not have the technical capabilities or institutional knowledge to conduct. The geothermal industry operates in a harsh subsurface environment with unique technical and operational challenges. Foremost among those challenges is that the resource is "out of sight" at a depth of approximately 2 to 5 kilometers, in hard, abrasive rock formations at elevated temperatures and pressures well beyond those typically encountered in oil, gas, or other subsurface operations. Consequently, DOE involvement in early stage research and development enables the geothermal sector to develop cutting-edge technologies and innovation that expands the potential for domestic geothermal energy growth and future production in new geographical regions of the country.

Highlights of the FY 2018 Budget Request

The Geothermal Technologies Program will pursue the following major activities in FY 2018:

- The EGS Collaborative (Collab) brings together National Laboratory-led teams, academia, and industry to develop centralized, small-scale testing facilities where the fundamental relationships between seismicity, stress state, and permeability (cracks in the rock) can be resolved, and thermal hydro mechanical chemical (THMC) models can be validated and verified. Funding under this budget request will support experiments at the site selected within the Sanford Underground Research Facility (SURF) Mine in South Dakota that focus on better understanding shear stimulation and mixed mode fracturing. FY 2018 will focus on the design of the stimulation tests based on the detailed site characterization, THMC modeling of desired tests to optimize preliminary test design, and the design and installation of novel geophysical, hydrological, and geomechanical monitoring networks. The basic science challenge addressed by the EGS Collab is to better understand fracture dynamics in crystalline rock and fluid flow at an intermediate scale, too far from commercialization to merit industry investment. The fundamental concepts associated with advancing our understanding of permeability creation, enhancement, and sustainability will be directly applied at the Frontier Observatory for Research in Geothermal Energy (FORGE) EGS field laboratory.
- FY 2018 will be the final year of a three-year Hydrothermal effort for three National Laboratory projects targeting innovative early-stage research on microhole drilling applications, self-healing cements, and subsurface imaging. If further developed and deployed by industry, microhole drilling has the potential to reduce exploration costs by allowing smaller diameter wells to be drilled cheaper and faster while still capturing necessary downhole data for resource evaluation. In addition, self-healing cements could provide a major cost saving opportunity for well completions, reducing the instances of wellbore collapse due to cement bond failure. Lastly, innovative subsurface imaging could allow for more discrete targeting of wells, thus increasing the probability of drilling a successful well.
- The Program will initiate new early-stage R&D in waterless stimulation in an effort to reduce the impact of energy development in water-starved regions of the west where geothermal resources are prevalent and in EGS systems. Candidate stimulation fluids such as CO2, gelled propane, and liquid nitrogen will be investigated through laboratory experiments and numerical modeling to quantify the underlying physics and identify controls.

[1] Hydrothermal resources exist where there is sufficient temperature, permeability, and fluid in the subsurface such that fluids can flow naturally at economic rates for power generation. EGS reservoirs require rock stimulation for permeability enhancement and fluid injection to allow commercial-scale fluid flow.

- The Geothermal Technologies Program will continue implementation of the Frontier Observatory for Research in Geothermal Energy (FORGE) to advance Phase 3 field operations at the FORGE site. While the Program does not request funds in the FY 2018 Budget Request for FORGE, prior year funds will support the commencement of drilling and continuation of site characterization in FY 2018.

The goal of the Geothermal Technologies Program is to support early-stage R&D, enabling development of geothermal energy technologies. These technologies will allow geothermal energy to be a fully competitive, widely available, and geographically diverse component of the national energy mix. Subprogram objectives include, improving the ability to visualize the subsurface and increasing understand of the stress in the subsurface. The results of these developments will allow industry to more efficiently and effectively tap into the 30 GW of undiscovered hydrothermal resources and 100+ GW of enhanced geothermal systems resources.

Geothermal Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Geothermal Technologies				
Enhanced Geothermal Systems	45,000	—	5,368	-39,632
Hydrothermal	13,800	—	6,077	-7,723
Low Temperature and Coproduced Resources	8,000	—	0	-8,000
Systems Analysis	3,700	—	1,055	-2,645
NREL Site-Wide Facility Support	500	—	0	-500
Total, Geothermal Technologies	**71,000**	**70,865**	**12,500**	**-58,500**

SBIR/STTR:

- FY 2016 Transferred: SBIR $885,000; STTR $133,000
- FY 2017 Projected: SBIR $883,000; STTR $132,000
- FY 2018 Request: SBIR $400,000; STTR $56,000

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Geothermal Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Geothermal Technologies	
Enhanced Geothermal Systems: Funding for FORGE Phase 3 field operations is fully funded through prior-year appropriations and no additional funding is requested FY 2018. Other reductions reflect the discontinuation of later-stage R&D in advanced stimulation, zonal isolation, and fracture propping tools.	**-39,632**
Hydrothermal: Reduced funding reflects the completion of the Play Fairway Analysis effort as well as a reduction in later-stage research in the areas of Wellbore Integrity, Subsurface Stress and Induced Seismicity, and New Subsurface Signals.	**-7,723**
Low Temperature and Coproduced Resources: Reflecting the shift in focus to early-stage research and development, no funding is requested for the Low-Temperature and Coproduced Resources subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.	**-8,000**
Systems Analysis: Reduced funding reflects the completion of the Vision Study in FY 2017.	**-2,645**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-500**
Total, Geothermal Technologies	**58,500**

Description

Enhanced Geothermal Systems (EGS) are engineered reservoirs, created where there is hot rock but little to no natural permeability or fluid saturation present in the subsurface. To develop an EGS, fluid is injected into the subsurface at low-to-moderate pressures under a safe, controlled, environmentally responsible, and well-engineered stimulation process that will cause pre-existing fractures or weaknesses in the rock fabric to open. The pressure increase causes displacements along the fracture planes and zones of rock heterogeneity, which results in increased permeability and allows fluid to circulate throughout the rock, heating up during circulation. Via a production well, this heated fluid then transports the heat to the surface, which can be used to generate electricity. In the long term, strengthening the body of EGS knowledge through early-stage R&D will enable industry to develop a baseload energy resource estimated at approximately 100+ GW.

EGS research is in a relatively early stage yet it shares common challenges with other subsurface industries; operational data and research experience to date indicate that overcoming the challenges in EGS technology development requires a broad-based, multidisciplinary approach. Critical to advancing EGS are technologies that facilitate characterization of local stress, chemical constituents, and fluid and thermal pathways evolution through space and over time. Economic access to the subsurface thermal resource, while ensuring wellbore integrity over multi-decadal timeframes, is another challenge requiring new materials and novel approaches. A final overarching hurdle is sustainable operation, which involves achieving sufficient productivity for power generation without excessive pressure build up or localization and decrease of flow.

Early stage R&D remains a fundamental part of the EGS subprogram. Because of the lengthy development timeline for subsurface technologies and methodologies, the EGS subprogram will maintain investment in R&D that feeds into the Frontier Observatory for Research in Geothermal Energy (FORGE) operations, such that basic geoscience and computational challenges are resolved and can inform the design of FORGE wells and stimulations. The EGS Collaborative (Collab) brings together a collaborative National Laboratory -led team comprised of eight national labs, academia, and industry to develop a first-of-its-kind intermediate-scale, in-situ experimental site where the fundamental relationships between seismicity, stress state, and permeability (cracks in the rock) can be resolved, and thermal hydro mechanical chemical (THMC) models can be validated and verified. FY 2018 will focus on experiments at a site selected by GTO in FY2017 within the Sanford Underground Research Facility (SURF) Mine in South Dakota that focus on better understanding shear stimulation and mixed mode fracturing. FY 2018 will focus on the design of the stimulation tests based on the detailed site characterization, THMC modeling of desired tests to optimize preliminary test design, and the design and installation of novel geophysical, hydrological, and geomechanical monitoring networks. EGS Collab addresses fundamental and basic science questions associated with subsurface fracture and flow dynamics in crystalline rocks at an intermediate scale, too far from commercialization to merit industry investment. The advanced knowledge of permeability creation, enhancement, and sustainability gained from work at Collab will be directly applied at the FORGE EGS field laboratory.

In FY 2018, the Geothermal Technologies Program has not included a request for funding to support FORGE, the Program's flagship initiative focused on EGS optimization. The Program will obligate prior appropriations to fully fund year two of Phase 3 in FY 2018. By enabling transformative and high-risk science and engineering, FORGE is an essential step toward establishing the capability to improve our understanding of EGS concepts. FORGE is a collaborative and inclusive effort involving a diverse group of geothermal and subsurface stakeholders; participation and contribution from industry, DOE National Labs, and academia are integral to its success. Furthermore, testing of new technologies and methodologies in the deep rock environment accessed at FORGE will facilitate a fundamental understanding of the key mechanisms controlling processes at depth at full operational scale.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Enhanced Geothermal Systems $45,000,000	**$5,368,000**	**-$39,632,000**
• Frontier Observatory for Research in Geothermal Energy (FORGE): o Finalize design of the first FORGE well and auxiliary wells that may be utilized for complementary R&D efforts, such as monitoring, characterization, and tracer analysis. o Continue further characterization of the in-situ stress field needed, utilizing various techniques and further characterization of fluid content and composition at depth. o Incorporate field testing of methodologies/tools/procedures developed through the EGS subprogram's FY 2014 Integrated EGS R&D solicitation (12 awards). o Continue micro seismic and other geophysical and geochemical signature monitoring initiated in Phase 2; all data put into dynamic reservoir modeling efforts. o Upload all characterization and monitoring data collected throughout the initial year of Phase 3 to the FORGE Data System/Node in real-time. o Issue first FORGE R&D solicitation, on research and technology testing related to site characterization technologies and other topics defined by the collaboratively developed FORGE multi-year R&D strategy.	• No funding is requested.	• No funding requested in FY 2018. Phase 3 FORGE field operations will continue throughout FY 2018. In FY 2017, the first FORGE well will be drilled, and the first set of competitive R&D awards will be made. In FY 2018, the second FORGE well will be drilled, and awards will be made on the second R&D solicitation. All baseline geophysical and geochemical characterization, data sharing, as well as robust communications will continue throughout the entirety of Phase 3.
• Advance R&D (funded through the Annual Operating Plan and performed by National Labs and industry or academic partners) focused on larger scoped, collaborative projects that utilize a systems approach to understand and design effective reservoir stimulation methodologies,	• No funding is requested.	• These AOP projects concluded at the end of FY 2017.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
induced seismicity, and to understand and predict reservoir sustainability.		
• Supported critical laboratory-scale work and first-of-their-kind feasibility studies on fracture characterization, innovative tracer technology development, and joint geophysical methods for reservoir imaging will continue through the down select of FY 2014 EGS R&D FOA projects.	• No funding is requested.	• FOA projects concluded at the end of FY 2017. No new projects will be solicited or awarded.
• N/A	• The EGS Collab will be located at an underground mine in the state of South Dakota. Under this initiative in FY2018, eight national laboratories with academic and industry partners will conduct simple fracture experiments focused on shearing in order to improve our understanding of fluid flow in fractured crystalline rock.	• The EGS Collab was awarded in FY 2017 to eight National Laboratories, led by Lawrence Berkeley National Laboratory. FY 2017 work focused on site selection within the mine, obtaining NEPA clearances, and experimental design for the first fracture experiment. The simple experimentation conducted in 2017 will validate modeling assumptions, leading to more complex and focused experiments in FY 2018.

Geothermal Technologies
Hydrothermal

Description

The U.S. Geological Survey's (USGS) 2008 Geothermal Resource Assessment estimated that over 30 gigawatts (GW)[1] of undiscovered hydrothermal resources exist in the western U.S. alone. However, the technical feasibility of discovering and developing this resource potential depends on innovative approaches to subsurface characterization. Hydrothermal resources have the following three key elements associated with geologically active areas: heat, fluid, and permeability (the ability for fluid to flow through rock). However, given the stage of geothermal development in the U.S., most of these remaining resources are either not yet discovered or in so-called "blind" systems (i.e., showing little to no surface expression). These systems require new and innovative approaches to exploration. The risks and costs associated with successful geothermal exploration and development in these poorly characterized areas are high, and the sector's inability to drill consistently economically viable wells is therefore a major barrier to industry's ability to expand capacity in the near-term.

The Hydrothermal subprogram supports the early stage research and development (R&D) of technologies necessary to effectively find and access hydrothermal resources, enabling the private sector to further develop and bring them online with an ultimate goal of reducing the cost of electricity generated from currently undiscovered hydrothermal resources to 10 cents/kWh by 2020. FY 2018 will be the final year of a three-year effort for three national lab projects targeting innovative approaches to microhole drilling applications, self-healing cements, and subsurface imaging. If further developed and deployed by industry, microhole drilling has the potential to reduce exploration costs by allowing smaller diameter wells to be drilled cheaper and faster while still capturing necessary downhole data for resource evaluation. In addition, Self-healing cements could provide a major cost saving opportunity for well completions, reducing the instances of wellbore collapse due to cement bond failure. Lastly, innovative subsurface imaging could allow for more discrete targeting of wells, thus increasing the probability of drilling a successful well.

In addition, the Hydrothermal subprogram is pursuing the goal of effective, adaptive, and safe control of fractures and fluid flow through four complementary pillars of research: wellbore integrity, subsurface stress and induced seismicity, permeability manipulation, and new subsurface signals. Having funded research in wellbore integrity and new subsurface signals in FY 2015-2017, the subprogram proposes for FY 2018 a new early-stage R&D effort in waterless stimulation. This research, in an effort to reduce the impact of energy development in water-starved regions of the west where geothermal resources are prevalent and in EGS systems, will investigate alternative methods to reduce or completely eliminate the use of water. Candidate stimulation fluids such as CO2, gelled propane, and liquid nitrogen will be investigated through laboratory experiments and numerical modeling to quantify the underlying physics and identify controls.

[1] (range from a 95 percent probability of identifying 7.9 GW to a 5 percent probability of identifying 73 GW)

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Hydrothermal $13,800,000	**$6,077,000**	**-$7,723,000**
• FY 2016 funds supported Phase II of the Play Fairway Analysis (PFA) program. In PFA, awardees used combinations of various data sets, such as gravity, seismic, and magnetelluric data, among others, to determine where it would be most likely that an unknown ("blind") hydrothermal resource could be found, thus reducing that upfront exploration risk. FY 2016 funds supported Phase II of the project whereby additional data was added to refine the geothermal favorability maps, with FY 2017 expected funds moving some of the awardees into Phase III, the start of drilling to validate, for one or two of the awardees, the methodologies investigated in Phase II.	• No funding is requested.	• The PFA effort will be completed by the end of FY 2018 with prior year appropriations. No new solicitations or awards will be made.
• The subprogram initiated competitively selected, three-year funding of DOE National Lab R&D to reduce cost and risk of drilling, wellbore materials, and advance innovative exploration techniques.	• In this final year of these three projects: o Microhole drilling: a comparison of the efficiency of various microhole drilling technologies will be completed. o Subsurface imaging: testing new imaging processing using a real-world data set o Cements: evaluate multiple cement recipes for durability and self-healing characteristics	• These projects have continued from FY 2016 through FY 2018.All projects will be completed in FY 2018. No additional solicitations or awards are planned.
• GTO participated in a joint competitive funding opportunity with other DOE offices involved in the Subsurface Engineering crosscut, a critical effort for advancing innovative RD&D. The crosscutting nature of these topics aims to result in outcomes that are accretive across multiple DOE Offices. Ongoing R&D projects at the national laboratories support the subsurface Initiative.	• Two projects at national laboratories investigating waterless stimulation techniques and various fluid chemistries.	• The three laboratory projects awarded in FY 2017 investigating wellbore integrity will continue through FY 2018. The new FY 2018 projects on waterless stimulation will broaden subsurface fracture propagation knowledge.

Geothermal Technologies
Low Temperature and Coproduced Resources

Description

The Low Temperature and Coproduced Resources subprogram supported targeted RD&D on technologies applicable to geothermal resources below a temperature of 300°F (150°C) as well as geothermal resources, including thermal desalination processes and hybrid power designs that can be co-developed with existing well-field infrastructure and other clean energy technologies. Although these low-temperature resources have a lower power conversion efficiency than other geothermal resources — due to the lower temperature fluids — these resources are abundant; highly accessible across the U.S.; and as in the case of co-produced fluids, have much of the necessary infrastructure in place — attractive attributes that lower the effective LCOE. Improving the efficiency of lower temperature geothermal systems, and expanding their utility through value-added commercial opportunities (i.e., combined mineral recovery, desalination) can enable near-term development of innovative geothermal technologies in more geographically diverse areas of the U.S. However, much of the research and development opportunity in the low temperature and coproduced resources space is later-stage. Thus, industry has a greater incentive and capacity to fund commercialization of novel technologies.

The Low Temperature and Coproduced Resources subprogram also supports R&D of the direct use of thermal resources for process and space heating applications. Direct use geothermal applications have the potential to provide cost-effective, renewable thermal energy in large portions of the U.S. A recently completed USGS assessment estimates 46,500 MW thermal (MWth) of total beneficial heat that is available from geothermal resources below 90°C in the U.S.[1] Preliminary calculations by NREL suggest that full utilization of this resource would equate to supplying nearly one quarter (23 percent), of the total U.S. residential heating demand for the next 30 years.

Reflecting the shift in focus to early-stage research and development, no funding is requested for the Low Temperature and Coproduced Resources subprogram in FY 2018. Some management activities related to the execution of prior year appropriations will continue until completion.

[1] Williams, et al., Revisiting the Assessment of Geothermal Resources <90°C in the U.S. April 10, 2015.

Low Temperature and Coproduced Resources

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Low Temperature and Coproduced Resources $8,000,000	**$0**	**-$8,000,000**
• To allow for well-structured timing between the completion of the nine Phase 1 projects and an open call for Phase 2 projects, the Low Temperature and Coproduced Resources subprogram released the Phase 2 FOA and award projects for the Low Temperature Mineral Recovery initiative in FY 2016. • The subprogram initiated competitively selected, three-year funding of DOE National Laboratory R&D in value-added hybrid systems and geothermal desalination technologies including at least one pilot-scale demonstration of geothermal water purification processes.	• No funding is requested.	• Reflects shift in focus to early-stage R&D. Existing projects will be continued to close.

Geothermal Technologies
Systems Analysis

Description

The goal of the Systems Analysis subprogram is to identify and address barriers to geothermal adoption in the U.S. and validate and assess technical progress across the geothermal sector primarily to inform the direction and prioritization of early-stage R&D. The Systems Analysis subprogram takes a holistic analytical approach across the program's technology portfolio to evaluate trends, conduct impact analyses, identify best practices, and identify key investments needed to refine the Geothermal R&D portfolio aimed at increase knowledge and understanding of complex geothermal systems and technologies to convert geothermal resources into useful energy. The Systems Analysis subprogram primarily conducts analyses in the following areas: the environmental impacts of geothermal, the policy and regulatory barriers to development and deployment, economic modeling and validation of geothermal technologies, and collecting and disseminating data for stakeholder use to spur geothermal development. Lessons learned resulting from these analyses are subsequently incorporated into the program's strategic planning and either validate or refine the program's overall direction of early stage R&D. The Systems Analysis subprogram conducts these activities in partnership with the DOE National Labs, Federal agencies, academic institutions, and industry stakeholders.

In FY 2018, the Program will continue support for data collection and dissemination across all Geothermal Technologies subprograms. This includes continuing input into the Geothermal Electricity Technology Evaluation Model (GETEM), and assisting FORGE teams in deploying a node on the National Geothermal Data System (NGDS) tailored to researcher data requirements, which will expedite EGS research results by leveraging data collection efforts-to-date. The Systems Analysis subprogram will deploy integrated datasets from Hydrothermal efforts into the NGDS to maximize the number of mapping tools that industry and academia can utilize, thereby reducing the time and cost of determining geothermal potential.

Systems Analysis

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Systems Analysis $3,700,000	**$1,055,000**	**-$2,645,000**
• The Systems Analysis subprogram conducted analyses and developed tools to reduce development and deployment barriers to geothermal development in the U.S. as well as conducted analysis to identify, validate, and assess progress being made across the geothermal sector. • The Program conducted a robust Geothermal Vision Study to illustrate the geothermal potential and impacts based on scenarios within a geothermal continuum addressing the valuation of a full spectrum of geothermal technologies, including both power generation and direct use. • Supported data collection and dissemination across Geothermal subprograms, specifically the EGS FORGE, Low Temperature Mineral Recovery, and the Hydrothermal Play Fairway Analysis initiatives.	• FY 2018 work will continue to support the Geothermal Electricity Technology Evaluation Model (GETEM) and assisting the FORGE teams in deploying a node on the National Geothermal Data System (NGDS).	• The Geothermal Vision Study will be completed in FY 2017, limiting FY 2018 activities to core responsibilities of the Systems Analysis subprogram

Geothermal Technologies
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $500,000	**$0**	**-$500,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding Requested within the Geothermal Technologies Budget Request.	• Reduction in the Request is offset with a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Geothermal Technology
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Geothermal - Systems - Reduce the Levelized Cost of Electricity (LCOE) from newly developed geothermal systems (cents/kWh)**		
Target	22.2 cents/kWh	22 cents/kWh	21.8 cents/kWh
Result	Met - 22.2	TBD	TBD
Endpoint Target	6 cents/kWh by 2030		

Advanced Manufacturing

Overview

The Budget for AMO reasserts the proper role of the Federal Government by reflecting an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies and focusing funding toward early-stage research and development (R&D). Through focused and limited early-stage applied R&D activities, the Advanced Manufacturing Office (AMO) Program works with universities, laboratories, companies (for-profit and not-for profit), state/local governments, or consortia groups through merit-based peer-reviewed R&D activities for manufacturing process, information, and materials technologies essential to the efficient and competitive domestic manufacturing of energy products and to support energy productivity across the entire U.S. manufacturing sector.

Manufacturing generates 12 percent of U.S. gross domestic product (GDP)[1] and employs more than 12 million Americans. The U.S. manufacturing sector also has an annual energy bill of about $200 billion and uses roughly one-third of primary energy in the US.[2] DOE's work researching new technologies with the potential to subsequently improve the energy efficiency and productivity of U.S. manufacturers when commercialized by industry, can enable manufacturers of all kinds to be more competitive in the global marketplace. The program accomplishes this by focusing on early-stage R&D on cross-cutting, platform technologies relevant to manufacturing in multiple energy fields, and partnering with industry to lower scientific uncertainty that would otherwise limit the subsequent demonstration, adoption and use of the new knowledge gained through R&D, to ensure that new energy technologies invented in the U.S. ultimately result in the manufacture of energy products in the U.S.

AMO supports R&D projects, R&D consortia, and early-stage technical partnerships with national laboratories, companies (for-profit and not-for profit), research institutions, and universities through competitive, merit reviewed funding opportunities designed to investigate novel manufacturing technologies. The program supports early-stage research on manufacturing technologies through three different modes: individual R&D projects, collaborative R&D consortia, and technology partnerships that inform subsequent research activities as well as provide a vehicle for field verification research, knowledge dissemination, and transfer of novel manufacturing technologies.

AMO's early-stage applied R&D technology areas are organized around a limited set of major, high potential impact focus areas that have been developed through extensive engagement and consultation with private sector firms, non-profits, universities, and National Laboratory partners, as well as consultation with other Federal Agencies and Departments. These AMO technical focus areas are targeted toward early-stage research needs that, if adopted by industry for further development, can support manufacturing process, information and materials technologies. The focus of work will be knowledge creation from early stage research in these high-priority technical focus areas.

AMO technology areas have scientific knowledge gaps applicable to manufacturing and energy. With the cross-cutting and platform nature of this research, the new knowledge discovered in this work will be applicable to two or more sectors in energy and manufacturing. The early-stage research supported by AMO is targeted at processes and technological challenges that present a significant degree of scientific or technical uncertainty, requiring long time frame solution sets, meaning this research is unlikely to be pursued by industry which is focused on near-term cost reduction and process improvements. Examples include:

1. Advanced Materials: Advanced materials broadly applicable to energy products, including energy conversion materials, materials for extreme or harsh conditions, and nanomaterials needing innovative approaches to processing;
2. Critical Materials: Critical materials (ex: rare-earth materials) essential to energy for which there is potential for supply chain disruption;
3. Composites and Lightweight Materials: New composite and lightweight materials processes generating high-strength and low-weight materials for energy;

[1] "GDP by Industry / VA, GO, II, EMP," 2013, Bureau of Economic Analysis; available from: http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1997-2013.xlsx.

[2] Annual Energy Outlook 2014: Reference Case Data, U.S. Energy Information Administration, available from: *http://www.eia.gov/forecasts/aeo/data.cfm.*

4. Additive Manufacturing Processing: Additive (3D) processes capable of direct net-shape formation of metals, polymers, and ceramic materials for application in energy;
5. Roll-to-Roll Processing: Roll-to-roll processes with potential to form complex two-dimensional multi-material assemblies, and functional structures, including batteries, membranes and fuel cells;
6. Wide Bandgap Power Electronics: Wide bandgap electronics based on semiconductors that potentially reduce energy losses and improve reliability in electric power systems;
7. Novel Sensors and Process Controls: Technologies that leverage advanced sensors, controls, platforms, and models to enable real-time, operational energy efficiency improvements in processes; this also includes the new application of High Performance Computing to improve materials and manufacturing process technologies;
8. Chemical and Thermal Process Intensification: Chemical and thermal process intensification to reduce the size and energy intensity of manufacturing processes through higher reaction efficiency, novel mixing and separations, and low thermal budget heating and cooling;
9. Grid and Resource Integration in Manufacturing: Grid and resource integration, including new technologies for high efficiency Combined Heat and Power (CHP), waste heat to power, distributed generation, and real-time manufacturing demand response; and
10. Sustainable Manufacturing: Sustainable manufacturing, including technologies for the efficient use of raw materials and water in manufacturing.

Highlights of the FY 2018 Budget Request

FY 2018 activities support Administration, Department and Programmatic goals. Highlights include:

- Orientation of program on early-stage applied R&D. [TRL 2-4] Program organized around three mechanisms of support in 1) individual research projects; 2) research consortia and 3) technology partnerships with national labs. The focus of this early stage R&D is the discovery of new technical knowledge and investigation of new technical ideas.

- Research and development projects ($41M): Focus on early stage research in materials and process knowledge relevant to manufacturing, including application of high performance computers for modelling and simulation relevant to energy in manufacturing.

- Research and development consortia ($27.5M): Focus on coordinated early stage R&D in high-priority areas essential to energy in manufacturing, including the discovery of foundational knowledge in rare-earth materials, additive processes, power semiconductors, innovative process controls, new materials and processes; and innovative approaches to clean water.

- Technology partnerships ($13.5M): Focus on research and validation of early-stage research through partnerships with national laboratories.

EERE's role in the initial establishment of the Oak Ridge Manufacturing Demonstration Facility (MDF) ended in FY 2016. In FY 2018, EERE will fund only early-stage R&D projects that utilize the MDF facility for validation and feedback to further research.

Advanced Manufacturing
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Advanced Manufacturing				
Advanced Manufacturing R&D Projects	101,500	—	41,000	-60,500
Advanced Manufacturing R&D Consortia (previously R&D Facilities)	98,500	—	27,500	-71,000
Advanced Manufacturing Technical Partnerships (previously Industrial Technical Assistance)	28,500	—	13,500	-15,000
Total, Advanced Manufacturing	**228,500**	**228,066**	**82,000**	**-146,500**

SBIR/STTR:

- FY 2016 Transferred: SBIR $6,000,000; STTR $900,000
- FY 2017 Projected: SBIR $5,989,000; STTR $898,000
- FY 2018 Request: SBIR $2,624,000; STTR $369,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Advanced Manufacturing
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Advanced Manufacturing R&D Projects: Activities will be refocused to support only early-stage advanced materials manufacturing R&D for energy applications in high-impact foundational technology areas. Funding allows for an increase in support of R&D at National Laboratoriesfor early-stage advanced manufacturing technology R&D, focusing on emergent technology challenges. Funding for high-performance computing for manufacturing (HPC4MFG) will be prioritized and listed as a separate element within the R&D project's budget.	**-60,500**
Advanced Manufacturing R&D Consortia(formerly Facilities): No funds are requested for the Critical Materials Hub, the Clean Water Hub, or the five Clean Energy Manufacturing Innovation Institutes in the National Network for Manufacturing Innovation (NNMI) program. Balances from prior year appropriations will be used to conduct an orderly wind-down and termination of the existing institutes. These insititutes have provided valuable innovative contributions, but their focus on near-term, demonstration and deployment-type activities is not aligned with AMO's shift in emphasis to early-stage research. Funding for the Manufacturing Demonstration Facility (MDF) and Carbon Fiber Test Facility (CFTF) will be focused on the highest priority projects focused on early-stage R&D. Additional activities will focus on early stage applied research in National Laboratory and university based consortia addressing the underlying scientific challenges in key advanced manufacturing technical areas, including support for winning Moore's Law in semiconductors and cybersecurity in manufacturing.	**-71,000**
Advanced Manufacturing Technical Partnerships: Reflecting the shift in focus to early-stage R&D, the Industrial Assessment Centers (IACs), which primarly supported technical assistance and deployment support for small and medium manufacturers, will be discontinued. Some existing partnership programs designed to inform the direction of applied R&D and clearly support new knowledge creation and validation of research results with the private sector will be maintained. A new Funding Opportunity Anouncement (FOA) will fund competitively selected university-led teams with projects that focus on early-stage R&D of novel manufacturing technologies. The nature of the merit based support would be a combination of research funding and partnership provided by National Laboratories.	**-15,000**
Total, Advanced Manufacturing	**-146,500**

Description

Through renewed focus on competitively selected, early-stage applied R&D projects in foundational, energy-related advanced manufacturing technologies, the program will increase the impact of its work in areas relevant to energy-intensive and energy-dependent manufacturing processes, as well as platform technologies widely applicable across multiple energy related manufacturing industries. The Advanced Manufacturing R&D Projects subprogram will support early-stage proof of concept projects, cost-shared with companies and research organizations that focus on generating knowledge relavent to specific manufacturing technology challenges. Through a combination of merit based competitive FOA solicitations and peer-reviewed National Laboratory based projects (in partnership with industry), the results of these foundational research projects will enable industry to development of next-generation manufacturing technologies. The program will identify the specific research challenges based on stakeholder input, alignment with the program's technology thrust areas, and potential energy, environmental, and economic impacts.

In FY 2018, the sub-program will support R&D projects totaling $41 million. There will be $12 million in competitive solicitations for Advanced Manufacturing R&D projects, including at least one FOA solicitation for laboratories and universities with emphasis on technologies on the well-defined AMO priority technology thrust areas identified in the AMO 2017 MYPP. The program will only fund early-stage research focused on technology challenges that have the potential for high return on investment, but which present a significant degree of scientific or technical uncertainty across a relatively lengthy time span, making it unlikely that industry will invest significant R&D on their own. Specifically, projects will be screened to ensure that industry either does not have the technical capability to undertake the research effort or the innovation is too far from market realization to merit sufficient industry focus and critical mass.

AMO will support $17 million in early-stage manufacturing research at National Laboratories in partnership with business, including $7.5 million which will be dedicated to supporting projects lead by early-career post-doctoral researchers, enabling fresh ideas and innovative approaches to address fundamental manufacturing challenges identified by industry where the need for new scientific and technical knowledge can be identified.

To enable research that leverages the unique High-Performance Computing resources of the National Laboratories on manufacturing relevant, first of kind early-stage R&D projects, $6 million will support the HPC4MFG program, with new knowledge gained in this research impacting both computer science and manufacturing science. $6 million is applied to analysis and early-stage R&D supporting smaller efforts which provide feedback identifying research gaps and potential new research activities.

Advanced Manufacturing R&D Projects

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Manufacturing R&D Projects $101,500,000	**$41,500,000**	**-$60,500,000**
• Through competitively selected R&D projects, FY 2016 funding continued to address core technical issues for foundational technologies that will enable U.S. manufacturers to realize significant gains in energy productivity, product yield, and economic growth. Two FOAs were supported in FY 2016, the Advanced Manufacturing Projects for Emerging Research Exploration FOA and the Next Generation Electric Machines: Enabling Technologies FOA.	• During FY 2018, AMO will support 25 to 50 competitively selected, merit-based, early-stage applied R&D projects (TRL 2-4) at National Laboratories, universities, and companies. Focus will be on early stage applied R&D in emerging manufaturing technology areas with significant potential for impact on energy and manufacturing. Specifically support will be for R&D addressing issues with scientific gaps and innovative new technical approaches that if explored would advance the state of technical knowledge for manufacturing, such as materials for harsh conditions, energy conversion materials, materials for energy systems, roll-to-roll materials and processes, innovative computational process modelling in manufacturing, and energy intensive manufacturing processes.	• Decrease attributable to support of fewer projects with the program re-focused on only early stage applied R&D (TRL 2-4) where there are gaps in knowledge or there are potential innovative new approaches to the materials and processes in manufacturing.

Description

The Advanced Manufacturing R&D Consorita subprogram supports collaborative, early-stage reseach and development between industry, acadamia, non-profit institutions, and National Laboratories that can help enable the development and deployment of novel technologies by U.S. manufacturers. These collaborative effortsare effective mechanisms for supporting early-stage R&D and transferring innovative technologies to the private sector. These advanced manufacturing R&D consortia are designed to generate knowledge spillover benefits from adjacent energy sectors into multiple industries and improve U.S. competitive advantage, especially for small- and medium-sized enterprises.

The FY 2018 funding of $27.5 million will support the establishment of four to six advanced manufacturing consortia to conduct collaborative early-stage R&D in the priority areas listed in the following paragraph. No funds are requested for the previously supported institutes in the NNMI program that focused on later stage demonstration and deployment activities (TRL 4-7). Through the use of prior year appropriation balances, termnation of the NNMI institutes will include assessment of impact of close-out costs and dual-use manufacturing base impacts. Similarly, no funds are requested for the Criticial Materials Institute and Energy Innovation Hub which by supporting manufacturing demonstration and deployment were unnecessary mechnisms to facilitate the transfer of knowledge from basic science through applied R&D. Instead, the program will achieve this same objective through a more concentrated focus only on early stage research targeting discovery of new scientific knowedge in national laboratory based consortia.

Research consortia are an effective means of conducting this early-stage applied R&D as they can focus the technology investigations on the creation of relevant new knowledge, while lowering the barriers to transferring that knowledge from laboratories to the private sector for subsequent advancement. Highest priority areas such as the scientific research into the foundational knowledge related to rare-earth materials; new approaches to sensors, modeling, communications, security and controls in manufacturing; next generartion materials, structures and processes for chemical processes; discovery of new composite materials and structures; semiconductor (power and nanoscale) manufacturing materials and processes; clean water in manufacturing and new materials approaches to cost-effective use of materials resources in manufacturing have been identified as high-impact manufacturing technology areas for support in consortia at National Laboratories and universities. In FY 2018, $16.5 million is requested for support of merit based, early-stage R&D consortia at National Laboratories and universities to address these important scientific and technical issues relevant to U.S. manufacturing. The program will ensure awarded consortia focus only on early-stage research to address technology challenges that have the potential for high return on investment, but which present a significant degree of scientific or technical uncertainty across a relatively lengthy time span, making it unlikely that industry would invest significant R&D on their own. Specifically, projects will be screened to ensure that individual industry actors do not have the technical capability to undertake the research effort absent collaboration.

Finally in FY 2018, $11 million is requested for early-stage R&D activities (TRL 2-4) at National Laboratory based manufacturing demonstration facilities (MDF), a model for public private partnership on cost-shared early-stage applied R&D at the National Laboratories, particularly in areas of additive manufacturing and carbon fiber materials research related to energy. Efforts will focus on expanding participation by university students and faculty in this early-stage research, in partnership with both National Laboratory and private sector researchers.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Manufacturing R&D Consortia $98,500,000	**$27,500,000**	**-$71,000,000**
• Supported the incremental funding ($14 million) of one new Institute, the Reducing Embodied-energy and Decreasing Emissions (REMADE) Institute. Also supported ($56 million) for four existing Institutes, ($25 million) of investment in the Critical Materials Hub, and ($3.5 million) for institute-related technical and analytical efforts located primarily at appropriate National Laboratories.	• The program will support only the highest priority early-stage R&D projects at the MDF and CFTF to enable the facilities to acommodate increased demand for projects funded by industry. No funding is requested for operations and maintenance of the MDF and CFTF, as these are now fully self-sustaining facilities. • Funding will support four to six early stage applied research projects by National Laboratory and university based public-private partnership consortia addressing underlying scientific challenges in high-priority advanced manufacturing technical areas. This early stage research is intended to discover foundational knowledge in technical areas where a consortia of different organizations provide a unique capacity to conduct the requisite research.	• The decrease is primarily attributable to the elimination of the Critical Materials Hub and Clean Energy Manufacturing Innovation Institutes.

Description

The advanced manufacturing technical partnerships subprogram provides engagement with the private sector to ensure that the results from the early-stage R&D related to advanced manufacturing and energy can be transferred to the private sector for further development or commercialization. These partnerships focus on knowledge transfer, of both the relevant results from scientific research as well as feedback from the private sector on the science and technology challenges that might be addressed through early-stage applied R&D.

In FY 2018 the Advanced Manufacturing technical Partnerships sub-program will request $13.5 million. Reflecting the shift in focus to early-stage R&D, the Industrial Assessment Centers (IACs), which primarly supported technical assistance and deployment support for small and medium manufacturers, will be discontinued. Close-out costs for the IAC program will include collection and public dissemination of scientific and technical data from prior IAC field verification studies to inform new research.

Within the available resources, $3.5 million is requested for early-stage R&D into new information tools and technologies that facilitate the exchange of technical knowledge and validate research results with the private sector in areas of advanced manufacturing and energy productivity, including tools for field validation of new technologies to inform future research direction. The request includes $2.0 million for student-led research projects at National Laboratories in areas relevant to advanced manufacturing and energy, advanced materials manufacturing and advanced chemical processes technologies. Student led projects provide a mechanism for partnership between universities and National Labs in early stage research where the results would subsequently have positive impact in industry.

Advanced Manufacturing Technical Partnerships

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Manufacturing Technical Partnerships $28,500,000	**$13,500,000**	**-$15,000,000**
• The program continued to support the CHP TAPs and expanded market analysis and outreach resources; increased the number of Better Buildings Better Plants Program Partners to 179; enhanced support for the 24 IACs with an increased emphasis on energy management systems and water-related issues; and expanded the number of SEP ISO/ANSI Certified facilities to 41. These efforts work together to drive a corporate culture of continuous improvement and wide-scale adoption of technologies, such as CHP, to reduce energy use and costs in the industrial sector.	• Support will support six to twelve partnerships between national labs and universities facilitating exchange to the private sector of new technical knowledge resulting from research. These partnerships will include tools for gathering information from technology validation as well as the feedback of information to inform new research opportunities. • New funding for student-led projects at National Labs will enable National Laboratories to house 25 to 35 students and provide the necessary access to R&D equipment, facilities, and expertise to complete their projects.	• The IAC program will be discontinued. Contract close-out activities will be completed by the end of FY18.

Advanced Manufacturing Office
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**AMO – R&D Consortia - Number of Manufacturing Research and Development Consortia selected for negotiation to demonstrate advanced material and process technologies, leading to commercialization**		
Target	1 Consortia	2 Consortia	N/A
Result	Met - 1	TBD	TBD
Endpoint Target	8 consortia by 2017. Measure discontinued in FY18 due to a shift in focus towards early-stage R&D.		

Federal Energy Management Program

Overview

The U.S. Federal Government is America's largest single energy consumer and with more than 350,000 buildings and 600,000 vehicles, it has an opportunity and responsibility to lead by example in cutting energy waste and advancing America's progress toward energy independence, resiliency, and security. The Federal Energy Management Program (FEMP) works with our stakeholders to enable federal agencies to meet energy related goals, identify affordable solutions, facilitate public-private partnership and provide energy leadership to the country by identifying government best practices.

Federal energy use is significant; in 2015, the Federal Government used 1.4 quads of energy at a cost of $21.3 billion[1]. Energy used in buildings and facilities represents about 57 percent of the total energy use of the Federal Government, with vehicles and equipment energy use accounting for 43 percent.[2] However, additional opportunities exist for further energy cost reduction and energy conservation. Agencies have identified potential $10 billion of self-financing efficiency measures in federal buildings. The Federal Energy Management Program (FEMP) works to improve the U.S. Federal Government's energy management by providing guidance, training, technical assistance, data coordination and review, and best practices to other federal agencies to improve and track overall federal energy management.

Highlights of the FY 2018 Budget Request

The FEMP FY 2018 Budget Request of $10 million supports federal agencies in meeting statutory energy and water management related goals and requirements[3]. With assistance from FEMP-supported initiatives and partnerships, the Federal Government has reduced its facility energy intensity by 49 percent since 1975 and 25 percent since 2003. To provide context with commercial facilities, General Services Administration facilities, which are mainly office buildings, have an energy intensity of 62,316 BTU per gross square foot while the energy intensity of US office buildings from CBECS is 89,838 BTU per gross square foot, Similarly, Veterans Affairs facilities, which are mainly hospitals, have an energy intensity of 146,657 BTU per gross square foot while the average hospital in the US from CBECS has an energy intensity of 187,878 BTU per gross square foot.

In FY 2018, FEMP will focus on reducing the operating costs of the government by assisting Federal agencies in identifying, designing, and completing energy-savings projects, building upon previous accomplishments. FEMP is the primary Federal entity that provides energy management support for agencies. FEMP provides technical project development assistance for energy savings performance contracts (ESPC), utility energy savings contracts, and power purchase agreements in pursuit of energy and water efficiency improvements and demand reduction services. FEMP coordinates with the US Army Corps of Engineers to provide a consistent and standardized process for Federal agencies and the Department of Defense to design and execute these types of performance contracts.

In conjunction with technical assistance, FEMP will provide portfolio planning guidance to promote strategic integration of advanced technologies into power supply and master facility planning, helping DOE as a whole strengthen national energy security by increasing energy supply, diversity, resiliency, and reliability. FEMP will also foster federal building and fleet optimization by providing guidance and tools focused on metering, auditing, operations and maintenance, and water use.

FEMP will continue to fulfill statutory requirements[4] to hold agencies accountable for energy management performance through proactive engagements and enhanced workforce development services and opportunities.

[1] Table A-4 and Table A-2 http://ctsedwweb.ee.doe.gov/Annual/Report/Report.aspx
[2] On a primary energy basis.
[3] Primary energy management requirements of the National Energy Conservation Policy Act, as amended (42 U.S.C. 8253-8258); the Energy Policy Act of 2005 (42 U.S.C. 15852); and Executive Order 13693. For full list of requirement refer to https://www4.eere.energy.gov/femp/requirements/
[4] Primary energy management requirements of the National Energy Conservation Policy Act, as amended (42 U.S.C. 8253-8258); the Energy Policy Act of 2005 (42 U.S.C. 15852); and Executive Order 13693. For full list of requirement refer to https://www4.eere.energy.gov/femp/requirements/

Federal Energy Management Program
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Federal Energy Management Program				
Federal Energy Management	23,100	—	**10,000**	-13,100
Federal Energy Efficiency Fund/AFFECT	3,000	—	0	-3,000
NREL Site-Wide Facility Support	900	—	0	-900
Total, Federal Energy Management Program	**27,000**	**26,949**	**10,000**	**-17,000**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Federal Energy Management Program
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Federal Energy Management (FEM): In FY 2018, FEM will assist with and track agencies' energy management performance and identification, design, and completion of energy-savings projects through performance savings contracts, utility energy savings contracts, and power purchase agreements. As part of the technical assistance available to agencies, FEM will provide system standardization, tools to foster building optimization, consistent best practices, guidance and process quality assurance. FEM programming will also focus specifically on developing and disseminating training resources that enhance the skills and agility of the existing Federal workforce.	**-13,100**
Federal Energy Efficiency Fund/AFFECT: In FY 2018, Federal Energy Efficiency Fund/AFFECT will not be funded. Some management activities related to execution of prior year appropriations will continue until completion.	**-3,000**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-900**
Total, Federal Energy Management Program	**-17,000**

Description

The Federal Energy Management (FEM) subprogram assists all Federal agencies in achieving the goals and objectives set forth by the federal energy and water usage requirements of the National Energy Conservation Policy Act, as amended (42 U.S.C. 8253-8258); the Energy Policy Act of 2005 (42 U.S.C. 15852); the Energy Independence and Security Act of 2007 (42 U.S.C. 8253) and Executive Order 13693. The Federal Government is the largest U.S. energy consumer. As such, the Federal Government carries significant responsibility to lead by example in improving energy efficiency and reducing energy costs. The authority provided during its establishment[1] authorizes FEM to act as the primary Federal program to provide guidance and facilitate adoption of best practices for energy and water management throughout the Federal Government. To provide this leadership, the FEM subprogram facilitates strategic partnerships to demonstrate effective practices for reducing energy and water management costs, and helps to enhance energy resiliency through public and private sector partners. FEM works with Federal agencies and National Laboratories to develop and disseminate training resources that enhance the skills and agility of the existing federal energy management workforce.

Currently, FEMP helps the Federal Government track and achieve the following goals:

- Improve energy efficiency of each agency through the reduction of energy intensity by 2.5 percent annually, or 25 percent by the end of FY 2025, relative to the baseline of the agency's energy use in FY 2015;
- Ensure that at least 10 percent of Federal building electric energy and thermal energy is clean energy by FY 2018 and 25 percent by 2025;
- Ensure that at least 10 percent of Federal electricity consumption is generated from renewable sources by FY 2018 and 30 percent by 2015; and
- Reduce water consumption intensity by 2 percent annually, or 36 percent by the end of FY 2025 as compared to the FY 2007 base year.

FEMP is also statutorily required to carry out the following functions specifically related to tracking and implementing effective energy and water management throughout the Federal Government:

- Hold agencies accountable and develop analytical reports to OMB and Congress annually which track Federal progress towards goals on energy efficiency (42 U.S.C. § 8258(a)), renewable energy use (42 U.S.C. § 15852(d)), and vehicles (42 U.S.C. § 6374e(a)).
- Each Executive agency is required to establish and maintain a program to ensure that facility energy managers are trained energy managers. Every agency is to report to DOE-FEMP on their progress in meeting this requirement. DOE-FEMP is authorized to develop training and resources to assist with this requirement (42 U.S.C. § 8262c(a)).
- FEMP is to develop energy efficiency design requirements for new Federal buildings and buildings undergoing major renovations through updates to rules 10 CFR 433 and 10 CFR 435, develop guidance, and track performance of agencies with regards to meeting 10 CFR 433 & 10 CFR 435 (42 U.S.C. § 6834(a)(3)(A)).
- FEMP, in consultation with the Secretary of Defense and the Administrator of General Services, shall develop, and issue a report on, best practices for the use of advanced metering of energy use in Federal facilities, buildings, and equipment by Federal agencies. (42 U.S.C. § 8253(e)).
- The term "FEMP designated product" means a product that is designated under the Federal Energy Management Program of the Department of Energy as being among the highest 25 percent of equivalent products for energy efficiency. FEMP's requirement is to establish the technical performance requirements for the applicable technologies (42 U.S.C. § 8259b(b)).

Since 1992, Congress authorized Federal agency use of performance contracts to help Federal agencies achieve energy and water conservation goals through energy efficiency, renewable energy, and water efficiency improvements in Federal facilities. By using performance contracts such as Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs), the government is able to engage a private sector energy service company to invest in needed energy

[1] Richard Nixon: "Statement Announcing Additional Energy Policy Measures," June 29, 1973. Online by Gerhard Peters and John T. Woolley, The American Presidency Project. http://www.presidency.ucsb.edu/ws/?pid=3886.

projects and pay for the investment through the energy, water, and operations and maintenance (O&M) savings achieved over the life of the contract. Federal building stock is aging—some equipment being replaced has been in operation from the 1940's, 50's, or 60's. Deferred maintenance is also increasing with $135 billion of identified building repairs, and $7.7 billion in deferred building equipment maintenance.[1] Performance contracting with oversight is one valuable tool to implement planned efficient infrastructure investments rather than emergency repairs. FEM support helped agencies achieve almost $1 billion of investment in FY 2016 and more than $4.4 billion since 2012. The 353 performance contracts awarded over the last five years will generate a savings of approximately $8 billion in the Federal government's utility and facility maintenance expenditures over the next 18 years. Over the life of the contract, the approximately $8 billion in savings are used to pay for the facility infrastructure investments, including the installation of new energy and water related equipment and savings verification. Additional savings that occur during the contract or after the contract term accrue to the agency. FEMP leverages performance contracting to assist agencies with statutory compliance and energy management portfolio planning for mission assurance.

FEM's performance contracting assistance also includes the continued use of the eProject Builder National ESPC & UESC database (ePB) – a tool developed by FEMP for Federal and non-Federal entities to standardize the collection, calculation, and reporting of performance data for all performance contracts and to provide government access to anonymized/arrogated project data across government and the private sector to improve analysis of performance contracting. As of March 2017, ePB contains 465 projects (373 Federal; 92 state/local), representing total project implementation costs of ~$4 billion and total cumulative guaranteed dollar savings of ~$10 billion. The continued support of the eProject Builder and federal access to the data will provide a best practice and valuable benchmarking information to improve the performance of all Federal contracts.

FEM also provides technical assistance, training, and progress to Federal agencies in tracking and achieving their energy management goals. FEM tracks the government's progress and status in energy and related goal achievement for trend analysis and ensures the program's capabilities are a known resource for federal energy management officials. The National Energy Conservation Policy Act (NECPA) (as amended by EISA 2007 (42 U.S.C. § 8258(a)) requires that DOE collect, verify, and report on Federal agencies' progress toward their goals to address energy efficiency in facilities. In FY 2018, the program will continue to collect and publish data for the Section 432 Annual Report to Congress and respond to inquiries to help ensure accuracy in reporting and analysis of trends. In addition, through its awards program, the activity recognizes energy efficiency and renewable energy champions at Federal agencies and showcases best practice efforts; and through the FEMP Veterans Intern program, provides opportunities for veterans to learn energy management, while helping agencies meet their goals. FEM will continue to enhance workforce competencies and strengthen performance through innovative, nationally accredited training programs while leveraging public-private partnerships, such as the Energy Exchange conference and accredited eTraining series. In 2016, FEM offered 119 FEMP courses, workshops, and webinars, plus 96 Energy Exchange accredited sessions, for a total of 215 training events, awarding more than 6,500 Continuing Education Unit (CEU) certificates in 2016 alone. FEM training offerings reached the economic sectors that directly control and operate the Nation's energy infrastructure. FEM's online training is available, at no cost to the participant, to Federal workforce, private sector and educational institutions. FEM will continue to develop and host the Energy Exchange event, which has become a cost-neutral training event for the Federal Government and which brings together subject matter experts from a wide range of technical disciplines to share their knowledge to help drive an efficient Federal Government and provide best practices for financial stewardship, energy independence, and energy security. Nearly 2,400 attendees from government and industry are expected to attend Energy Exchange 2018 for training, networking and to discuss cost-effective best practices and lessons learned.

As part of the authorized responsibility of the program to respond to and support Federal agencies requests for assistance, in FY 2018 FEM will concentrate support on and address agencies requests to develop technical assistance services and guidance for implementing energy management projects and results. As part of this support request by Federal agencies, the FEM subprogram, working directly through experts at the DOE National Laboratories, will:

[1] Bureau of the Fiscal Service: 2015 Financial Report of the United States Government
https://www.fiscal.treasury.gov/fsreports/rpt/finrep/finrep15/supp_info/fr_supplement_info_defer_maint.htm

- Offer portfolio planning guidance to promote strategic integration of advanced energy technologies (such as renewable energy, micro-grids and advanced battery storage) into site/facility power supply and master site planning;
- Develop best practices for implementing resilient energy management strategies in Federal facilities;
- Develop best practice approaches to address the challenges and risks organizations face from cyber threats to the energy management platform;
- Standardize steps agencies can take to secure their energy-related hardware and data while integrating effective energy management; and
- Improve facility resiliency through enhanced energy management technologies and tools focused on optimization and cost reduction.

Nearly two thirds of all Federal facility energy use occurs in the top 450 sites with Federal facilities, therefore the specific focus on promoting a comprehensive and integrated master energy management planning is critical. Given that 5.4% of the government facilities represent 79% of energy use and 65% of square footage, FEM will focus on using existing and new tools, such as renewable analysis optimization tools, to drive results towards integrated project implementation.

As part of the integrated portfolio planning, FEM provides project assistance and expertise in renewable energy project assessment and implementation areas to help Federal agencies identify and implement renewable energy technologies, provides a collection of resource maps and assessment tools to help Federal agencies screen for potential renewable energy projects, and consults with agencies on available options to purchase renewable power and renewable energy certificates to meet energy regulatory requirements and goals.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Federal Energy Management $23,100,000	**$10,000,000**	**-$13,100,000**
• Continue to support Federal agencies in identifying and implementing energy projects using performance contracting and assist agencies achieve $4 billion of Performance Contracting investment through 2016. FY 2016 funding also supports the full utilization of the eProject Builder National Energy Savings Performance Contracts database designed to standardizing the collection, calculation, and reporting of performance data for ESPCs across Government. • Expanded technical assistance on energy efficiency and renewable energy technologies results in accelerated Federal sector acceptance of these technologies. In particular, the renewable energy program is focused on agency achievement of the 20 percent renewable energy by 2020 requirement. FY 2016 funding supports the ongoing efforts of the Better Buildings Data Center Challenge (BBDCC), improve partner's data center efficiency by 20 percent over 10 years. • Continue to track the Government's progress in energy goal achievement; ensuring the program's capabilities are a known resource for energy management; coordinating the program's strategic planning, budgeting, and evaluation; and supporting public access to Federal energy data. • Continue assisting agencies with meeting or exceeding requirements for reducing fleet petroleum consumption.	• Support agencies in identification, design, and completion of energy-savings projects through the use of performance contracting and power purchase agreements. • Based on feedback from agencies, including DoD, advance energy management best practices and the agility of the Federal Government through training to enhance workforce competency, developing technical guidance to demonstrate replicable project solutions, develop tools to enhance building performance optimization, and implementing public-private partnership solutions through performance-based contracting. • Develop best practices implementing resilient energy management in federal facilities.	• Subprogram will concentrate activities to focus FEM efforts on technical assistance leveraging performance contracting and power purchase agreements, helping agencies meet their statutory requirements, and enhancing workforce development and free training opportunities in the field of effective energy management for the civil service.

Federal Energy Management Program
Federal Energy Efficiency Fund/AFFECT

Description

The Federal Energy Efficiency Fund/AFFECT (AFFECT) subprogram will not be funded in FY 2018.

Section 152(f) of the EPAct of 1992, Public Law 102-486, authorized the Secretary of the DOE to establish a Federal Energy Efficiency Fund with the stated purpose of providing grants to Federal agencies to assist them in meeting the energy management requirements of the NECPA (42 U.S.C. 8256(b)).

The AFFECT subprogram provided direct funding for technology deployment. In FY 2018, agencies will be expected to use technical assistance offered by FEMP in conjunction with their own funding and authorities to implement well-designed and meritorious energy management projects that increase energy efficiency, conserve water, and increase renewable energy generation at Federal facilities.

Federal Energy Efficiency Fund

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Federal Energy Efficiency Fund/AFFECT $3,000,000	**$0**	**-$3,000,000**
• Through Federal Energy Efficiency Fund/AFFECT, award approximately 6 projects focused on providing direct funding to support the best available agency projects and leverage cost sharing at other Federal agencies for capital improvement projects and other initiatives to increase energy efficiency, conserve water, and increase renewable energy investments at Federal agency facilities.	• No funding is requested.	• The Federal Energy Efficiency Fund/AFFECT subprogram will not be funded in FY 2018. Some management activities related to execution of prior year appropriations will continue until completion.

Federal Energy Management Program
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $900,000	**$0**	**- $900,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding is requested.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Program Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Federal Energy Management Program
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**FEMP - Investments - Total Federal Investment in Facilities Energy Conservation Measures Government-Wide ($Million)**		
Target	$750 Million	$750 Million	$1,770 Million
Result	Exceeded – $1,735	TBD	TBD
Endpoint Target	$12.4 Billion in total efficiency investment between 2018 and 2024 required to meet the 25% energy reduction goal for 2025 vs. 2015 baseline. $1,770 million annually through 2024 to be invested by Federal agencies Government-wide through direct obligations and through performance contracting (Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs)).		

Building Technologies

Overview

Residential and commercial buildings are the single largest energy-consuming sector in the U.S. economy, representing approximately 75% of all the nation's electricity use and 40% of its total energy demand. As a result, Americans spend nearly $400 billion each year to power their homes, offices, schools, hospitals, and other commercial and residential buildings.[1] Government investment in early-stage research and development (R&D) to enable industry to develop and deploy novel technologies that can improve the efficiency and reduce the energy costs of the nation's buildings is essential because the building sector consistently and significantly under-invests in R&D compared to the U.S. industry average. For example, R&D funding in the building construction industry is about 0.3%, about one tenth of U.S. industry average is about 3%.[2] This underinvestment is due to the buildings industry's highly fragmented nature. The buildings sector is divided in multiple (and overlapping) ways: residential and commercial sectors, new construction and retrofit, building use, climate etc. In addition, within any given building, there are numerous building sub-systems or technologies (lighting, heating, building envelope, controls, etc.) many with their own technological and market complexities. In order for a building to operate efficiently and meet the needs of the occupants, each building sub-system must be integrated into a full building system in a unique manner. These different layers of market fragmentation and the complexity of the integration challenges necessary to improve efficiency at the building levels makes it difficult for any given firm to fully capture the benefits of energy efficiency R&D (and thus recover their R&D costs). Through pre-competitive, early stage R&D supported by EERE's Building Technologies Office (BTO) a fundamental understanding of physical properties and phenomena relevant to buildings, building materials, and building equipment enables the various buildings technology industries to innovate novel technologies that ultimately improve the efficiency of energy services such as light and heat to consumers.

BTO-sponsored research focuses on opportunities to transform the energy efficient technologies that impact the largest energy system users within buildings: lighting, space conditioning and refrigeration, water heating, appliances and miscellaneous electric loads (MELs), as well as the building envelopes themselves. BTO's research also focuses on developing the physics-based algorithms for improved energy modeling and system controls required to better predict and manage energy efficient appliance/equipment, system, and whole-building energy usage. Additionally, BTO's early stage R&D on advanced and transactive controls will help strengthen the body of knowledge to enable industry to develop and deploy truly "smart" buildings capable of connecting with the power grid in new and increasingly adaptive manners to help with overall electric system efficiency, resiliency and bringing down energy prices across the grid. As a result, BTO not only acts as a catalyst for innovation but spurs U.S. economic competiveness through scientific and engineering leadership.

BTO also conducts building systems research to gain knowledge and understand physical phenomena that occur not only at a component level but at the system and whole building levels. In addition, BTO collaborates with industry, academia and other leaders across the building sector to validate and verify solutions that help building owners and homeowners reduce energy waste. These design and decision tools help Americans apply efficient building operational practices and technologies through improved understanding of their costs and benefits, resulting in more cost effective, productive and healthy buildings.

Lastly, BTO works with industry and stakeholders to test and implement statutorily-mandated efficiency standards, which are expected to save U.S. business and residential consumers more than $1 trillion in energy costs by 2020.[3] Similarly, as

[1] Spending derived from the U.S. Energy Information 2012 Commercial Building Energy Consumption Survey (CBECS) and 2009 Residential Energy Consumption Survey (RECS) from "Total Building Site Energy Expenditures".
[2] Wolfe, Raymond M. (2013). Business Research and Development and Innovation: 2008-10 Detailed Statistical Tables. NSF 13-332. Arlington, VA: National Center for Science and Engineering Statistics. Accessed September 24, 2014: http://www.nsf.gov/statistics/nsf13332/pdf/nsf13332.pdf.
[3] U.S. Department of Energy, Building Technologies Office (January 2017). "Saving Energy and Money with Appliance and Equipment Standards in the United States." Accessed April 24, 2017: https://energy.gov/sites/prod/files/2017/01/f34/Appliance%20and%20Equipment%20Standards%20Fact%20Sheet-011917_0.pdf

required by statute, BTO evaluates changes to model building energy codes, which inform state and local building code processes, including making a formal determination.

Highlights of the FY 2018 Budget Request

FY 2018 activities support Administration, Departmental, and Programmatic goals. Highlights include:

- Buildings-to-Grid R&D ($11 million): Focus early stage R&D on key building blocks for cyber physical systems for buildings to include advanced communication platforms and data management systems; digital sensing, monitoring, and control capabilities; and data analytics to ensure assets are secure and resilient. This research is critical to meeting BTO's overall goals for reducing the energy use in buildings because, one, these advanced buildings-to-grid technologies will allow for much greater control of building energy management (such as zone-specific energy reductions) and, two, today building efficiency is significantly degraded due to poor operation and maintenance practices.
- HVAC & Refrigeration R&D ($5 million): Focus early stage research on solid state cooling and non-vapor compression solutions, such as combined experimental and theoretical discovery and characterization of magnetocaloric, electrocaloric, thermoelectric materials.
- Solid State Lighting R&D ($7.5 million): Lighting research focus on critical early stage R&D challenges for advancing understanding of semiconductor physics behind LED and Organic LED (OLED) technologies such as emitter materials research, exploration of high-efficiency wavelength conversion materials, and research into materials deposition and device fabrication processes and investigations.
- Commercial & Residential Building Integration R&D ($12 million): Research and validation to integrate connected, energy-efficient building components and subsystems into efficient, resilient and secure building systems and advanced building construction and retrofit design principals.
- Equipment and Building Standards ($26 million): Meet statutory obligations.

In addition, FY 2018 funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, and economic research studies and other analyses across the BTO portfolio.

Building Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Building Technologies				
Building Energy Research & Development				
Lighting R&D	24,000	—	8,190	-15,810
HVAC & Refrigeration R&D	17,415	—	5,460	-11,955
Buildings-to-Grid R&D[1]	22,000	—	10,930	-11,070
Building Envelope R&D	13,700	—	1,640	-12,060
Building Energy Modeling R&D	5,300	—	3,280	-2,020
High-Impact Technology R&D	3,500	—	0	-3,500
U.S. China Clean Energy Research Center – Building Energy Efficiency Consortium (CERC-BEE)[2]	*2,500*	—	*2,500*	*0*
Total, Building Energy Research & Development	**85,915**	**—**	**29,500**	**-56,415**
Commercial Buildings Integration	**32,000**	**—**	**5,500**	**-26,500**
Residential Buildings Integration	**23,000**	**—**	**6,500**	**-16,500**
Equipment and Buildings Standards	**57,485**	**—**	**26,000**	**-31,485**
NREL Site-Wide Facility Support	**2,100**	**—**	**0**	**-2,100**
Total, Building Technologies	**200,500**	**200,119**	**67,500**	**-133,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR $2,652,000; STTR $398,000
- FY 2017 Projected: SBIR $2,647,000; STTR $397,000
- FY 2018 Request: SBIR $1,232,000; STTR $173,000

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[1] Sensors & Controls and Transactive Controls are combined into a single, integrated Buildings-to-Grid R&D activity.

[2] U.S. China Clean Energy Research Center – Building Energy Efficiency Consortium funding does not count towards subprogram totals. This activity is crosscutting to the Building Energy Research & Development subprogram and so the funding is spread amongst the other line items.

Building Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Building Energy Research & Development: Decrease reflects elimination of late-stage R&D efforts in all technology areas. The most significant eliminations include technology application R&D for solid-state lighting, CRADAs with industry for HVAC&R, demonstration and deployment of transactive controls at the campus- and neighborhood-level, as well as an ~87 percent reduction in the annual BENEFIT FOA. The SSL FOA will only include topics on core technologies development for LEDs and OLEDs, not product development or manufacturing topics. The remaining funds support pre-competitive R&D that allow for world-class energy discoveries, particularly at the DOE National Laboratories. These innovations can be leveraged broadly across industry to facilitate secure, connected, energy-efficient buildings that will benefit American consumers, both household and business.	**-56,415**
Commercial Buildings Integration. Decrease reflects elimination of later-stage development and commercialization activities including: High Impact Technology early adoption efforts; Commercial Buildings FOA; and funding for research evaluating linkages between energy efficiency and building financial performance metrics. Decrease reflects reductions in research, development and advancements in building energy modeling technologies and design and decision tools; and eliminates activity related to technology commercialization or more market-ready technology adoption efforts.	**-26,500**
Residential Buildings Integration: Decrease reflects elimination of later-stage development and commercialization activities including: Home Performance with ENERGY STAR program, Better Buildings Residential program, and demonstration efforts with industry partners. The Building America R&D program will be reduced to focus on early-stage R&D.	**-16,500**
Equipment and Buildings Standards: Decrease reflects elimination of all ENERGY STAR test procedure development and performance verification efforts and limiting energy conservation standard compliance activities to the minimum necessary to maintain compliance with statute. Technical assistance to state and local governments on state and local building codes will be limited to maintaining and updating DOE's REScheck and COMcheck software and the energycodes.gov website.	**-31,485**
NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-2,100**
Total, Building Technologies	**-133,000**

Description

The Building Energy Research & Development (BERD) program sponsors early-stage R&D in energy-efficient building technologies, enabling a range of U.S. industries in fields like building construction and renovation as well as appliance and material manufacturing to develop and deploy novel building technologies. BERD's technology areas are Buildings-to-Grid; Heating, Ventilation and Air-Conditioning & Refrigeration (HVAC&R); Windows & Envelope; Solid State Lighting; and Building Energy Modeling (BEM). This work leverages the National Laboratories' researchers and high performance computing capabilities as well as unique National Laboratory facilities needed for BTO to enable industry to achieve the goal of reducing the average energy use per square foot of all U.S. buildings by 50% from 2010 levels, thus saving consumers money while enhancing productivity and comfort.

The innovations supported through this early-stage research provide foundational lessons to domestic industry and academia, defining new research opportunities. This research is focuses on fundamental technical questions that have the potential for high return on investment because of their broad relevance. However, a significant degree of scientific or technical uncertainty and long-time spans are inherent to early stage research, making it unlikely that industry will invest significant R&D on their own. In many cases, private companies working in the building sector do not have the technical capabilities to undertake these types of early-stage research activities. The building sector can be divided in numerous ways and within any given building, there are numerous building sub-systems or technologies (lighting, heating, building envelope, controls etc.) many with their own market complexities. In order for a building to operate efficiently and meet the needs of the occupants, all of the technologies must be integrated into a full building system that meets the specific needs of that building and its occupants. As a result, it difficult for any given firm to fully capture the benefits of investments in energy efficiency R&D. Through pre-competitive, early stage R&D supported by EERE's Building Technologies Office (BTO) a fundamental understanding of physical properties and phenomena relevant to buildings, building materials, and building equipment enables the various buildings technology industries to innovate novel technologies that ultimately improve the efficiency of energy services such as light and heat to consumers. While this foundational research is focused on buildings sector applications, it generates knowledge spillover benefits for other industries, such as defense, computing, manufacturing.

In FY 2018, funding supports a competitive Funding Opportunity Announcement (FOA) in solid-state lighting (SSL). This FOA will target early-stage R&D projects for both LEDs and Organic LEDs (OLEDs) that seek to address the key scientific challenges to the SSL industry. Lighting research will focus on advancing understanding of semiconductor physics critical to advancing LEDs & OLEDs. This research will assist industry on the path to a 2030 LED package efficacy goal of 255 lumens/Watt and a 2030 OLED panel efficacy goal of 190 lm/W.

The priority research areas for LEDs include:

- Identifying the fundamental physical mechanisms for droop for blue LEDs.
- Exploratory research into new high-efficiency wavelength conversion materials with an emphasis on improving spectral efficiency and improving thermal stability and longevity.

The priority research areas for OLEDs include:

- Developing novel materials and structures that can help create highly efficient, stable white-light devices.
- Understanding basic research principles associated with materials deposition, device fabrication methods and encapsulation of high performance OLED panels.

The FY 2018 BENEFIT (Building Energy Efficiency Frontiers & Innovation Technologies) FOA will target early-stage R&D for separation materials and processes research for building applications. This FOA will leverage workshops and technical reports currently under development and build off of Topic 1 from the FY 2017 BENEFIT FOA entitled "Early Stage Innovations" that was specifically developed to engage university researchers.

Example research areas include:

- Membrane research for separate sensible and latent cooling research, traditional closed sorption and semi-open sorption systems
- Hybrid or biomimetic materials capable of selectivity separating water, CO_2 and/or other pollutants from air streams to reduce HVAC and air exchange requirements.
- Functionalization of ultralow thermal conductivity building materials to separate moisture from interior air within wall assemblies.

The BERD subprogram request includes direct laboratory funding, comprising support for pre-competitive, early-stage R&D that fosters National Laboratory collaboration and accessibility. While this work is pre-competitive and early-stage, it will include private sector and university engagement. BTO will build on its existing partnerships with industry and universities in work that is typically too high risk or far from commercial application to warrant private sector investment.

The direct laboratory funding includes the U.S. China Clean Energy Research Center – Building Energy Efficiency Consortium (CERC-BEE) ($2.5 million). CERC-BEE is a 10 year bi-lateral commitment to support R&D of building energy efficient technologies and solutions, through teams of scientists and engineers from the U.S. and China. Phase 2.0 of the CERC-BEE program is for years 6-10 and started in FY 2016. The bilateral R&D teams are comprised of U.S. National Laboratories, and U.S. and Chinese universities, research institutes, and industry partners. Current R&D projects are in the areas of advanced controls, building design and construction, DC power, indoor air quality and policy and market engagement.

The remaining direct laboratory funding is divided into the four technology categories where BTO will conduct analytical and laboratory-scale studies into emerging technologies as well as research on basic principles and physical phenomena impacting building and building component operations.

1. Buildings-to-Grid (B2G) R&D ($8.7 million) consists of foundational cyber-physical systems research that utilizes high performance computing resources to combine physics-based models, numerical analysis and deep model predictive control algorithms to identify, measure and prevent vulnerabilities associated with communication between the electricity grid and energy efficient buildings that are enabled by an increasing number of internet-connected devices. This cyber-physical systems research is also a critical strategy in meeting BTO's overall goals for reducing the average energy use in buildings because today building efficiency is significantly degraded due to poor operation and maintenance practices. It is estimated 20-30% of the energy savings opportunity in buildings can be achieved through improvements in operating efficiency. This work is outside of the scope of electric utilities' grid modernization activities as utility companies are not in a position (due to engineering, legal, business model, and/or regulatory constraints) to operate "across the meter", that is to say, on end-user assets, equipment and/or buildings. As a result, building assets are stranded and are not benefiting from the kind of R&D that is focused on securing assets on the utility side of the meter (e.g. generation, transmission, distribution). This is the core issue that defines the scientific questions addressed by BTO's R&D within buildings and at the building-to-grid edge. For example, one major research thrusts is the investigation into deeply layered artificial neural networks capable of self-training recognizing the complex patters in digital representations of buildings connected to the electricity grid and/or distributed energy sources. This research enables data-driven, automatic vulnerability assessments of connected buildings so that resources are secure and resilient. BTO's B2G strategy has been developed in coordination with partners like NIST and DOE's Office of Electricity Delivery and Energy Reliability in order to fully address cyber physical security and resiliency in a closely aligned fashion to avoid duplication. BTO has also played a strong role in DOE's grid modernization efforts which focus on the tools and technologies to measure, analyze, predict, protect, and control the grid of the future. BTO will continue supporting the early-stage R&D that enables the Grid Modernization Multi-Year Program Plan which focuses on devices and integrated system testing, sensing and measurement, system operations and power flow, design and planning tools, and security and resilience.

   Research areas for next-generation sensors include:
   - Solid-state device physics such as studying energy transfer mechanisms and antenna-diode interfaces.
   - Optimizing or eliminating conversion processing of analog signals to a digital format.

   Research areas for advanced control theory include:

- Multi-variate optimization across generating and consuming devices using predictive analytics and high-fidelity physics-based and data-driven models.
- Autonomous control and pattern matching capable of changing or alternating operation to reduce system distortion at the building-level and to facilitate building-to-grid integration.
- Model integration and control implementation, execution and adaptation to enable whole-building fault-detection and diagnostics as well as use of local analytics at the grid-edge to store and stage energy, accommodating distributed energy resources.

2. HVAC&R R&D ($2.6 million) targets fundamental research that enables performance advances in building equipment technologies. This work includes the characterization of new materials properties, novel thermal cycle development and innovative device design (e.g. next-generation heat exchangers). The R&D portfolio supports early-stage, pre-commercial investigations that have multiple practical applications, and therefore, are less likely to be researched by industry due to difficulties in capturing knowledge spillover benefits. BTO addresses the foundational scientific questions that are most relevant to a wide-range of industries, such as appliances, heating, air-conditioning and water-heating, as well as academic researchers. For example, computational fluid dynamics (CFD) modeling is utilized to gain a better understanding of physical phenomena like flammability and toxicity of refrigerants and combined experimental and theoretical research is used for the discovery of materials and system integration of magnetocaloric and electrocaloric materials. In both of these cases, the scientific advancements have the potential to transform the capabilities of a variety of building equipment types, not just for a specific application. This research will contribute to BTO's goal to enable industry to achieve a 24% reduction in HVAC energy consumption and 37% savings in water heating energy consumption by 2030 relative to a 2010 baseline.

   Research areas for heat transfer science and research include:
   - Thermally driven compressors used in fuel-fired applications, including natural gas or propane.
   - Thermodynamic performance of refrigerants including charges for HVAC, water heating and appliance applications.
   - Exploring methods for enhancing the heat transfer rate, including across solid/liquid interfaces.

   Research areas for materials for building equipment system research include:
   - Membrane research for separate sensible and latent cooling research.
   - Electrochemical compression for water heating and thermotunneling processes for space conditioning applications.

   Foundational research areas include:
   - Computational Fluid Dynamics (CFD) to optimize designs, including multi-physics tools key for high part-load efficiency.
   - Developing predictive tools for the laminar burning velocity of refrigerants to optimize for performance while minimizing flammability.

3. Building Energy Modeling (BEM) R&D ($2.6 million) seeks to characterize and implement models of the physical phenomena for building components and systems that enables increased use of building energy modeling tools for the design and operation of cyber-secure, energy efficient buildings in the U.S. This includes scientific validation to improve basic algorithms with an increased emphasis on new, innovative model development combining numerical, analysis, symbolic algebra and high performance computing necessary for grid-integration and advanced building design.

   BTO's BEM research portfolio has been developed to enable and support the building energy modeling field, but does not compete with companies and other market actors. BTO's software is the most sophisticated and advanced BEM tool available; it directly leverages the researchers and facilities at the DOE National Laboratories. The software accounts for thermal loads based on a wide-range of internal and external variables, thermal and energy consumption of all major building subsystems, including distributed generation and storage while accounting for control schemes, complex interactions among building systems and calculates and reports thermal comfort, visual comfort and indoor air quality. This requires unique experimental and theoretical physics characterization as well as numerical analysis and computer science expertise. BTO maintains the scientific expertise in building physics as well as measurement and validation

facilities that are unique National Laboratory assets. BTO ensures that the software has a commercial-friendly open-source license so that it can be embedded and utilized broadly by researchers in academia and industry. BEM does not support end-users and end-use applications and leaves that for market actors to ensure that limited federal funds can be widely utilized.

Whole-building experimental and theoretical physics research areas include:

- Developing new BEM models from measured experimental data, equation derivation and testing analytical/quasi-analytical solutions.
- Treatment of uncertain and stochastic inputs, such as occupancy and infiltration, via hybrid models and uncertainty frameworks.

Model implementation and integration research areas include:

- Numerical stability and time-step issues, specifically for incorporating building controls and grid-integration.
- Differentiability, composability and multi-resolution issues to maintain flexibility, execution speed, long-term maintenance and integration with other models.

4. Windows & Building Envelope R&D ($0.9 million) supports materials discovery, characterization and integration work that can be leveraged by the research community to enable industry to develop and deploy cost-effective R-10 windows and R-12/inch insulation material that can be applied to existing building structures by 2030. Like the HVAC&R R&D strategy outlined above, the windows & building envelope research supports early-stage, pre-commercial investigations that are impactful to a number of potential building envelope applications, making the research unlikely to be undertaken by industry due to difficulties in capturing knowledge spillover benefits. Early stage applied research in building envelope systems is particularly limited for construction and buildings envelope because that industry does not have the technical capability to undertake it. In addition, BTO's windows and building envelope research will focus on is too far from market realization to merit significant industry focus. This provides an opportunity to develop a research thrust targeting heat transfer and materials scientists at universities and the DOE National Laboratories. For example, investigations into methods for manipulating the phonon transport properties of non-electrically conductive materials or mixed electrical conductivity composites would be informative to a range of building envelope applications, but could also benefit material design for cutting-edge heat exchangers and other equipment components.

   Heat transfer and hygrothermal research areas include:

   - Understanding mechanisms affecting thermal conductivity in nanomaterials and manipulating heat transfer at interfaces.
   - Thermal modeling to develop an understanding of stress/strain at material interfaces under extreme temperature changes.

   Materials science research opportunities include:

   - Self-healing and multi-property materials for non-linear thermal transport in order to reclaim and dissipate heat.
   - Independent modulation of near infrared and visible light for dynamic windows.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Building Energy Research & Development $85,915,000	**$29,500,000**	**-56,415,000**
Lighting R&D ($24,000,000) • Continue support to improve performance and cost for LEDs and OLEDs. The roadmap-driven LED cost target for FY 2017 is 210 lumens/$, leading to the 2020 goal of 271 lumens/$. Competitive FOAs were released in FY16 and FY17 to pursue innovations in LED and OLED core technologies (i.e., LED emitter materials, OLED stable emitter systems), product development (i.e., novel LED luminaires, improved OLED light extraction), and manufacturing (i.e., LED luminaire manufacturing, OLED deposition equipment). In addition, technology application R&D at PNNL is funded to support field and laboratory evaluations, technical support for industry standards and technology competitions.	*Lighting R&D ($8,190,000)* • Continue support early-stage R&D into LEDs and OLEDs materials through limited pre-competitive research that will enable industry to reach the long-term SSL goals for LED package efficacy (255 lm/W) and OLED panel efficacy (190 lm/W). A targeted competitive FOA that is expected to fund 5-6 projects will be released in FY 2018. The FOA will pursue only materials innovations and characterization for LED and OLED core technologies (i.e., LED emitter materials, OLED stable emitter systems). This topic area is expected to support universities in partnership with National Laboratories and industry.	*Lighting R&D (-$15,810,000)* • In FY18, the Lighting R&D competitive FOA will not include product development (i.e., novel LED luminaires, improved OLED light extraction) or manufacturing (i.e., LED luminaire manufacturing, OLED deposition equipment) which would have led to 3-4 additional projects. The technology application R&D work including field and laboratory evaluations, technical support for industry standards and technology competitions will not be funded in FY18. .
HVAC & Refrigeration R&D ($17,415,000) • Lab-directed R&D on appliances, water heaters, and HVAC systems continued with a particular emphasis on low-global-warming-potential commercial refrigeration systems using CO_2 as the refrigerant, efficient refrigeration using a rotating heat exchanger or the magnetocaloric cycle, gas-fired absorption heat pumps for water heating, and integrated heat pumps that provide space conditioning and water heating, both electric and gas-fired. One sub-topic in the	*HVAC & Refrigeration R&D ($5,460,000)* • Continue to support direct laboratory funding for research in HVAC, water heating, and appliances with an increased emphasis on heat transfer science and materials and system science and research for novel materials as well as foundational, pre-competitive research lessons learned that are a broadly applicable for making U.S. businesses more globally competitive. This will include 1-2 mid-size projects as well as 4-5 scoping studies to inform future research directions.	*HVAC & Refrigeration R&D (-$11,955,000)* • Reduced number of anticipated awards under the BENEFIT FOA for space conditioning and refrigeration R&D. • Ongoing CRADAs with industry partners will be eliminated in favor of early-stage, transformational R&D. The work that will be eliminated or down-scoped includes air-source integrated heat pumps; a commercial integrated heat pump with thermal storage; cold climate heat pumps; residential gas-fired absorption

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
FY 2016 BENEFIT FOA was targeted improved joining technologies for HVAC&R with the potential to increase lifetime equipment operating efficiency and reduce refrigerant leakage.		heat pumps; gas-fired adsorption and absorption water heaters; and high-efficiency, low-emission refrigeration systems.
Buildings-to-Grid (B2G) R&D ($0) • This work was not included in the FY 2016 appropriations, instead *Sensors & Controls* and *Transactive Controls* were written as separate activities.	*Buildings-to-Grid (B2G) R&D ($10,930,000)* • FY 2018 funding will support 1-2 projects in solid-state physics research for advanced sensor development as well as 6-7 projects focused on autonomous control and pattern matching and integrated multi-scale data analytics.	*Buildings-to-Grid (B2G) R&D (+$10,930,000)* • There will be no competitive FOA for B2G R&D in FY 2018. The total *B2G* funding level decrease in funding is due to the elimination of demonstration and deployment projects. The explanations of the reductions are included under *Transactive Controls* and *Sensors & Controls.*
Sensors & Controls ($4,000,000) • Lab-directed R&D continued to enable building appliances and energy management systems to operate properly within the building to ensure energy efficiency performance while transacting with the electric utility. This work was based largely on the open-source VOLTTRON control platform developed at PNNL. Monitoring and verification capabilities were improved in part by incorporating occupancy data, and the ability to dim lighting systems and control HVAC systems were investigated for transactive purposes. There were also two topics in the FY 2016 BENEFIT FOA – human-in-the-loop sensor and control systems and plug-and-play sensor systems.	*Sensors & Controls ($0)* • No funding is requested.	*Sensors & Controls (-$4,000,000)* • *Sensors & Controls* and *Transactive Controls* are combined into a single, integrated *B2G R&D* activity in FY18. Activities supporting the open-source VOLTTRON control platform and the development data taxonomies will be terminated.
Transactive Controls ($18,000,000) • In coordination with DOE Grid Modernization Initiative, funding supported R&D in the development of Transactive Energy Applications to better integrate Distributed Energy Resources directly within buildings and the electric power system. Through this work, the subprogram	*Transactive Controls ($0)* • No funding is requested.	*Transactive Controls (-$18,000,000)* • *Sensors & Controls* and *Transactive Controls* are combined into a single, integrated *B2G R&D* activity in FY 2018. • Terminated projects include campus- and neighborhood-level demonstrations of transactive energy, activities to advance

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
developed a characterization methodology to quantify the capacity/availability of resources in buildings to deliver grid and other services; designed, developed, and fielded a multi-purpose controller and algorithms to ensure real time optimal operation.		transactive control for grid services – especially tools and applications needed for direct building/campus participation, building and campus scale microgrids and smart cities deployments that provide grid resources utilizing open communication standards, protocols, platforms.
Building Envelope R&D ($13,700,000) • Lab-directed R&D will continue to improve the WINDOW and THERM software packages, and their integration with EnergyPlus. Support continued for windows and building envelope testing facilities, to be used by manufacturers for research and for testing and improving their products. The FY 2016 BENEFIT FOA included two building envelope topics, air sealing and infiltration control systems (5 air changes/hour at $0.9/ft^2 in FY 2015, to 3 and $0.5/ft2 in 2020 for residential buildings) and air-infiltration diagnostic technologies, as well as a number of projects selected from the open topic on advanced insulation materials, hygrothermal modeling and daylighting technologies.	*Building Envelope R&D ($1,640,000)* • Direct laboratory R&D funding in building envelope and windows will be redirected to focus on early-stage materials development and characterization for a wide-range of building envelope applications, both opaque and transparent. This is a new research thrusts that will result in one $500-750K project and 2-3 small scoping studies that will be well-suited to academic researchers and National Laboratory scientists with expertise in heat transfer, material science and building science.	*Building Envelope R&D (-$12,060,000)* • 3-4 fewer awards anticipated under the BENEFIT FOA. • Elimination of ongoing work testing and verifying performance with industry partners; Eliminated work includes the technical support of the Attachments Energy Rating Council, windows durability testing and demonstration for next-generation air-sealing systems. • Redirection and streamlining of the WINDOW and THERM software packages has been moved at a reduced budget to *Building Energy Modeling Research*.
Building Energy Modeling Research ($5,300,000) • Lab-directed funding will continue to support the development of the open-source EnergyPlus building energy modeling software, including two planned upgrade releases in FY 2016. Enabled by the recent migration from FORTRAN to C++, EnergyPlus will be refactored in an object-oriented design paradigm, which will allow parallel processing and easier code updates. BESTEST simulation validation tests and the Modelica Buildings Library will continue to be supported. Contractors selected through a competitive request for proposal will develop	*Building Energy Modeling Research ($3,280,000)* • Develop physics-based building energy models from measured experimental data characterizing physical phenomena and processes for building components and systems. Once governing equations are developed, model implementation and integration will be done to ensure flexibility, execution speed, maintainability and integration with other models.	*Building Energy Modeling Research (-$2,020,000)* • Lab-direct R&D to improve and streamline the WINDOW and THERM software packages was moved from Building Envelope to Building Energy Modeling in FY16. Research on WINDOW will focus on characterization of heat and light transfer and THERM will focus on numerical analysis for 2D heat transfer. • The decrease relative to the FY 2016 budget reflects the reduction in effort in the evolution of the EnergyPlus package towards a modular framework, based on Modelica had an increase in FY 2016 funding that was completed in

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
modules for some building components.		FY 2017. FY 2018 funding will be limited to streamlined, maintenance activity at a much lower level.
High-Impact Technology R&D ($3,500,000) • Funding supports a BUILD FOA that provides university-led funding in a variety of building energy-efficiency technologies. The remaining funds are directed towards a joint laboratory call with the Commercial Buildings Integration Program targeting near-term technologies facing the "valley of death."	*High-Impact Technology R&D ($0)* • No funding is requested.	*High-Impact Technology R&D (-$3,500,000)* • This work will be completed in FY 2017.
U.S. China Clean Energy Research Center – Building Energy Efficiency Consortium (CERC-BEE) ($2,5000,000) • Year 1 of a 5-year commitment of funding to support R&D of building energy efficient technologies and solutions, through teams of scientists and engineers from the United States and China. This is Phase 2.0 of the CERC-BEE program. The bilateral R&D teams are comprised of U.S. National Laboratories, and US and Chinese universities, research institutes, and industry partners. Current R&D projects are in the areas of advanced controls, building design and construction, DC power, indoor air quality and policy and market engagement.	*U.S.-China Clean Energy Research Center – Building Energy Efficiency Consortium (CERC-BEE) ($2,500,000)* • Year 3 of the 5-year commitment for Phase 2.0 of CERC-BEE.	*U.S.-China Clean Energy Research Center – Building Energy Efficiency Consortium (CERC-BEE) ($0)* • No change
Partnership to Advance Clean Energy – Research (PACE-R) ($1,250,000) • Joint clean energy R&D effort between the U.S. and India on energy efficient buildings – Center for Building Energy Research & Development.	*Partnership to Advance Clean Energy – Research (PACE-R) ($0)* • No funding is requested.	*Partnership to Advance Clean Energy – Research (PACE-R) (-$1,250,000)* • The PACE-R program will complete Phase 1.0 in FY2017. No additional work is planned for FY2018.

Building Technologies
Commercial Buildings Integration

Description

The U.S. commercial building sector (representing 5.6 million buildings and 90 billion square feet of real estate) uses nearly 7 quadrillion Btu of total site energy, roughly 18% of the nation's total energy consumption; accounts for 36% of all U.S. electricity consumption;[1] and costs nearly $175 billion to power each year.[2] This is a growing sector, which is expected to see significant growth in the coming years with more than 4 billion square feet of net new floor area being added over the next four years.[3]

BTO has a goal to enable industry to reduce U.S. buildings energy use intensity (EUI, defined as primary energy consumption per floor space) by 50% and an interim goal of reducing building EUI 30% by 2030. The Commercial Building Integration (CBI) program's research, development, and evaluation helps advance a range of innovative building technologies and solutions, paving the way for industry to deploy high performing buildings that could use 50-70% less energy than typical buildings.

BTO will build upon its existing R&D on the integration of commercial building systems. Specifically, the CBI program will conduct early-stage R&D and analytical studies into building systems (e.g., lighting, HVAC, envelope, sensors and controls, etc.) and whole commercial buildings (e.g., office buildings, schools, hospitals, stores, warehouses, public infrastructure buildings, etc.) to better understand and assess the interactive effects of combining multiple novel technologies within a commercial building system. CBI's R&D initiatives will provide a theoretical foundation for the design and system-level engineering for packages comprising multiple building energy subsystems, as well as whole-commercial buildings. Investigations include simulation, experimental and field-based validation of interactive physical effects among and within systems; measurement and characterization of the improvement and degradation of performance of materials, subsystems and systems; and field-based and other experiments on complex systems (such as occupant-controls interactions).

Within this multifaceted and complex building framework, CBI will limit research to exploring high impact technologies that are too far from commercialization to merit industry investment. Focus areas will include cold climate heat pumps, energy management and information systems (EMIS), lighting controls, shading attachments and refrigeration systems.

The subprogram will also support R&D efforts that leverage recent advancements in whole-building technology integration – including the development and enhancement of innovative energy simulation modeling, analysis tools and both laboratory- and field-based techniques. By leveraging existing DOE data analysis and simulation tools, like the commercial building asset score and the standardized energy efficiency database, CBI explores how building assets interact within buildings and then help identify pathways to optimize energy-saving strategies and solutions. These R&D efforts also provide the infrastructure for developing new innovative analytical capabilities (such as building data management and interoperability, energy use measurement and verification, and building and building component energy attribution) across the heterogeneous commercial building population, leading to constant improvement of whole building assessment and performance.

[1] https://www.eia.gov/consumption/commercial/reports/2012/energyusage/ Note, this data includes federal buildings.
[2] U.S. Energy Information Administration. *Annual Energy Outlook 2015 with projections to 2040*. DOE/EIA-0383(2015). Washington, DC: U.S. Department of Energy, April 2015. Accessed January 11, 2016: http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf.
[3] U.S. Energy Information Administration. *Annual Energy Outlook 2017 with projections to 2050*. Washington, DC: U.S. Department of Energy, April 2015. Accessed April 11, 2017: https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Commercial Buildings Integration $32,000,000	**$5,500,000**	**-$26,500,000**
• Update the HIT Catalyst to guide technology-to-market activities. Execute technology demonstrations, procurement specifications and installation guides to accelerate market acceptance of FY 2015 focus technologies include interior lighting, building controls and technology systems. Assess HIT list to develop 3-4 focus technologies for FY 2016 and develop multi-year technology to market plan.	• Six National Laboratory led R&D projects examining systems efficiency and integrated building issues. Projects will focus on multi-system or multi-technology (groups of technologies), specifically targeting multiple technology areas and innovative saving-energy interactions across envelope, lighting/electrical, plug, process, heating, ventilation, cooling, refrigeration, energy management and information, and sensors and controls. • Initiate National Laboratory-led projects on 5 targeted priority & high-potential technologies, including research that answers questions related to energy saving validation and verification, integration complexities, performance specification development, and cost-benefit analysis.	• Reflecting the shift in focus to early-stage R&D, the High Impact Technology early adoption efforts will be eliminated. In addition, activities related to market-ready technologies and their deployment will be discontinued.
• Supports a FOA in the small and medium commercial buildings sector through regional and national partnerships.	• No FOA funding is requested.	• Eliminates FOA funding.
• Maintain successful market partnership programs such as the Better Buildings Challenge to accelerate adoption of energy efficiency technologies and practices. In FY16, CBI will focus on developing robust partnerships with industry organizations to extend the impact.	• Leverage existing networks and partnerships by focusing on validation and field testing of various energy-saving solutions for the purpose of informing R&D.	• Eliminates later-stage commercialization activities related to strategic market engagement with industry stakeholders • Eliminates or significantly reduces market engagement activities, including solutions platforms, sharing best practices including implementation models and showcase projects, peer-to-peer exchange, R&D outreach and delivery, technology peer groups, and themed accelerators.
• Launch new product specifications with the potential to reduce energy use by 1 quad and demonstrate and evaluate impact of several	• No funding is requested.	• Eliminates activity related to technology commercialization or more market-ready technology adoption efforts.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
promising new technologies in commercial buildings with the total potential to reduce energy use by 1 quad. • Continue T2M activities with the Building Energy Research & Development subprogram and collaboration with the Equipment and Building Standards subprogram through high-impact technology commercialization projects.		

Building Technologies
Residential Buildings Integration

Description

The U.S. residential building sector (representing over 118 million single family homes, multi-family units, and mobile homes)[1] uses over 10 quadrillion Btu of total site energy[2], accounting for roughly 22% of the nation's total energy consumption.[3] The residential sector accounts for 38% of all U.S. electricity consumption, costing consumers over $157 billion in utility bills.[4] This is a growing sector, expected add more than 4 million new housing units over the next four years.[5]

The Residential Buildings Integration (RBI) program has a program performance goal of enabling industry to develop and deploy cost-effective technologies and practices that can reduce the EUI of new single family homes by at least 60 percent and existing homes by at least 40 percent by 2020 (relative to a 2010 baseline) while maintaining performance in all major climate regions, with a focus on reducing heating, cooling and water heating loads.

RBI's overarching R&D strategy is to identify building integration technology areas and technical solutions that offer the potential for large energy savings in new and existing homes and conduct research to resolve the major technology and system integration challenges to achieving these goals.

RBI investments support early-stage energy efficiency R&D, in partnership with private industry and academia. RBI works to innovate new housing construction and home improvement retrofit technologies and validate the performance of these innovations. These R&D efforts create the basis for private sector entities to voluntarily test new and improved technologies and provide feedback to DOE, including field-based datato informing the prioritization of future R&D.

In FY 2018, the RBI program will invest in residential building system research through the Building America FOA to gain knowledge and understand physical phenomena specific to residential buildings. These investigations provide a theoretical foundation for the design and system-level engineering for packages comprising multiple building energy subsystems, as well as whole homes. Applied research investigations include simulation, experimental and field-based validation of interactive physical effects among and within systems; measurement and characterization of the improvement and degradation of performance of materials, subsystems and systems; and field-based and other experiments on complex systems (such as occupant-controls interactions).

Work will build upon its existing residential building R&D and advance it on key residential building system target areas:

- Optimized Low-Load Comfort Solutions: Solutions for high-performance homes with much lower heating and cooling requirements that need to ensure full mixing with much lower airflow and humidity control during longer swing seasons. Specialized solutions for these research areas may be required for different climates.
- Novel approaches to ventilation: Identify and test concepts for effective whole-house and spot ventilation in energy efficient homes;
- Moisture Managed High-R Envelopes: Technical solutions ensuring moisture management in highly insulated and tighter, high performance building envelopes;

[1] U.S. Energy Information Administration. Residential Energy Consumption Survey 2015, Housing Characteristics (Table HC2.1). Accessed May 19, 2017: https://www.eia.gov/consumption/residential/data/2015/
[2] U.S. Energy Information Administration. Residential Energy Consumption Survey 2009. Accessed May 19, 2017: https://www.eia.gov/consumption/residential/data/2009/
[3] U.S. Energy Information Administration. March 2017. Monthly Energy Review. DOE/EIA-0035(2017/3). Accessed May 19, 2017: https://www.eia.gov/totalenergy/data/monthly/archive/00351703.pdf
[4] U.S. Energy Information Administration. February 2017. Electric Power Monthly. Accessed May 19, 2017: https://www.eia.gov/electricity/monthly/current_year/february2017.pdf
[5] U.S. Energy Information Administration. Annual Energy Outlook. Residential Sector Key Indicators and Consumption. Accessed May 19, 2017: https://www.eia.gov/outlooks/aeo/

- Integrated High Performance Retrofit Solutions: Solutions to improve the energy efficiency of existing homes. Such projects could include whole home exterior retrofits, smart heating and controls and diagnostics and high performance heating, cooling and its distribution systems.
- Zero Energy Ready Homes (ZERH): research to support the construction of homes that are 50 to 60 percent more energy efficient than homes built to the 2006 model energy code.

In addition, funding will support the continued development of open-source, state of the art computer models that serve as the benchmark against which other industry-based models are validated. These models complement industry's efforts to test their innovations before introduction into test homes and eventual commercialization, and are used in priority setting efforts by DOE and other programs to determine research direction.

RBI will also support research to better understand the economic and engineering barriers to residential building efficiency technologies and solutions. RBI data tool work is focused on performing original investigation into the energy and security performance and fundamental characteristics of whole buildings as well as building components. The data and the associated analytics are used throughout the private sector to acquire new knowledge about the building stock, informing their strategic direction. This research is also critical to developing new applied research opportunities for innovative technologies, building subsystems and building systems and provides foundational knowledge to a range of private-sector partners such as manufacturers, utility companies and developers as well as state and local governments. The work is particularly valuable to small businesses, who would not otherwise have access to sector-wide whole building information.

In FY 2018 RBI will support the Solar Decathlon. This is an international collegiate competition made up of 10 contests that challenge student teams to design and build full-size, solar-powered, highly energy-efficient houses. The winner of the competition is the team that best blends design excellence and smart energy production with innovation, market potential, and energy and water efficiency.

Residential Buildings Integration

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Residential Buildings Integration $23,000,000	**$6,500,000**	**-$16,500,000**
• Focus on applied research through its Building America Program as well as its Better Buildings Residential Program. Technical research will address High Performance Enclosures, Optimal Comfort Solutions for Low-Load Homes and Healthy Efficient Ventilation and Indoor Air Quality Solutions in the remaining climate zones.	• Solicit and select 2 to 4Y projects from a competitive Building America FOA that will address High Performance Enclosures, Optimal Comfort Solutions for Low-Load Homes and Healthy Efficient Ventilation and Indoor Air Quality Solutions.	• Reflecting the shift in focus to early-stage R&D, the Better Buildings Residential Program is eliminated and only two to four Building America projects will be selected relative to the eight selected in FY16.
• Evaluation, stakeholder engagement, and other activities to support the expansion of retrofit facilitation activities to all residential buildings and income levels. This program would expand RBI's retrofit efforts beyond single-family homes to multi-family (low-rise) and manufactured homes. The program will support RBI's continued shift to the larger opportunity of cost effective staged home improvements.	• 3 to 5 National Laboratory-led projects will focus on improving the climatic range of heat pumps, heat pump water heaters, and examining the technical approaches to measure the proper installation of HVAC.	• Multifamily and manufactured homes retrofit efforts will be completed in FY2017. • Eliminates or significantly reduces market engagement activities, including solutions platforms, sharing best practices including implementation models and showcase projects, peer-to-peer exchange, R&D outreach and delivery, technology peer groups, and themed accelerators.
• Continue to support infrastructure development through its Solution Centers, providing technical and programmatic solutions to the market. The RBI program will support standards development and, Building Science curriculum development. The Home Energy Score will continue to provide information to homeowners on the energy efficiency of their homes. The RBI program will demonstrate market-based cases through its Zero Energy Ready Homes Program to builders and homeowners. The RBI program will also provide options for increasing lower-cost, high-volume single measure activities that increase efficiency in homes. The Home Performance with ENERGY STAR Program, the RBI subprogram will help efficiency programs and their partners	• Activities related to the Home Performance with ENERGY STAR program will be discontinued. • RBI will maintain its solutions centers, its ZERH program and the HEScore which test and highlight the research conducted by Building America Research Program and other research centers. However, RBI will not add additional modules or conduct efforts to expand these sub-programs	• RBI will no longer support the Building Science curriculum development. • National Home Performance with ENERGY STAR Program eliminated • Solution Centers, ZERHs, HEScore well be placed in maintenance mode to highlight research relevant to builders, contractors and sponsors, and to receive feedback on such research

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
to more comprehensively address barriers to adoption of retrofits.		
	• RBI will support the Solar Decathlon.	• Solar Decathlon is transferred from Strategic Programs where it was managed in FY 2016/2017

Buildings Technologies
Equipment and Buildings Standards

Description

The Equipment and Buildings Standards program generates cost-effective energy savings through the development of national appliance and equipment standards, as required by statute. The program sets minimum efficiency standards for products covered by statute that are manufactured or imported into the U.S., and can incrementally raise the standards over time if technology feasible and economically justified.

The Appliance and Equipment Standards program regulates the efficiency of new products that ultimately account for the vast majority of energy use in the building sector—nearly 90 percent of all energy used in residences and nearly 60 percent of all energy in the commercial buildings.

DOE is committed to meeting its legislatively mandated deadlines for covered appliances and equipment and to actively enforcing its existing standards to provide a level playing field for all manufacturers. The Energy Policy and Conservation Act (as amended) legislatively mandates the Program's test procedure and standards rulemaking activities. The rulemaking schedule, and thus the level of program activity, is determined by existing statute.

In FY 2018, ($25.0 million) for Appliance and Equipment Standards will fund all necessary and feasible steps to finalize legally required efficiency standards and test procedures, and meet all applicable judicial and statutory deadlines. DOE will, to the extent possible, maintain its activities regarding the certification and enforcement of existing energy conservation standards. Specifically, in FY 2018, Appliance and Equipment Standards activities will:

- Issue 3 energy conservation standards final rules for 11 products;
- Issue 3 test procedure final rules for 11 products; and
- Enforce standards violations to the extent possible.

This program includes ($1.0 million) for Building Energy Codes. This activity fulfills a statutory requirement for DOE to evaluate changes to model building energy codes, which inform state and local building code processes, including making a formal determination. Through this activity, DOE also assists states and localities when they adopt and enforce energy codes.

Equipment and Buildings Standards
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Equipment and Buildings Standards $57,485,000	**$26,000,000**	**-$31,485,000**
• Program will complete work on proposed and final rules to meet statutory obligations and issue requests for information (RFIs) to gather information for future statutory requirements. Program will continue to enforce minimum standards, issue test procedure waivers as appropriate, and verify the performance of ENERGY STAR products.	• Program will meet statutory obligations for energy conservation standards and test procedures. Program will continue to issue test procedure waivers and enforce minimum standards as budget allows. Statutory requirements including: Three test procedure final rules or determinations, three energy conservation standards proposals or determinations, and three energy conservation standards final rules.	• Limit rule making and related activities, including enforcement, to the minimum required to maintain compliance with statute. • Eliminate all ENERGY STAR test procedure development and performance verification.
• The Building Energy Codes activity will continue to meet statutory obligations to participate in national model code development activities, and seek to increase the number of states (by at least 5) that have adopted and are complying with updated codes. • Release a Commercial Building Energy Codes FOA.	• The Building Energy Codes activity will meet statutory obligations, including participation in national model code development and implementation.	• Limit technical assistance to state and local government regarding code adoption, compliance and enforcement. • Limit participation in industry processes to review and modify national model codes to the minimum required for compliance with statute.

Building Technologies
NREL Site-Wide Facility Support

Description

In FY 2018, EERE will continue to directly fund National Renewable Energy Laboratory (NREL) Site-Wide Facility Support costs rather than fund those costs as laboratory overhead.

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

NREL Site-Wide Facility Support
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $2,100,000	**$0**	**-$2,100,000**
• Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure Budget rather than continue to fund these costs in the laboratory overhead rate.	• No funding requested within the Building Technologies Budget Request.	• Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Buildings - Lighting - Decrease the manufacturing cost of a warm white LED package. (Lumens / $)**		
Target	188 lm/$	210 lm/$	240 lm/$
Result	Met - 188	TBD	TBD
Endpoint Target	271 lm/$ by 2020		

Weatherization and Intergovernmental Programs

Overview

The FY 2018 President's Budget eliminates the two subprograms, Weatherization Assistance Program and State Energy Program, managed by the Office of Weatherization and Intergovernmental Programs to reduce Federal intervention in State-level energy policy and implementation and to focus funding on limited, early-stage applied energy research and development activities where the Federal role is stronger.

The mission of the Weatherization and Intergovernmental Programs (WIP) was to partner with state and local organizations to facilitate strategic investments focused on states' energy priorities, including advancing policies to enable deployment of energy efficient and renewable energy technologies.

WIP programs have addressed the demand and supply sides of energy by subsidizing State investments in both energy efficiency (demand), and renewable energy generation (supply), as well as alternative transportation fuels and vehicles.

For decades, states have demonstrated leadership through their unique authorities to develop and implement energy efficiency and renewable energy policies and programs. State governments wield considerable influence in the building sector through upgraded building codes and incentives; in the utility sector through energy efficiency and renewable energy targets and customer programs; and in the industrial sector with policies that encourage efficiency and/or fuels substitutions (such as energy audits and combined heat and power). States advance these energy solutions through regional networks, strategic energy planning, executive orders, legislation, management of retrofit programs, and land use plans. Local governments are an important bridge between state action and community investment. They uniquely have the understanding of municipal ecosystems and community needs, and a significant role in revitalization that are critical to integrating innovative energy thinking into the built environment.

Highlights of the FY 2018 Budget Request

WIP's FY 2018 Budget Request includes no funding for the Weatherization Assistance Program (WAP) and the State Energy Program (SEP). These programs are not aligned with EERE's focus in FY 2018 on early stage applied research and development for energy efficiency and renewable energy technologies. Activities in FY 2018 will focus on completing work activities associated with existing financial and technical assistance awards and initiatives with states and local governments and stakeholder organizations, closing out awards and agreements as they come to the end of their periods of performance, and providing resources and institutional knowledge to state and local entities as practicable.

Weatherization and Intergovernmental Programs
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Weatherization and Intergovernmental Programs				
Weatherization Assistance Program				
Weatherization Assistance (formula grants)	211,600	211,198	0	-211,600
Training and Technical Assistance	3,000	2,994	0	-3,000
NREL Site-Wide Facility Support	400	399	0	-400
Total, Weatherization Assistance Program	**215,000**	**214,591**	**0**	**-215,000**
State Energy Program	**50,000**	**49,905**	**0**	**-50,000**
Total, Weatherization and Intergovernmental Programs	**265,000**	**264,496**	**0**	**-265,000**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Weatherization and Intergovernmental Programs
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Weatherization Assistance Program: Budget Request eliminates the Weatherization Assistance Program to reduce Federal intervention in State-level energy policy and implementation and focus funding on limited, early-stage applied energy research and development activities where the Federal role is stronger.	**-215,000**
• NREL Site-Wide Facility Support: In FY 2018, EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.	**-400**
State Energy Program: The Budget Request eliminates funding for the State Energy Program	**-50,000**
Total, Weatherization and Intergovernmental Programs	**-265,000**

Weatherization and Intergovernmental Programs
Weatherization Assistance Program

Description

The Weatherization Assistance Program (WAP) mission was to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety. Through retrofitting residential buildings, WAP activities reduced the cost of low-income household energy bills. Since 1976, WAP performed over 6 million upgrades to low-income households, including 1 million retrofits supported through American Recovery and Reinvestment Act of 2009[1] funding. In addition, through coordination with industry stakeholders, WAP developed and assisted in the implementation of voluntary and comprehensive national certifications and standards in retrofit worker training, energy audits, and weatherization methods.

WAP has allocated its funds on a statutory formula basis and made awards to a single agency within each State, Washington, DC, and U.S. territories, to increase the energy efficiency of homes occupied by families with household incomes of 200 percent or less of the poverty guidelines updated periodically in the Federal Register by the U.S. Department of Health and Human Services under the authority of 42 U.S.C. 9902(2). These agencies, in turn, contracted with approximately 800 Community Action Agencies and local governmental and nonprofit agencies to provide weatherization services to low-income families. Typical energy conservation measures included installing insulation, sealing ducts, repairing or replacing heating and cooling systems, reducing air infiltration, improving hot water production and use, and reducing electric base load consumption.

DOE completed a national evaluation of WAP in FY 2015. The evaluation covered the program year 2007 and 2008 and American Recovery and Reinvestment Act of 2009 performance periods. An impact analysis estimated national energy savings and program cost effectiveness, as well as, non-energy benefits and a comprehensive process evaluation addressed program characterization, operation, training, and quality assurance. Publically released results include:

- Single-family home average annual energy cost savings of $283;
- 8,500 job supported;
- Program-wide savings-to-investment ratio of 1.4; and
- Program-wide benefit cost ratio when including health and safety benefits of 4.1.

In FY 2018, the Weatherization Assistance Program (WAP) will use existing resources to conduct close-out activities including administration of multi-year formula awards to 59 grantees (50 states, the District of Columbia, 5 U.S. Territories, and 3 Native American Tribes) made with FY 2017 and prior year funding.

WAP's Training and Technical Assistance (T&TA) activities supported the development and implementation of a variety of tools needed to implement work quality, training accreditation, and worker certification. In FY 2018, WAP will use existing resources to conduct close out activities including transferring or archiving tools and materials in a manner that ensures continued access to the public resources.

NREL Site-Wide Facility Support ($0)

EERE proposes to eliminate the NREL Site-Wide Facility Support subprograms in its individual technology programs, and consolidate NREL Site-Wide Facility Support funding in the Facilities and Infrastructure program. Locating this funding in the Facilities and Infrastructure program will provide clarity and transparency in communicating EERE's stewardship for NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

[1] http://www.gpo.gov/fdsys/pkg/PLAW-111publ5/pdf/PLAW-111publ5.pdf

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Weatherization Assistance Program $215,000,000	**$0**	**-$215,000,000**
Weatherization Assistance ($211,600,000) • Supports energy upgrades in the homes of low-income families through formula grants. • Award and actively manage 59 weatherization formula grantees, which will support approximately 33,600 comprehensive energy audits and residential energy retrofits.	*Weatherization Assistance ($0)* • No funding is requested	*Weatherization Assistance (-$211,600,000)* • Existing balances will be used to conduct close-out activities.
Training and Technical Assistance ($3,000,000) • Continue development of national certifications and work specifications for residential retrofit worker training, energy audits, inspections, and weatherization methods. Activities include: updating 14 training curricula for crew workers, crew leaders, auditors, and QC inspectors skills development; reviewing certification requirements for energy auditors and preparing any needed training modules; and conducting one or more workshops with training centers and community colleges to identify available resources and improvements to training platforms.	*Training and Technical Assistance ($0)* • No funding is requested	*Training and Technical Assistance (-$3,000,000)* • Existing balances will be used to conduct close-out activities.
• Facilitate the on-line use of a suite of residential energy auditing tools related to the WAP. • Continue to cooperate with other Federal agencies involved in the Federal Healthy Homes Initiative (HUD, EPA, Centers for Disease Control and Prevention, Department of Labor), and local non-profit organizations to provide training to 400-500 weatherization service providers to help qualify them to assess health issues along with conservation needs.	• No funding is requested	• Existing balances will be used to conduct close-out activities.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Continue grantee and subgrantee operations improvement through the WAP Quality Management Plan for training and skills development through identifying the knowledge, skills and abilities state and local staff need, reviewing existing training resources, and developing two or more curricula designed to address specific management needs. Improve grantee and subgrantee performance through state plan process with adoption of WAP Quality Work Plans features including certified quality control inspectors.	• No funding is requested	• Existing balances will be used to conduct close-out activities.
• Implement strategic planning and analysis; define program performance measurement; and facilitate advanced techniques and collaborative strategies through pilot programs, publications, training programs, workshops and peer exchanges.	• No funding is requested	• Existing balances will be used to conduct close-out activities.
NREL Site-Wide Facility Support ($400,000) • Directly fund NREL site-wide facility support costs that are not included in the Facilities and Infrastructure budget rather than continue to fund these costs in the laboratory overhead rate.	*NREL Site-Wide Facility Support ($0)* • No funding requested within the WIP Budget Request.	*NREL Site-Wide Facility Support (-$400,000)* • Reduction in the Request is offset by a corresponding increase in the Facilities and Infrastructure Budget Request. Funding is consolidated in EERE's NREL Site-Wide Facility Support.

Weatherization and Intergovernmental Programs
State Energy Program

Description

The State Energy Program (SEP) assisted states in establishing and implementing energy plans, policies, and programs to reduce energy costs, increase economic competitiveness, improve emergency planning and strengthen energy security, and improve the environment. SEP provided states with financial assistance, technical assistance, and best practice sharing networks to facilitate the adoption of plans, policies, and programs designed to address state and regional circumstances. Examples of the types of state programs supported with SEP funding, and developed and administered by state energy offices also include: energy savings performance contracting to retrofit state and local infrastructure including government buildings and facilities; comprehensive residential energy programs for homeowners; diverse financing mechanisms for public institution retrofit programs; loan programs; transportation programs that facilitate the use of alternative fuels; programs that remove barriers and support supply side and distributed renewable energy; and state and local building energy code adoption and implementation.

SEP also funded competitive projects to develop and promote new policy approaches to address state and local energy challenges. Examples of successful SEP competitive projects include:

- Iowa's engagement of regional energy managers (REMs) throughout the state to work with local governments to assist 20 local governments to create energy plans and move forward with energy audits for 1.8 million of building space;
- New Mexico's work with four local governments to pilot a state energy savings performance contracting program and assisting them to establish a pre-qualified list of providers. The first of the four local agencies has completed its retrofits and is realizing savings;
- Washington's efforts with its state legislature to strengthen its energy efficiency resources standard, which was implemented on April 6, 2015. Changes include removal of a formula based shortcut approach, a more flexible cost-effectiveness standard, and better documentation of measurement and verification protocols; and
- Massachusetts invested SEP competitive funding in the Schools and Public Housing Integrating Renewables and Efficiency (SAPHIRE) program for school districts. Upgrades through this program have significantly reduced the participating school districts' need to purchase heating oil and will yield an estimated $46,000 in energy savings per year while also providing significant environmental benefits.

In FY 2018, SEP will use existing resources to conduct close-out activities including administration of multi-year formula financial assistance awards to 56 grantees (50 states, the District of Columbia, and 5 U.S. Territories) made with FY 2017 funding, with a total of between $50 million to $70 million in combined funding from FY 2016 and FY 2017. SEP will also use existing resources to complete a new round of competitive financial assistance awards initiated in FY 2017 funding (subject to a final FY 2017 Budget or CR), and manage existing competitive awards totaling between $11 million and $16 million.

DOE completed a national evaluation of SEP in FY 2015. The evaluation covered the FY 2008 and American Recovery and Reinvestment Act of 2009 performance periods and developed independent estimates of key program outcomes and metrics, including energy savings, employment impacts, renewable energy production, and environmental co-benefits. Preliminary evaluation results for program year 2008 from the report, which is representative of a normal year of funding, include:

- For every SEP dollar spent, program participants received $4.50 in bill savings over the lifetime of the measures installed.
- 2,044 SEP-attributable jobs were created or retained, which is equal to about 1 job per $12,500 in SEP dollars invested.
- The SEP investments resulted in lifetime energy savings and renewable generation of 9.7 trillion BTUs (primary source), enough energy to power up to 52,000 homes per year.
- There were SEP-attributable lifetime cost savings of $94.6 million.
- Total costs of $37.4 million were avoided due to reduced emissions associated with program-induced energy savings and renewable generation.

In addition to the work outlined above, SEP made the following accomplishments in partnership with state and local governments: achieved $280 million in energy cost savings, reduced energy use by over 29 trillion Btus, and reduced water use by over 800 million gallons in public sector buildings and facilities through Better Buildings Challenge and other

collaborative initiatives; assisted 25 public entities to develop replicable approaches for improving public buildings with over $2.0 billion in energy savings performance contracting investments by 18 states, 6 cities and 1 school district; facilitated the upgrade of 1.3 million street lights to high performance LED lighting by partnering with 3 states, 16 cities and 6 regional energy organizations between 2014 and 2016; leveraged over $300 million in voluntary commitments from 39 state and local partners for programs to make energy more affordable for low-to-moderate income communities; and established partnerships with 17 states, 8 local governments and 2 regional organizations to improve the energy efficiency of 100 water resource recovery facilities in their jurisdictions by at least 30 percent.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
State Energy Program $50,000,000	**$0**	**-$50,000,000**
• Advance state government energy priorities, including effective energy efficiency and renewable energy policies and technologies by state governments. • Award and actively manage 56 formula grants supporting $39 million in state energy projects. Competitively selected 12 or more projects, involving 20+ states (some projects will be multi-state) for innovative state/regional projects in a variety of areas including comprehensive energy planning; public-private efforts to expand use of and development of new financing and PACE models; expand use of performance contracting in underserved sectors and with local governments, state/local partnerships to lead by example on energy technology upgrades, benchmarking and disclosure; and, streamlining permitting and interconnection for renewables. Develop and deliver a portfolio of strategic technical assistance offerings to state energy offices. • Begin implementing changes based on the findings of the major national evaluation of the program. • Develop and deliver a portfolio of strategic technical assistance offerings to state energy offices.	• No funding is requested	Existing balances will be used to conduct close-out activities.

Weatherization and Intergovernmental Programs
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**OWIP - Retrofits - Weatherize homes of low income families**		
Target	33,600 homes weatherized	33,000 homes weatherized	N/A
Result	Not Met - 31,370	TBD	N/A
Endpoint Target	Measure is discontinued as of FY 2018.		

Program Direction

Overview

Program Direction enables EERE to maintain and support a world-class Federal workforce to manage early-stage research and development and regulatory functions in sustainable transportation, renewable power and energy efficiency to address our Nation's energy and environmental challenges. The FY 2018 Program Direction Budget Request provides essential resources for program and project management, oversight activities, contract administration, workforce management, IT support, stewardship of the National Renewable Energy Laboratory, and headquarters and field site non-laboratory facilities and infrastructure.

To align with reductions in technology program budgets, EERE will reduce Full-Time Equivalents (FTEs) by 33 percent from the FY 2017 level. Of EERE's portfolio of approximately 2,500 multi-year (3-5 year) projects, at least two-thirds will remain active in FY 2018. The approximate 30 percent decrease in projects will result in an equivalent 30 percent reduction in FTEs across EERE. Remaining staff are critical in ensuring continuity of the essential oversight activities for EERE's project portfolio and maintaining proper stewardship of taxpayer dollars. A limited amount of staff will remain in the Weatherization and Intergovernmental Program Office to provide minimum required oversight of existing projects. Due to the reduced financial assistance project and grant workload in FY 2018, EERE will consolidate procurement and project management functions at the Golden Field Office, allowing for the elimination of staff support at the National Energy Technology Laboratory (NETL).

EERE will achieve staff reductions through a series of functional transfers to eliminate redundancies and increase operational efficiency by centralizing staff expertise in corporate offices, including International Affairs and Public Affairs within Departmental Administration and the Office of Technology Transitions. Additionally, EERE will utilize a suite of available options, including the Voluntary Separation Incentive Program (VSIP), the Voluntary Early Retirement Authority (VERA), extended administrative furloughs, and Reduction in Force (RIF) authority, to achieve staffing reductions and cost savings. EERE does not expect to have prior year funds for use in FY 2018.

Highlights of the FY 2018 Budget Request

The FY 2018 EERE Program Direction Budget Request will:

- Achieve cost savings by reducing staff to an FTE level of approximately 458, a reduction of 187 FTE funded by EERE relative to FY 2016;
- Continue the EERE Program Information Center (EPIC) enterprise IT modernization effort to improve EERE's operational effectiveness and efficiency through an integrated IT-based platform for EERE's business processes, including: budget planning, formulation, and execution; Funding Opportunity Announcement (FOA) development through award selection; project management of EERE projects with industry and university performers; and award and management of EERE's projects with the National Laboratories; overall EPIC developmental costs will be reduced through leveraging efforts with other DOE offices;
- Support project management and procurement across EERE's full portfolio of projects, including closing out completed financial assistance awards while reducing staff by 30 percent; and,
- Maximize the efficient and effective use of available resources to accomplish EERE's core mission while reducing overall expenses and improving the delivery of EERE services to the public.

Program Direction
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Program Direction				
Washington Headquarters				
Salaries and Benefits	73,629	—	57,124	-16,505
Travel	3,190	—	2,150	-1,040
Support Services	10,330	—	7,700	-2,630
Other Related Expenses	25,623	—	36,580	+10,957
Total, Washington Headquarters	**112,772**	**—**	**105,754**	**-9,218**
Golden Field Office				
Salaries and Benefits	23,634	—	18,125	-5,509
Travel	160	—	150	-10
Support Services	1,700	—	1,200	-500
Other Related Expenses	1,900	—	1,320	-580
Total, Golden Field Office	**27,394**	**—**	**20,095**	**-6,599**
National Energy Technology Laboratory				
Salaries and Benefits	8,484	—	0	-8,484
Travel	150	—	0	-150
Support Services	700	—	0	-700
Other Related Expenses	5,500	—	0	-5,500
Total, National Energy Technology Laboratory	**14,834**	**—**	**0**	**-14,834**
Total Program Direction				
Salaries and Benefits	105,747	—	75,249	-30,498
Travel	3,500	—	2,300	-1,200
Support Services	12,730	—	10,400	-2,330
Other Related Expenses	33,023	—	37,900	+4,877
Total, Program Direction	**155,000**	**154,705**	**125,849**	**-29,151**
Federal FTEs	**595**	**632**	**458**	**-137**
Additional FE FTEs at NETL supporting EERE[b]	50	48	0	-50
Total EERE-funded FTEs	**645**	**680**	**458**	**-187**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[b] EERE funds 50 FTEs at FE's National Energy Technology Laboratory who support EERE activities through a reimbursable agreement. The 50 FTEs are in FE's FTE totals and are not included in the EERE FTE totals shown on the "Federal FTEs" line.

	FY 2016 Enacted	FY 2017 Enacted Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Support Services				
Technical Support	7,831	—	7,520	-311
Management Support	4,899	—	2,880	-2,019
Total, Support Services	**12,730**	**—**	**10,400**	**-2,330**
Other Related Expenses				
Other Services	14,301	—	9,402	-4,899
Working Capital Fund (WCF)	18,722	—	28,498	+9,776
Total, Other Related Expenses	**33,023**	**—**	**37,900**	**+4,877**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Program Direction $155,000,000	**$125,849,000**	**-$29,151,000**
Salaries and Benefits $105,747,000	**$75,249,000**	**-$30,498,000**
• Funding enables EERE to maintain and support a world-class Federal workforce of 645 FTEs to accomplish its mission to win the clean energy future in the transportation, renewable power, and energy efficiency sectors. Provides necessary resources for program and project management, administrative support, contract administration, and human capital management. FTE numbers will increase during FY 2016 as EERE recruits to reach its operational hiring goals.	• Funding levels provide minimal resources for program and project management, administrative support, contract administration, and human capital management.	• EERE's Federal workforce will be reduced to approximately 458 FTEs, a decrease of 187 FTEs funded by EERE relative to FY 2016 and 222 FTEs (33%) from the FY 2017 current level of 680 FTEs funded by EERE. Funding reductions are not directly proportional to FTE reductions due to costs associated with staff leaving federal service, e.g. leave payouts. • Includes the elimination of EERE support of NETL, significant staff reductions in the Office of Weatherization and Intergovernmental Programs, staff transfers to Departmental support offices (International Affairs, Public Affairs, Office of Technology Transitions), and federal staff buyouts, furloughs and RIFs.
Travel $3,500,000	**$2,300,000**	**-$1,200,000**
• EERE's FY 2016 travel budget supports management of projects across the country, providing government oversight of EERE-funded projects.	• EERE's FY 2018 travel budget supports management of projects and close-outs, providing essential oversight of EERE-funded projects.	• The 34 percent decrease in travel funding is proportional to decrease in FTEs, and reflects the decrease in anticipated site-visits and other travel related to managing a lower number of projects and financial assistance awards.
Support Services $12,730,000	**$10,400,000**	**-$2,330,000**
• Support services funding provides technical and administrative contract support and information technology services. This funding also contributes to training, education, safety, health support, safeguards and security, computer configuration, and maintenance.	• Support services funding provides technical and administrative contract support, and information technology services. This funding also contributes to training, education, safety, health support, safeguards and security, computer configuration, and maintenance.	• Legacy IT services will continue through FY18 as EERE's new IT modernization effort is completed. The 18 percent reduction in funding is related to a reduction of non-IT support contractors in Headquarters and the Golden Field Office by approximately 40 percent to achieve further cost savings.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Other Related Expenses $33,023,000	**$37,900,000**	**+$4,877,000**
• Other Related Expenses provides funds for office space and overhead at DOE Headquarters and field sites through EERE's contribution to the WCF for common administrative services and through direct payments in the field. Expenses covered include building operations, telecommunications, network connectivity, supplies/equipment, printing/graphics, copying, mail, contract closeout, purchase card surveillance, computer equipment (hardware, software, licenses, and support), utilities, postage, administrative expenses, security, and publications. Includes funding for EERE's IT modernization project.	• Other Related Expenses provides funds for office space and overhead at DOE Headquarters and the Golden Field Office through EERE's contribution to the WCF for common administrative services and through direct payments in the field. Expenses covered include building operations, telecommunications, network connectivity, supplies/equipment, printing/graphics, copying, mail, contract closeout, purchase card surveillance, computer equipment (hardware, software, licenses, and support), utilities, postage, administrative expenses, security, and publications. Includes funding for EERE's IT modernization project.	• Growth accounts for cost increases in the DOE-wide WCF costs of approximately $9.7 million and increased costs for EERE's IT modernization project $1.7 million offset by $6.6 million in reductions in Other Services, primarily due to the consolidation of procurement services at Golden Field Office.

Strategic Programs

Overview

Strategic Programs funded high-impact, crosscutting, integrative activities most efficiently executed by a single cross-cutting organization in coordination with Technology Programs.

Highlights of the FY 2018 Budget Request

In an effort to eliminate redundancies and increase efficiencies across the Department, staff will be centralized within corporate offices, including International Affairs and Public Affairs within Department Administration and the Office of Technology Transitions. Therefore, no funds are requested for Strategic Programs within the EERE account in FY 2018.

In FY 2018, Strategic Programs will transition the following activities as indicated:

- Technology-to-Market subprogram activities will transfer to DOE's Office of Technology Transitions, with the exception of the Solar Decathlon which will transfer to the EERE Building Technologies Program, where it was historically funded.
- Strategic Priorities and Impact Analysis subprogram will be dissolved and analysis activities will be conducted, as appropriate, within relevant EERE technology programs.
- International subprogram activities will transfer to the Departmental Administration International Affairs Program.
- Communication and Outreach subprogram activities associated with external outreach will be transferred to the Departmental Administration Public Affairs Program. Internal communications activities, such as EERE-specific graphics and informational materials, will be managed within relevant EERE offices.

Strategic Programs
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Strategic Programs				
Technology-to-Market	5,974	—	0	-5,974
Strategic Priorities and Impact Analysis	6,769	—	0	-6,769
International	3,789	—	0	-3,789
Communications and Outreach	4,468	—	0	-4,468
Total, Strategic Programs	**21,000**	**20,960**	**0**	**-21,000**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Strategic Programs
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Strategic Programs	
Technology-to-Market: No funds are requested for the Technology-to-Market subprogram in FY 2018. Strategic Programs will transition activities currently funded by the Technology-to-Market subprogram to DOE's Office of Technology Transitions.	**-5,974**
Strategic Priorities and Impact Analysis (SPIA): No funds are requested for the SPIA subprogram in FY 2018. Analysis activities will be conducted, as appropriate, within relevant EERE technology programs.	**-6,769**
International: No funds are requested for the International subprogram in FY 2018. International activities will be transferred to Departmental Administration's International Affairs Program.	**-3,789**
Communications and Outreach: No funds are requested for the Communications and Outreach subprogram in FY 2018. Communication activities associated with external outreach will be transferred to Departmental Administration's Public Affairs Program. Internal communications activities will be managed within relevant EERE technology programs.	**-4,468**
Total, Strategic Programs	**-21,000**

Strategic Programs
Technology-to-Market

Description

The Technology-to-Market (T2M) subprogram's mission was to accelerate the successful commercialization of EERE technologies toward market adoption by overcoming key barriers in the U.S. energy technology innovation ecosystem. In support of this mission, the subprogram, in coordination with the Office of Technology Transitions (OTT), worked across the entire ecosystem, including technology developers, startups, and small and medium enterprises, sources of capital, and other key stakeholders, and provided them with tools, resources, and expertise to address barriers to commercialize promising technologies or otherwise develop new commercialization pathways, especially those more particular to EERE technologies. The subprogram also supported development of the next generation of clean energy entrepreneurs at National Laboratories, universities, and emerging companies. The Budget consolidates programs focused on bringing technologies to the market into one office, the Office of Technology Transitions and shifts the burden of technology commercialization more appropriately to industry and the capital markets.

No funds are requested for the Technology-to-Market subprogram in FY 2018. Strategic Programs will transition all technology commercialization activities currently funded by the Technology-to-Market subprogram to DOE's Office of Technology Transitions. The Solar Decathlon, which was moved from the Building Technologies Program to T2M, will be moved back to the Building Technologies Program.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Technology-to-Market $5,974,000	**$0**	**-$5,974,000**
• Launch a new program to accelerate investment from a range of philanthropic organizations to clean technology development and commercialization. • Launch a new Clean Energy Jobs Initiative to develop classifications, career pathways, and analytical tools for jobs related to clean energy technologies and conduct outreach and education events that help accelerate education, workforce development, and hiring in the clean energy sector. • Scale the Lab-Corps Program from the FY 2014 — FY 2015 pilot effort to a full program across all National Laboratories. Expand other laboratory impact and commercialization activities for continued acceleration of moving EERE technologies into the market. • Continue implementation and management of existing programs including NIICE and the National Student Entrepreneurship Prize (NSEP). • Provide ongoing support to the Energy Transition Initiative for islands and expand to other sectors, specifically local governments. • Develop a customizable, online, multi-disciplinary energy mini-course for the public. • Continue minimal support of NTER as is necessary to complete transition to external entity.	• No funding is requested.	• T2M activities will be transferred to DOE Office of Technology Transitions, with the exception of Solar Decathlon. • Solar Decathlon will be transferred to the EERE Building Technologies Program.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Support the EERE Solar Decathlon, an award-winning program that challenges college teams to design, build, and operate cost-effective, energy-efficient, and attractive solar-powered houses. • Strategic Programs' management of the Solar Decathlon will include the exploration of alternative business models to ensure that this initiative is sustainable as a workforce development and technology deployment activity.		

Strategic Programs
Strategic Priorities and Impact Analysis

Description

The Strategic Priorities and Impact Analysis (SPIA) subprogram supported EERE's cutting-edge, transformational research and development and ensured favorable short- and long-term returns on investment by Americans by providing evidence-based, portfolio-wide analysis for energy decision-makers in EERE and beyond. This was accomplished by performing cross-cutting, gap-filling, and corporate analyses associated with EERE technologies; developing tools and methods that enabled consistent evaluation and analysis across EERE; and providing analytical thought leadership across DOE, other government agencies, and external stakeholders.

No funds are requested for the SPIA subprogram in FY 2018. Analysis activities will be conducted, as appropriate, within relevant EERE technology programs, and corporate level review of practices and methodologies will be performed by the EERE Budget Office.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Strategic Priorities and Impact Analysis $6,769,000	**$0**	**-$6,769,000**
• Complete retrospective impact and ROI evaluation studies that quantify EERE impact and guide future EERE program implementation. • Launch new funding opportunity announcement (FOA) to partner with competitively selected cities to acquire data and perform analysis toward long-term clean energy roadmaps. • Continue to support and maintain the DOE Data Catalog on OpenEI.org developed in FY 2015 by EERE to ensure DOE datasets housed across various platforms are properly federated with Data.gov and OSTI in accordance with Project Open Data and open data priorities. • Provide analytical support to assess impact of potential climate related policies to internal DOE stakeholders. • Provide support for grid integration efforts, focusing on scenarios that can achieve maximum grid flexibility with high penetration of renewable technologies. • Support clean energy databases that contain real-world market data, modeled cost and performance data, and reviews of published studies as well as an inventory of state policies and incentives that impact the deployment of EERE technologies. • Complete an assessment of EERE technology program methodologies and assumptions for prospective impact analyses methods and assumptions for impact analyses and project data collection, identify best practices, and establish a standard approach across EERE to ensure consistent and comparable information is available to inform policy decisions.	• No funding is requested.	• The SPIA subprogram will be conducted as appropriate, within relevant EERE technology programs, and corporate oversight of analysis methodologies will shift to the EERE Budget Office. • Corporate oversight of analysis methodologies will be performed by the EERE Budget Office

Strategic Programs
International

Description

The International subprogram's mission was to increase the speed and scale of clean energy deployment and facilitate market access for American companies through international collaboration with strategic partners. The subprogram funded only U.S.-based technical experts to lead engagement in targeted opportunity spaces. Project activities led to increased exports of U.S. clean energy technology and services, and improved energy security. The International subprogram also facilitated R&D partnerships with strategic partners with developed economies, as identified by EERE technology programs, to leverage the funding and expertise of foreign governments and researchers to achieve EERE's domestic program goals. The subprogram's activities in the EERE mission space were fully coordinated with DOE's Departmental Administration International Affairs Program and the Departments of State and Commerce. The subprogram also coordinated and collaborated with U.S. clean energy technology manufacturers and service providers when appropriate.

No funds are requested for the International subprogram in FY 2018. International activities and program staff will be transferred to Departmental Administration's International Affairs Program.

International

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
International $3,789,000	**$0**	**-$3,789,000**
• Provides U.S. contribution to support the U.S. -Israel Energy Cooperative Agreement. • Support market-priming and clean energy deployment activities with up to 10 core partner countries. Representative activities include: expand testing of PV reliability (U.S. -made panels) in Indian climates; develop an industrial energy efficiency audit program and database of retrofit opportunities with Brazil; train experts in South Africa on simulation and testing of energy efficient building envelope components; facilitate project finance for up to 3 demonstration sites for renewables deployment in remote Indonesian grids, and develop a replication strategy; conduct technical review of proposed energy efficiency legislation in Chile and develop new programs to promote energy efficiency by large energy consumers.	• No funding is requested.	• International activities will be transferred to Departmental Administration's International Affairs Program.

Strategic Programs
Communications and Outreach

Description

The Communications and Outreach subprogram provided strategic communications leadership, coordination, and operation support for EERE and for the Department by organizing, editing, and disseminating information and associated impacts to media and the public on EERE programs, activities, and technologies. This information fully leveraged EERE's technology investments by helping raise awareness and overcoming informational barriers to understanding EERE technologies, making stakeholders aware of resources and opportunities that may be available to them through EERE, and encouraging the accelerated adoption of EERE technologies.

No funds are requested for the Communications and Outreach subprogram in FY 2018. Communication activities associated with external outreach will be transferred to Departmental Administration's Public Affairs Program. Internal communications activities, such as EERE-specific graphics and informational materials, and corporate level responses to DOE queries, will be managed within relevant EERE offices.

Communications and Outreach

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Communications and Outreach $4,468,000	**$0**	**-$4,468,000**
• Maintains content for EERE web and social media presence. • Provides modest support for analysis of communications data. • Complete transition of subsites and content to the Energy.gov platform and maintain support for ongoing content management. • Maintain public inquiries and distribution function as digital publications strategy is executed. • Maintain support for legislative affairs and stakeholder engagement. • Expands support for high-priority crosscutting activities, including the Clean Energy Manufacturing and National Laboratory impact initiatives. • Continues support to EERE senior leaders in developing presentation materials and messages for frequent speaking engagements.	• No funding is requested.	• External relations activities will be transferred to Departmental Administration's Public Affairs Program. • Internal communications activities will be managed within relevant EERE offices.

Facilities and Infrastructure

Overview

The National Renewable Energy Laboratory (NREL) is the Office of Energy Efficiency and Renewable Energy's (EERE) Federally Funded Research and Development Center. EERE is NREL's steward and primary sponsor. NREL serves as the Nation's preeminent institution for delivering impactful scientific knowledge and technology innovations that transform renewable energy technologies, systems, and markets. NREL's research advances the science and engineering of energy efficiency, sustainable transportation, and renewable power technologies, and provides the scientific knowledge to integrate and optimize energy systems. To succeed in this mission, EERE's Facilities and Infrastructure (F&I) Program FY 2018 Budget Request ensures NREL's existing research and support infrastructure are maintained and upgraded in key areas, and provides new capabilities in emerging Research and Development (R&D) areas to attract world-class research scientists and to develop cutting-edge, innovative solutions to the most challenging technology issues.

The objectives of the F&I Program are to:

- Provide the laboratory with a safe, secure work environment for the protection of personnel, partners, and the public;
- Provide NREL with secure information networks with strong cybersecurity protocols;
- Maintain NREL's science and support infrastructure through regular reinvestments determined by age, condition, risk, and DOE and industry standards, ensuring the availability of a world-class R&D environment for ongoing EERE mission activities and emerging areas of R&D of interest throughout all of Government and industry;
- Acquire new mission-critical science and technology capabilities, when warranted;
- Provide direct funding for operational activities of major facilities and infrastructure and site-wide investments; and
- Develop and steward grid modernization and broader energy systems integration capabilities at the Energy Systems Integration Facility (ESIF), a DOE-designated User Facility designed to inform early-stage research, utilizing its high performance computing capabilities.

Highlights of the FY 2018 Budget Request

To posture NREL's capabilities to support emerging technologies and future requirements, the FY 2018 F&I Budget Request focuses on sustaining NREL's world-class R&D environment by maintaining and, where necessary, upgrading its equipment and facilities. NREL facilities are under increasing demand by Government and industry R&D activities as exemplified by the steady increase in ESIF users, from 46 in FY 2014 to a projected 100 in FY 2017. As users have increased so have the complexity of the efforts, such as a major utility project to install an integrated, multi-technology power and controller hardware-in-the-loop testbed for testing advanced microgrid controllers. NREL has six other ongoing projects of similar complexity with utilities, equipment suppliers, software companies, computer hardware providers, automotive companies, and other key public and private stakeholders involved in energy systems integration.

Funding supports laboratory upgrades, including a leading-edge Microbial Energetic Laboratory for research in the energy flow in micro-organisms. Breakthroughs in this area will contribute foundational knowledge to enable the design of next-generation organisms and processes to more efficiently produce biofuels and chemicals. Funding also supports a power generation upgrade at the National Wind Technology Center (NWTC) to increase grid interconnection capacity from 10MW to 19.9MW, enabling experimentation with larger turbines and research on large-scale solar and energy storage systems.

Additionally, this request supports the initial phase of a four-year refresh of the Peregrine High Performance Computer (HPC) at the ESIF. The HPC's current utilization rate is already at 91 percent and requirements for advanced modeling and simulation capabilities continue to trend upward as the variety of energy sources grows and the internet of things expands, placing new demands on power generation equipment, storage, transmission, cybersecurity and grid modernization. The funding provides an increase in computing speed from 2 to 5-10 petaflops to meet this growing demand. The improved capacity will also enable the HPC to continue to provide enhanced analytic capability for evermore complex, specific clean energy technology issues across all EERE applied programs. In the past, this has included such tasks as simulations of enzyme-plant cellulose interactions to reduce biofuel costs; multi-scale simulations of electric-drive vehicle battery systems to help improve electric vehicle (EV) performance; and modeling of wake fields and inflow conditions in whole wind plants with realistic terrain to reduce wind energy costs.

The FY 2018 Budget Request places a high priority on cybersecurity requirements to reduce vulnerabilities and lessen the threat of successful cyber attacks. Funding provides for continuous monitoring, protection of networks and information, and detection, analysis, and mitigation of intrusions.

To ensure the continued support of diverse early-stage R&D activities, which require state-of-the-art facilities, the Operations & Maintenance and Facility Management requests remain at FY 2016 request levels. In FY 2016 and under the FY 2017 Continuing Resolution, individual technology program lines provided the $30 million for Site-Wide Facility Support. In FY 2018, EERE proposes to consolidate NREL Site-Wide Facility Support funding, at FY 2016 levels, within the F&I Program. Locating this funding in the F&I Program will provide clarity and transparency in communicating EERE's stewardship for NREL and will simplify planning and execution of EERE's annual budget. This consolidation into a single program line allows for better integration and coordination of operations and investments. Funding site-wide costs directly reduces NREL's labor rate multiplier, which strengthens its position to capture work for others and establish Cooperative Research and Development Agreements (CRADAs) with industry.

Facilities and Infrastructure
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Facilities and Infrastructure				
Operations and Maintenance	26,000	-	26,000	0
Facility Management	36,000	-	36,000	0
NREL Site-Wide Facility Support	0	-	30,000	30,000
Total, Facilities and Infrastructure	**62,000**	**61,882**	**92,000**	**30,000**

[a]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Facilities and Infrastructure
Budget Structure Crosswalk ($K)

FY 2016 Budget Structure	Proposed FY 2018 Budget Structure			Total
	Operations and Maintenance	Facility Management	NREL Site-Wide Facility Support (Facilities and Infrastructure)	
Facilities and Infrastructure				
Operations and Maintenance	26,000	0	0	**26,000**
Facility Management	0	36,000	0	**36,000**
NREL Site-Wide Facility Support	0	0	30,000	**30,000**
Vehicle Technologies	0	0	3,000*	**0**
Bioenergy Technologies	0	0	6,500*	**0**
Hydrogen and Fuel Cell Technologies	0	0	1,800*	**0**
Solar Energy	0	0	9,100*	**0**
Wind Energy	0	0	4,700*	**0**
Water Power	0	0	700*	**0**
Geothermal Technologies	0	0	500*	**0**
Federal Energy Management Program	0	0	800*	**0**
Building Technologies	0	0	2,500*	**0**
Weatherization and Intergovernmental Prgs	0	0	400*	**0**
Total, Facilities and Infrastructure	**26,000**	**36,000**	**30,000**	**92,000**

***** Represent FY 2016 (non-add) contributions from EERE Technology Offices to the NREL Site-Wide Facility Support.

Facilities and Infrastructure

Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Facilities and Infrastructure	
NREL Site-Wide Facility Support: Within EERE's overall Budget Request, this change is "net-zero." EERE proposes to move funding for the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. The NREL Site-Wide Facility Support subprogram funding provides basic site services, functions, and infrastructure for site operations, which includes management, building operators and technicians, building and grounds maintenance, fire and emergency response, engineering and construction support, electrical safety program, utilities, facilities planning support; and activities within the sustainability and environmental health and safety portfolios. Including this funding in the Facilities and Infrastructure Program, instead of individual technology program budgets, will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into the F&I Program enables better integration and coordination of operations and investments.	**+30,000**
Total, Facilities and Infrastructure	**+30,000**

Facilities and Infrastructure
Operations and Maintenance

Description

The Operations and Maintenance subprogram provides the program planning and implementation required by DOE Order 430.1B, Real Property and Asset Management, to maintain real property assets at NREL. The subprogram includes General Plant Projects (GPP), General Plant Equipment (GPE), Maintenance and Repair (M&R), and Safeguards and Security (S&S).

GPP investments maintain and enhance the real property portfolio, renovate general science capabilities and buildings, and upgrade laboratories for technical advancements. Examples of GPP are laboratory refurbishments, laboratory reconfigurations, utility enhancements, facility additions, and projects to accommodate new research capabilities.

Major GPP activities include:

- Completion of a power capacity upgrade from 10MW to 19.9MW at the National Wind Technology Center (NWTC) to enable experimentation with larger turbines and accommodate research on larger-scale grid integration experiments;
- Completion of an upgrade to the aging boiler and air compressor at the Integrated Biorefinery Facility (IBRF) to provide reliable sources of steam and compressed air;
- Replacement of a 40-year old thermal evaporator with a new optical, thin film evaporation system with both thermal and electron-beam sources; and
- Renovation and refurbishment of various laboratories, including a leading-edge Microbial Energetic Laboratory to conduct research to understand the energy flow in micro-organisms for foundational knowledge to design next-generations of organisms and processes.

GPE investments acquire shared science and support equipment to meet research mission needs, replace outdated technology, and provide for emergent research opportunities.

Specific GPE investments include:

- Lifetime efficiency analyzers to establish an electrochemical testing and characterization station to support storage research at all scales;
- Multi-scale storage equipment that includes an environmental control chamber to test equipment for thermal management research;
- In-line process control equipment for experimental roll-to-roll processing for research on high-throughput systems such as batteries;
- High-throughput molecular robotics to increase productivity in the identification and selection of desired bacterial, yeast, algae, and/or fungal strains from thousands of samples;
- Automated blade manufacturing equipment to develop advanced manufacturing technology for composite blades;
- Autonomous vehicle sensor equipment that enables fusing data from multiple sensors to provide accurate 3D rendering for autonomous vehicle technology research; and
- Microplate reader that provides research in the (bio)-systems and enzymes at 50° C and higher in an oxygen-lacking environment.

M&R funding provides for recurring maintenance and repair of real property and equipment to include prevention, prediction, and repair of failed items. M&R funding is within the DOE control standard of 2-4 percent of Replacement Plant Value (RPV).

S&S funding provides for physical security to maintain a safe, secure work environment to protect personnel, property, and networks. In addition, funding addresses high-priority cybersecurity requirements to reduce vulnerabilities. Funding provides for network and information protection through continuous monitoring, analysis, detection, and mitigation.

Operations and Maintenance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Operations and Maintenance $26,000,000	**$26,000,000**	**$0**
• Provides funding for GPP and GPE at NREL. EERE's investments ensure that the science and support infrastructure at NREL is maintained in good condition and readily available for use by EERE and other users. Maintains an Asset Condition Index (ACI) of 0.97 (Excellent) for all NREL facilities. • Provides funding for M&R and S&S at NREL for operational readiness and a secure environment.	• Continues GPP level of investments similar to FY 2016. • Continues GPE investment level similar to FY 2016. • Maintains operational readiness for M&R activities and keeps funding within the DOE control standard of 2-4 percent of RPV. • Maintains operational readiness for S&S activities, similar to FY 2016 levels, with a focus on cybersecurity.	• There are no significant changes from FY 2016.

Facilities and Infrastructure
Facility Management

Description

The Facility Management subprogram provides funding for core operations at the Energy Systems Integration Facility (ESIF), ensuring the availability of this important user-facility to DOE, and other Federal agency, university, and private sector partners. ESIF is a unique national asset with a demonstrated record of providing the public and private sectors with the ability to conduct critical R&D on multiple technologies and energy sources in integrated energy systems.

ESIF's primary role is to explore and enhance the integration of various generators, loads, and storage to meet industrial, commercial, and consumer reliability and affordability requirements. ESIF provides the technical capabilities needed to help advance the Nation's energy system into a more secure, intelligent, resilient and modernized infrastructure.

ESIF has numerous laboratories interconnected by a shared research infrastructure. Through a highly flexible design, the laboratories can be sub-divided into multiple test stand locations to enable experiments by individual and multiple users. The design also accommodates maintenance in one or more sections of a lab while work continues elsewhere, ensuring maximum availability and function to the user.

Fees charged for use of the ESIF vary based on the type of user. Users pay full cost of conducting research to retain their intellectual property and data rights. Users who agree to publish their research results are not assessed a user fee.

This facility provides testing, simulation, data analysis, engineering, and evaluation techniques that address grid and broader energy-system integration challenges using hardware and software in a controlled environment. ESIF supports R&D initiatives in six technical areas outlined in DOE's Grid Modernization Multiyear Program Plan by working with public and private partners to develop the concepts, tools, and technologies needed to measure, analyze, predict, protect, and control the grid of the future.

EERE has continued to expand ESIF's capabilities while demonstrating that the ESIF infrastructure can effectively address the technical questions posed by utilities, electronic equipment manufacturers, distributed generation companies, and all other entities involved in energy systems integration.

ESIF'S High Performance Computer (HPC) modeling and simulation provides critical support to the breadth of EERE's mission. Simulations conducted on the HPC have led to significant advances in clean energy technologies. Examples of research performed in FY 2016 by the HPC include:

- Modeling the transport of species through plant cell walls for bioenergy applications;
- Performing large-scale analysis of the U.S. residential building stock for potential energy-efficiency projects;
- Running computational fluid dynamics (CFD) and finite element analyses to help design, build, and field-test an engineering prototype of a laser-based geothermal well completion tool, and applying high-fidelity CFD simulations to wave energy converters;
- Employing density functional theory (DFT) to investigate cation degradation pathways in alkaline-membrane fuel cells and predict the thermodynamic and kinetic behaviors of perovskite and spinel materials of interest for solar thermochemical water splitting;
- Investigating third-generation advanced high-strength steels for automotive applications;
- Investigating wind power plant optimization at both the wind turbine and plant system level; and
- Combinatorial screening of materials, efficiency gains in organic photovoltaic materials.

Demand for computing from well-established R&D efforts by the Wind Energy, Solar Energy and Bioenergy Technologies Programs has saturated the current HPC capabilities. In FY 2018, the first phase of a four-year refresh will begin that will increase capability to 5-10 petaflops to meet growing EERE mission need for advanced modeling and simulation capabilities.

EERE and NREL maintain an ESIF stewardship plan that includes the following success metrics:

- Availability of the high performance computer to support research by DOE and non-DOE users;
- Availability of research laboratory space to conduct renewable energy experiments;
- Number of users;
- Partner cost share commitments;
- Technical outputs to include NREL technical reports, peer-reviewed papers, Record of Invention/Patent, Intellectual Property license, R&D 100 Awards; and
- Annual publication of the market impact of ESIF-related R&D.

In FY 2018, there will be multiple peer-reviewed "user calls" for university and industry (including small businesses and entrepreneurs) researchers to propose new grid modernization and other projects to utilize ESIF's full capacity. With DOE's focus on early stage research, NREL will solicit new "work for others" agreements and CRADAs with industry partners to maximize research support and impact of the ESIF.

The table below describes the major categories funded by this subprogram.

Major ESIF Costs
ESIF Administration & Facility Management ($8.6 million): ESIF Administration includes ESIF operations director and administrative support. This also includes other labor and non-labor costs to implement a user program, e.g., user outreach, engagement and education; developing calls for proposal; conducting technical peer reviews of proposal; scheduling R&D projects and reporting ESIF status and progress. ESIF Facility Management includes functions to maintain the safety envelope of the ESIF and provides technical support to research activities. Ensures adherence to and implements Integrated Safety Management, Environmental Management, and Hazard Management requirements within the ESIF. Includes maintenance, repair, and modification connection for SCADA, lab safety, research chiller/boiler; research project equipment receiving, placement, setup, fabrication, and decommissioning; gas distribution, fuel distribution, and gas detection; and general logistics support (consumables procurement, equipment storage, material handling, and general maintenance activities).
Scientific Staff ($10 million): ESIF-dedicated technical staff that steward individual capabilities, including experimental and high-performance computing. Technical staff supports users in designing, setting up and conducting experiments in ESIF. In the user-facility model, peer reviewed and selected projects receive facility-funded support for equipment and experimental configuration design, set-up, problem solving and operation.
HPC Equipment & Operations ($12.4 million): HPC refresh and expansion; HPC operations, HPC cybersecurity, user operations, data center operations, and HPC project management/scheduling.
Operations, Maintenance, & Utilities ($5 million): Labor includes dedicated ESIF building engineer and the labor associated with other NREL site operations staff or service contractors to maintain facility systems and sustain readiness. Examples include custodial services, fire & emergency systems, HVAC maintenance, and small parts. This also includes a prorated share of NREL site operating costs, such as road maintenance and snow removal as well as maintenance and calibration for all user-program research equipment. Power, Water, Natural Gas, Dedicated Exhaust, House Nitrogen, Compressed Air, (utilities billed by service providers).

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Facility Management $36,000,000	**$36,000,000**	**$0**
• In the third and final year of facility startup, the FY 2016 Budget completed the planned expansion of ESIF equipment and staff to support continued training for safe and effective operations. NREL developed ESIF's unique external user support capabilities and reported on the facility's demonstrated value through reports and articles in technical literature. External user proposals were peer reviewed, selected, and developed into active projects in various electrical, thermal, and fossil fuel laboratories. Project outputs included the demonstrated delivery of multiple energy sources to a single customer's demand for heating, cooling, lighting, and electrical service.	• Provides for the initial phase of a four-year refresh of the Peregrine High Performance Computer (HPC), increasing petaflops from 2 to 5-10 petaflops to meet growing mission needs. • Provides for utilities, building operations, and routine maintenance. • Provides for energy system security and resilience to ensure that activities at ESIF meet all cybersecurity requirements and needs of users. • Provides for systems engineers, area supervisors, health and safety personnel, and management for ESIF research activities. • Provides for experimental connections and enhanced data collection.	• While there are no significant changes in facility costs, NREL will increase "user calls" for proposals, "work for others", and CRADAs to maximize research support for ESIF.

Facilities and Infrastructure
NREL Site-Wide Facility Support

Description

In FY 2018, EERE proposes to move funding of the NREL Site-Wide Facility Support subprogram from individual technology programs to the Facilities and Infrastructure Program. Locating this funding in the Facilities and Infrastructure Program will provide clarity and transparency in communicating EERE's stewardship of NREL, and will simplify planning and execution of EERE's annual budget. This consolidation into a single program allows for better integration and coordination of operations and investments.

The NREL Site-Wide Facility Support subprogram funding provides basic site services, functions, and infrastructure for site operations, which includes management, building operators and technicians, building and grounds maintenance, fire and emergency response, engineering and construction support, electrical safety program, utilities, facilities planning support; and activities within the sustainability and environmental health and safety portfolios. These are core functions for site operations, safety, environmental compliance, and sustainability at NREL. These activities ensure availability of critical facilities and capabilities for the growing demand of R&D mission needs. Funding site-wide costs directly reduces NREL's labor rate multiplier, which strengthens its position to capture "work for others" and establish Cooperative Research and Development Agreements (CRADAs) with industry.

NREL Site-Wide Facility Support

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NREL Site-Wide Facility Support $0	**$30,000,000**	**+$30,000,000**
• Funding previously requested in individual EERE technology program budgets. No funding requested within the Facilities and Infrastructure Budget Request.	• Instead of withdrawing funds from various technology program budgets, directly funding NREL Site-Wide Facility costs from this subprogram budget will provide basic site services, functions, and infrastructure for site operations. This removes the burden of funding these activities from the EERE technical programs.	• A corresponding decrease in the EERE technology program Budget Requests offsets this request. This funding is critical to stabilizing NREL labor rate and its ability to capture research support from non-EERE partners, including private sector.

Facilities and Infrastructure
Capital Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2018 Request	FY 2018 vs FY 2016
Capital Operating Expenses Summary (including Major Items of Equipment (MIE))[1]					
Capital Equipment > $500K (including MIE)	n/a	n/a	3,600	3,600	0
Plant Projects (GPP and IGPP)	n/a	n/a	7,800	7,800	0
Accelerator Improvement Projects (AIP) (<$5M)	0	0	0	0	0
Total, Operations and Maintenance Expenses	**n/a**	**n/a**	**11,400**	**11,400**	**0**
Capital Equipment > $500K (including MIE)					
Total Non-MIE Capital Equipment (>$500K)	n/a	n/a	3,600	3,600	0
Total, Capital Equipment (including MIE)	**n/a**	**n/a**	**3,600**	**3,600**	**0**
Plant Projects (GPP and IGPP)					
Total Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$5M)	n/a	n/a	7,800	7,800	0
Total, Plant Projects (GPP/IGPP)	**n/a**	**n/a**	**7,800**	**7,800**	**0**
Total, Capital Summary	**n/a**	**n/a**	**11,400**	**11,400**	**0**

[1] Each MIE Total Estimated Cost (TEC) > $2,000,000. Each Plant Project (GPP/IGPP) Total Estimated Cost (TEC) > $5,000,000.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Ames Laboratory			
Energy Efficiency and Renewable Energy			
Hydrogen & Fuel Cell Technologies	400	100	150
Vehicle Technologies	1,900	2,000	0
Advanced Manufacturing	25,000	0	3,500
Bioenergy Technologies	13	611	0
Total, Energy Efficiency and Renewable Energy	**27,313**	**2,711**	**3,650**
Total, Ames Laboratory	**27,313**	**2,711**	**3,650**
Argonne National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	625	1,464	830
Hydrogen & Fuel Cell Technologies	9,000	7,123	2,409
Water Power	0	381	300
Solar Energy	589	1,613	1,000
Vehicle Technologies	43,647	41,404	21,709
Building Technologies	260	783	0
Advanced Manufacturing	3,730	5,045	3,000
Bioenergy Technologies	5,271	6,151	2,834
Total, Energy Efficiency and Renewable Energy	**63,122**	**63,964**	**32,082**
Total, Argonne National Laboratory	**63,122**	**63,964**	**32,082**
Brookhaven National Laboratory			
Energy Efficiency and Renewable Energy			
Geothermal Technologies	500	425	425
Hydrogen & Fuel Cell Technologies	1,300	819	50
Vehicle Technologies	2,052	1,768	1,300
Total, Energy Efficiency and Renewable Energy	**3,852**	**3,012**	**1,775**
Total, Brookhaven National Laboratory	**3,852**	**3,012**	**1,775**
Chicago Operations Office			
Energy Efficiency and Renewable Energy			
Wind Energy	75	0	0
Hydrogen & Fuel Cell Technologies	2,500	0	0
Vehicle Technologies	158	0	0
Total, Energy Efficiency and Renewable Energy	**2,733**	**0**	**0**
Total, Chicago Operations Office	**2,733**	**0**	**0**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Golden Field Office			
Energy Efficiency and Renewable Energy			
Wind Energy	52,550	43,556	0
Program Direction	27,394	20,000	20,095
Geothermal Technologies	15,800	23,256	0
Hydrogen & Fuel Cell Technologies	38,050	38,629	4,000
Water Power	45,924	36,000	2,000
Solar Energy	162,400	147,000	2,000
Building Technologies	49,135	31,500	4,500
Federal Energy Management Program	5,380	0	0
Weatherization Assistance	1,150	1,144	0
State Energy Program	7,240	7,145	0
Advanced Manufacturing	143,663	164,580	43,007
Strategic Programs	3,200	4,200	0
Bioenergy Technologies	45,930	30,800	0
Total, Energy Efficiency and Renewable Energy	**597,816**	**547,810**	**75,602**
Total, Golden Field Office	**597,816**	**547,810**	**75,602**
Idaho National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	297	811	450
Geothermal Technologies	1,900	858	350
Hydrogen & Fuel Cell Technologies	100	600	195
Water Power	0	530	500
Vehicle Technologies	10,966	10,054	4,232
Federal Energy Management Program	258	300	120
Advanced Manufacturing	200	3,600	500
Bioenergy Technologies	14,890	16,189	6,150
Total, Energy Efficiency and Renewable Energy	**28,611**	**32,942**	**12,497**
Total, Idaho National Laboratory	**28,611**	**32,942**	**12,497**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Lawrence Berkeley National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	1,060	1,484	950
Geothermal Technologies	2,804	635	2,821
Hydrogen & Fuel Cell Technologies	2,400	3,738	2,200
Solar Energy	1,443	2,800	1,300
Vehicle Technologies	10,631	12,730	4,097
Building Technologies	28,224	27,866	16,610
Federal Energy Management Program	3,104	2,674	1,025
Weatherization Assistance	200	200	0
State Energy Program	780	780	0
Advanced Manufacturing	5,238	8,152	6,000
Strategic Programs	1,665	1,672	0
Bioenergy Technologies	5,678	9,013	4,375
Total, Energy Efficiency and Renewable Energy	**63,227**	**71,744**	**39,378**
Total, Lawrence Berkeley National Laboratory	**63,227**	**71,744**	**39,378**
Lawrence Livermore National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	578	741	661
Geothermal Technologies	110	515	900
Hydrogen & Fuel Cell Technologies	2,000	1,366	2,080
Vehicle Technologies	3,041	3,572	2,137
Building Technologies	0	52	0
Advanced Manufacturing	6,750	1,000	6,000
Total, Energy Efficiency and Renewable Energy	**12,479**	**7,246**	**11,778**
Total, Lawrence Livermore National Laboratory	**12,479**	**7,246**	**11,778**
Los Alamos National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	0	163	0
Geothermal Technologies	700	500	777
Hydrogen & Fuel Cell Technologies	6,600	5,620	1,134
Solar Energy	677	2,050	800
Vehicle Technologies	1,149	1,020	541
Building Technologies	0	125	0
Advanced Manufacturing	400	0	1,500
Bioenergy Technologies	2,456	5,167	2,050
Total, Energy Efficiency and Renewable Energy	**11,982**	**14,645**	**6,802**
Total, Los Alamos National Laboratory	**11,982**	**14,645**	**6,802**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
National Energy Technology Lab			
Energy Efficiency and Renewable Energy			
Program Direction	14,834	14,834	0
Geothermal Technologies	35,600	35,309	0
Solar Energy	0	1,380	0
Vehicle Technologies	140,424	110,000	6,500
Building Technologies	14,000	14,114	7,500
State Energy Program	115	115	0
Advanced Manufacturing	400	1,287	0
Strategic Programs	130	0	0
Bioenergy Technologies	33	231	0
Total, Energy Efficiency and Renewable Energy	**205,536**	**177,270**	**14,000**
Total, National Energy Technology Lab	**205,536**	**177,270**	**14,000**
National Renewable Energy Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	17,751	23,415	18,702
Facilities and Infrastructure	62,000	61,882	92,000
Geothermal Technologies	3,870	2,712	610
Hydrogen & Fuel Cell Technologies	17,800	14,734	9,198
Water Power	4,156	6,747	2,100
Solar Energy	55,052	60,414	47,869
Vehicle Technologies	27,283	23,025	10,657
Building Technologies	11,066	11,557	6,845
Federal Energy Management Program	5,670	4,246	3,160
Weatherization Assistance	625	624	0
State Energy Program	265	265	0
Advanced Manufacturing	2,532	2,590	500
Strategic Programs	8,731	6,688	0
Bioenergy Technologies	56,327	50,608	24,825
Total, Energy Efficiency and Renewable Energy	**273,128**	**269,507**	**216,466**
Total, National Renewable Energy Laboratory	**273,128**	**269,507**	**216,466**
Oak Ridge Institute for Science & Education			
Energy Efficiency and Renewable Energy			
Vehicle Technologies	338	371	200
Building Technologies	1,767	0	0
Advanced Manufacturing	4,447	0	0
Strategic Programs	650	0	0
Bioenergy Technologies	700	3,000	0
Total, Energy Efficiency and Renewable Energy	**7,902**	**3,371**	**200**
Total, Oak Ridge Institute for Science & Education	**7,902**	**3,371**	**200**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Oak Ridge National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	0	398	170
Geothermal Technologies	1,748	363	87
Hydrogen & Fuel Cell Technologies	5,500	4,010	575
Water Power	2,800	3,492	3,350
Solar Energy	0	3,321	1,498
Vehicle Technologies	42,440	35,426	13,637
Building Technologies	12,406	11,185	7,910
Federal Energy Management Program	3,429	1,446	1,900
Weatherization Assistance	525	525	0
State Energy Program	25	25	0
Advanced Manufacturing	25,373	30,510	15,000
Strategic Programs	0	757	0
Bioenergy Technologies	11,317	14,010	4,166
Total, Energy Efficiency and Renewable Energy	**105,563**	**105,468**	**48,293**
Total, Oak Ridge National Laboratory	**105,563**	**105,468**	**48,293**
Oak Ridge Office			
Energy Efficiency and Renewable Energy			
Hydrogen & Fuel Cell Technologies	400	0	0
State Energy Program	215	215	0
Total, Energy Efficiency and Renewable Energy	**615**	**215**	**0**
Total, Oak Ridge Office	**615**	**215**	**0**
Pacific Northwest National Laboratory			
Energy Efficiency and Renewable Energy			
Wind Energy	1,654	2,565	1,685
Geothermal Technologies	1,228	1,199	2,048
Hydrogen & Fuel Cell Technologies	3,800	3,930	1,885
Water Power	3,300	6,991	5,350
Solar Energy	0	1,709	900
Vehicle Technologies	9,150	9,340	7,304
Building Technologies	23,000	27,292	8,165
Federal Energy Management Program	1,582	1,121	875
State Energy Program	175	175	0
Advanced Manufacturing	450	0	0
Strategic Programs	150	402	0
Bioenergy Technologies	19,396	21,617	6,300
Total, Energy Efficiency and Renewable Energy	**63,885**	**76,341**	**34,512**
Total, Pacific Northwest National Laboratory	**63,885**	**76,341**	**34,512**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Sandia National Laboratories			
Energy Efficiency and Renewable Energy			
Wind Energy	4,248	4,672	4,199
Geothermal Technologies	2,790	1,145	2,635
Hydrogen & Fuel Cell Technologies	5,200	6,123	5,436
Water Power	4,620	6,562	2,400
Solar Energy	13,300	12,593	4,000
Vehicle Technologies	9,665	11,874	4,597
Building Technologies	0	183	0
Federal Energy Management Program	90	0	0
Advanced Manufacturing	225	500	0
Strategic Programs	130	402	0
Bioenergy Technologies	2,688	8,286	2,100
Total, Energy Efficiency and Renewable Energy	**42,956**	**52,340**	**25,367**
Total, Sandia National Laboratories	**42,956**	**52,340**	**25,367**
Savannah River National Laboratory			
Energy Efficiency and Renewable Energy			
Hydrogen & Fuel Cell Technologies	3,100	800	195
Solar Energy	2,129	406	0
Vehicle Technologies	0	53	0
Bioenergy Technologies	310	290	0
Total, Energy Efficiency and Renewable Energy	**5,539**	**1,549**	**195**
Total, Savannah River National Laboratory	**5,539**	**1,549**	**195**
SLAC National Accelerator Laboratory			
Energy Efficiency and Renewable Energy			
Hydrogen & Fuel Cell Technologies	0	85	0
Solar Energy	0	1,500	333
Vehicle Technologies	569	600	1,169
Building Technologies	0	275	0
Total, Energy Efficiency and Renewable Energy	**569**	**2,460**	**1,502**
Total, SLAC National Accelerator Laboratory	**569**	**2,460**	**1,502**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Efficiency and Renewable Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Energy Efficiency and Renewable Energy			
Wind Energy	16,612	16,000	4,053
Program Direction	112,772	119,871	105,754
Geothermal Technologies	3,950	3,948	1,847
Hydrogen & Fuel Cell Technologies	2,800	13,081	15,493
Water Power	9,200	9,164	4,400
Solar Energy	6,010	6,355	10,000
Vehicle Technologies	6,587	46,174	3,920
Building Technologies	60,642	75,187	15,970
Federal Energy Management Program	7,487	17,162	2,920
Weatherization Assistance	212,500	212,098	0
State Energy Program	41,185	41,185	0
Advanced Manufacturing	10,092	10,802	2,993
Strategic Programs	6,344	6,839	0
Bioenergy Technologies	59,991	58,598	3,800
Total, Energy Efficiency and Renewable Energy	**556,172**	**636,464**	**171,150**
Total, Washington Headquarters	**556,172**	**636,464**	**171,150**
Total, Energy Efficiency and Renewable Energy	**2,073,000**	**2,069,059**	**695,249**

Electricity Delivery and Energy Reliability

Electricity Delivery and Energy Reliability

Electricity Delivery and Energy Reliability

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Electricity Delivery and Energy Reliability
Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for electricity delivery and energy reliability activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $120,000,000, to remain available until expended: Provided, That of such amount, $27,000,000 shall be available until September 30, 2019, for program direction.

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977

Public Law 109-58, "Energy Policy Act of 2005"

Public Law 110-140, "Energy Independence and Security Act, 2007"

Public Law 114-94, "Fixing America's Surface Transportation Act", 2015

Electricity Delivery and Energy Reliability
($K)

FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request
206,000	205,608	120,000

Overview

The Office of Electricity Delivery and Energy Reliability (OE) leads the Department's efforts to strengthen, transform, and improve energy infrastructure so that consumers have access to reliable, secure, and clean sources of energy. OE provides solutions to market, institutional and operational failures that go beyond any one utility's ability to solve.[b] To accomplish this critical mission, OE works with private industry and Federal, state, local, and tribal governments on a variety of initiatives to modernize the electric grid.

Grid modernization is critical to achieving public policy objectives, sustaining economic growth, supporting environmental stewardship, and mitigating risks to secure the Nation. The goal for the future grid is to deliver reliable, affordable, and clean electricity to consumers where, when, and how they want it.

Within the next decade, proactive, coordinated, and innovative steps are needed to address four critical challenges:

- Changes in demand driven by population growth, adoption of more energy efficient technologies, dynamic economic conditions, and broader electrification, including possible mass-markets for electric vehicles
- Changes in the supply mix and location (centralized, distributed, and off-shore) of the Nation's generation portfolio
- Increasing variability and uncertainty from both supply and demand, including integration of variable renewables, more active consumer participation, and accommodating new technologies and techniques
- Increasing challenges to the reliability and security of the electric infrastructure

Due to the critical role the electric grid plays across Federal, state, and local jurisdictions, OE programs are working in an integrated manner, in partnership with industry and other stakeholders as well as other DOE offices, to enhance key characteristics of the U.S. electric transmission and distribution systems:

- Reliability—consistent and dependable delivery of high quality power.
- Flexibility—the ability to accommodate changing supply and demand patterns and new technologies.
- Efficiency—low losses in electricity delivery and more optimal use of system assets.
- Resiliency—the ability to withstand and quickly recover from disruptions and maintain critical function.
- Affordability—more optimal deployment of assets to meet system needs and minimize costs.
- Security—the ability to protect system assets and critical functions from unauthorized and undesirable actors.

Timely action is needed to perform the research, development, and demonstration that will result in an electric power grid that is reliable and enables the vitality of other critical sectors that depend on electricity, such as telecommunications, banking and finance, water, and public health and safety. A reliable and resilient power grid is critical to U.S. economic competiveness and leadership.

Within the appropriation, OE funds:

- Research and Development—pursuing early stage research for technologies to improve grid reliability, efficiency, flexibility, functionality, and security
- Modeling and Analytics—developing core analytic, assessment, and engineering capabilities that can evolve as the technology and policy needs mature to support decision making within the Department and for stakeholders; analyses explore complex interdependencies among infrastructure systems, such as between electricity and natural gas systems.

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] Examples include wide-area visibility, identified from the 2003 Northeast blackout, and faster modeling and analysis, identified in the 2011 Southwest blackout.

- Institutional Support and Technical Assistance—building capacity in the industry and convening stakeholders to coordinate efforts to transform the electric grid; providing technical assistance to states and regions to improve policies, utility incentives, state laws, and programs that facilitate the modernization of the electric infrastructure.
- Coordination of Federal Transmission Permits—streamlining permits, special use authorizations, and other approvals required under Federal law to site electric transmission facilities.
- Emergency Preparedness and Response—pursuing enhancements to the reliability, survivability, and resiliency of energy infrastructure, and facilitating faster recovery from disruptions to energy supply.

Highlights and Major Changes in the FY 2018 Budget Request
The FY 2018 request focuses OE's R&D efforts on cutting-edge early stage R&D, while maintaining a robust cybersecurity program. The FY 2018 request renames three OE programs to better describe the activities proposed for these programs. There are no functional transfers between programs associated with these name changes.

Transmission Reliability (formerly Clean Energy Transmission and Reliability) ($13,000,000; -$26,000,000) is focused on ensuring the reliability and resiliency of the U.S. electric grid through early stage and foundational research and development (R&D) on measurement and control of the electricity system and risk assessment to address challenges across integrated energy systems. Funding targeted to industry is eliminated and DOE activity is refocused on foundational work using the synchrophasor measurement for model validation to increase resiliency. Modeling activities are reduced and the portfolio is refocused towards early stage cutting edge research into resiliency and security of the grid and moving away from funding commercial applications.

Resilient Distribution Systems (formerly Smart Grid Research and Development) ($10,000,000; -$25,000,000) focuses on the development of innovative technologies, tools, and techniques to modernize the distribution portion of the electric delivery system: the infrastructure that takes power from the transmission system and delivers it to individual businesses and homes. The FY 2018 request ends funding for R&D activities related to microgrid controller demonstrations, transactive-based control approaches including standards development and demonstration projects and Advanced Distribution Management System (ADMS) application development.

Cybersecurity for Energy Delivery Systems ($42,000,000; -$20,000,000) supports game-changing early stage R&D to mitigate cyber incidents in today's systems and to develop next-generation resilient energy delivery systems and information sharing providing a near-real-time capability for energy owners and operators to voluntarily share cyber threat data, analyze this data, and receive machine-to-machine mitigation measures. The FY 2018 request does not include funding for the Virtual Energy Sector Advanced Digital Forensics Analysis Platform, which completes implementation and begins transition to the private sector in 2017, the industry-scale electric grid test bed, or for cyber and cyber-physical solutions for advanced control concepts for distribution and municipal utilities. The remainder of the CEDS budget includes an increase to establish an Energy Delivery System (EDS) cybersecurity testing and analysis laboratory with a focus on supply chain vulnerabilities and risks, offset by a reduction due to completion of Cybersecurity Capability Maturity Model (C2M2) toolkit development. C2M2 is available online.

Energy Storage ($8,000,000; -$12,500,000) focuses on accelerating the development of new materials and device technologies that can lead to significant improvements in the cost and performance of energy storage systems and accelerated adoption of the energy storage solutions. The FY 2018 request discontinues grid scale field validation support engagements with states and utilities, eliminates state and Federal regulatory body policy engagements to understand regional market barriers to energy storage deployment, reduces the number of university subcontracts, eliminates OE participation in industry led Safety Codes and Standards development, and discontinues the biannual Safety Forum.

Transformer Resilience and Advanced Components ($5,000,000; $0) supports modernization, hardening, and resilience of the grid by addressing the unique challenges facing transformers and other critical grid components that are responsible for carrying and controlling electricity from where it is generated to where it is needed. In FY 2018, TRAC will focus on applied materials research to address some of the fundamental gaps for insulators, magnetics, and metals required for building next-generation transformers and other grid components. Research to improve asset monitoring capabilities and equipment performance under stress will enhance the portfolio of solutions needed to increase grid security, reliability, and resilience.

Transmission Permitting and Technical Assistance (formerly National Electricity Delivery) ($6,000,000; -$1,500,000) assists state, regional, and tribal entities that wish to develop, refine, or otherwise change their electricity-related laws, regulations, policies, and programs. TPTA also implements a number of legal authorities, such as coordination of transmission permitting by Federal agencies, periodic transmission congestion studies, permitting of cross-border transmission lines, authorization of electricity exports, and supporting actions by the Secretary of Energy during electricity emergencies.

Infrastructure Security and Energy Restoration ($9,000,000; $0) coordinates a national effort to secure U.S. energy infrastructure against all hazards, reduce impacts from disruptive events, and assist with restoration activities. The FY 2018 budget proposal supports on-going efforts and maintains capability to respond to energy sector emergencies through a regionalized volunteer delivery model and improves the Federal national energy infrastructure situational awareness and visualization capability provided by EAGLE-I. ISER will continue work on evolving threats and hazards and will explore public-private partnerships to focus and support capabilities at DOE National Laboratories that address cyber, physical, and supply chain vulnerabilities.

FY 2016 Key Accomplishments

Transmission Reliability

- Developed and demonstrated a prototype wide-area synchrophasor-based voltage stability tool at two Western utilities, Idaho Power Company and San Diego Gas and Electric.
- At ISO-New England, developed and successfully deployed a real-time Phasor-only State Estimator (PSE) which corrects for synchrophasor errors and improves the accuracy of data, as well as providing additional observability by computation of virtual phasor measurements for substations without data.
- Held the first international first International Synchrophasor Symposium in March, 2016, which brought together over 200 industry experts from around the world to share information on the use of synchrophasor technology for system protection, wide-area monitoring and situational awareness, and emerging applications for electric distribution.

Resilient Distribution Systems

- Completed the R&D phase of advanced microgrid controllers that are capable of accomplishing community-specific resilience objectives while meeting the DOE program targets of reducing outage time of critical loads by 98%, reducing emissions by over 20%, and improving system energy efficiencies by over 20%.
- Emissions Quantification Tool released at the National Summit on Smart Grid and Climate Change. The Emissions Quantification Tool is an online calculator that is used to estimate the nitrogen oxide, sulfur oxide, and carbon dioxide repercussions of smart grid infrastructure investments.

Cybersecurity for Energy Delivery Systems

- The Collaborative Defense of Transmission and Distribution Protection and Control Devices against Cyber Attacks (CODEF) team successfully demonstrated the transmission-level cybersecurity functions at Bonneville Power Administration (BPA). CODEF was used to detect and block cyber-attacks designed to control the substation circuit breakers. Attacks on intelligent electronic device (IED) configurations were also detected and blocked by the functions. CODEF can detect insider attacks, spoofed power system data, malicious commands or configuration set points by anticipating their effect on power grid operations. Also, it is designed to block incorrect device function and report compromised devices.
- The Quantum Security Modules for the Smart Grid project at Los Alamos National Laboratory (LANL) advanced the state-of-the-art in secure communications for critical infrastructure protection, reducing the facility footprint and improving the performance of their hybrid classical-quantum communications system. Based on the results of field trials, researchers reduced the size of the installed hardware by 80%, while doubling the operating range and increasing the key generation rate by 73%. Quantum key distribution offers the unique advantage that the presence of an adversary attempting to intercept the secret key as it is exchanged will be revealed because the attempted intrusion results in an unavoidable distortion of the received quantum signal.

Energy Storage

- Completed research on mixed acid vanadium flow batteries, reducing system cost from $600/kWh to $300/kWh, while increasing energy density by 70% and the temperature window by 80%.

- Published a documents for guidance to municipalities providing information to consider as they develop solicitations for resilient energy storage projects. The documents are designed to give specific examples of what should be included in a solicitation for the procurement and installation of a battery energy storage project designed to provide backup power during outages.

Transformer Resilience and Advanced Components

- Oak Ridge and Lawrence Livermore National Laboratories determined the models, simulation tools, and experimental approach needed to refine and validate models of electromagnetic pulse/geomagnetic disturbance coupling to transformers in substations and to assess their vulnerabilities.
- Pacific Northwest and Oak Ridge National Laboratories developed dynamics models and performance envelopes for high-voltage direct current terminals. These improved models will be used to assess the benefits of enhanced grid control from these technologies.

Transmission Permitting and Technical Assistance

- Responded to 49 direct, single-state technical assistance requests and 24 multi-state/regional requests. Topics included energy efficiency, regional planning and transmission, smart grid, demand response, utility business models, and renewables.
- Expanded the Regulatory and Permitting Information Desktop (RAPID) Toolkit from the Western states to the Midwestern states. The RAPID Toolkit offers one location for agencies, developers, and industry stakeholders to work together on state and federal bulk transmission and renewable energy regulatory processes by using a wiki environment to share permitting guidance, regulations, contacts, and other relevant information.

Infrastructure Security and Energy Restoration

- A significantly expanded and very successful Clear Path IV and annual exercise program led to awareness of opportunities to improve our collaboration with NNSA and our needs for an expanded cadre of emergency responders. Clear Path IV was DOE's first cross-sector exercise and involved nearly 200 participants from Federal, state, and local governments as well as the electric sector and oil and natural gas industries. Clear Path IV helped strengthen ties and coordination between government and industry: the FEMA Region X office used the exercise to help develop a power outage incident document that would be used during real-word emergencies that impact electric infrastructure.
- The consolidation of EAGLE-I and its transfer has put that system on a footing from which its reliability and capabilities can be expanded, while saving ISER -$400k per year. A plan for significant improvements to the system is in place, with increased reliability as the first priority, followed closely by expanding data sources. ISER first obtained satellite imagery during FY 2016 from the National Geospatial Agency to assist in damage assessments post event. ISER is exploring the addition of this capability and others to EAGLE-I.
- Successfully facilitated responses to 7 Stafford Act events and 4 non-Stafford Act events. Stafford Act activations included Hurricanes Joaquin, Madeline, Lester, and Hermine, and Tropical Storms In-fa and Amos, for which ISER deployed approximately 50 staff. Non-Stafford Act events supported include the East Coast Winter Storm of January 2016, the Alison Canyon and Colonial Pipeline events, and the Louisiana Flooding of September 2016.

Electricity Delivery and Energy Reliability
Non-Comparable Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Transmission Reliability	0	-	13,000	+13,000
Clean Energy Transmission and Reliability (renamed to Transmission Reliability)	39,000	38,926	0	-39,000
Resilient Distribution Systems	0	-	10,000	+10,000
Smart Grid Research and Development (renamed to Resilient Distribution Systems)	35,000	34,933	0	-35,000
Cybersecurity for Energy Delivery Systems	62,000	61,882	42,000	-20,000
Energy Storage	20,500	20,461	8,000	-12,500
Transformer Resilience and Advanced Components	5,000	4,990	5,000	0
Transmission Permitting and Technical Assistance	0	-	6,000	+6,000
National Electricity Delivery (renamed to Transmission Permitting and Technical Assistance)	7,500	7,486	0	-7,500
Infrastructure Security and Energy Restoration	9,000	8,983	9,000	0
Program Direction	28,000	27,947	27,000	-1,000
Total, Electricity Delivery and Energy Reliability	**206,000**	**205,608**	**120,000**	**-86,000**
Federal FTEs	**89**	**-**	**77**	**-12**
Additional FE FTEs at NETL supporting OE[b]	29	-	22	-7
Total OE-funded FTEs	118	-	99	-19

SBIR/STTR:

- FY 2016 Transferred: SBIR: $3,885; STTR: $583
- FY 2018 Request: SBIR: $2,112,; STTR: $298

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] OE funds FTEs at FE's National Energy Technology Laboratory who are FE employees, but support OE activities. The FTEs are in FE's FTE totals and are not included in the OE FTE totals shown on the "Federal FTEs" line.

Electricity Delivery and Energy Reliability
Comparable Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Transmission Reliability	39,000	38,926	13,000	-26,000
Resilient Distribution Systems	35,000	34,933	10,000	-25,000
Cybersecurity for Energy Delivery Systems	62,000	61,882	42,000	-20,000
Energy Storage	20,500	20,461	8,000	-12,500
Transformer Resilience and Advanced Components	5,000	4,990	5,000	0
Transmission Permitting and Technical Assistance	7,500	7,486	6,000	-1,500
Infrastructure Security and Energy Restoration	9,000	8,983	9,000	0
Program Direction	28,000	27,947	27,000	-1,000
Total, Electricity Delivery and Energy Reliability	**206,000**	**205,608**	**120,000**	**-86,000**
Federal FTEs	**89**	**-**	**77**	**-12**
Additional FE FTEs at NETL supporting OE[b]	29	-	22	-7
Total OE-funded FTEs	118	-	99	-19

Electricity Delivery and Energy Reliability
Comparability Matrix for FY 2018 Request ($K)

New Structure / Old Structure	Transmission Reliability	Resilient Distribution Systems	Transmission Permitting and Technical Assistance
Clean Energy Transmission and Reliability	13,000	0	0
Smart Grid Research and Development	0	10,000	0
National Electricity Delivery	0	0	6,000

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] OE funds FTEs at FE's National Energy Technology Laboratory who are FE employees, but support OE activities. The FTEs are in FE's FTE totals and are not included in the OE FTE totals shown on the "Federal FTEs" line.

Transmission Reliability (formerly Clean Energy Transmission and Reliability)

Overview

The Transmission Reliability, or TR, (formerly Clean Energy Transmission and Reliability) program provides the electric sector with the necessary tools and analyses to assess risks, inform decisions, and improve power system planning and performance including mitigating the risks of large-scale blackouts. The TR program is focused on ensuring the reliability and resiliency of the U.S. electric grid through early stage and foundational research and development (R&D) concentrated on measurement and control of the electricity system and risk assessment to address challenges across integrated energy systems. TR brings together energy stakeholders from government, industry, and academia to generate ideas and develop solutions to the Nation's energy infrastructure challenges.

TR's mission manifests itself in several key areas:

- Advancing electrical engineering through early stage and foundational research in measurements, models, mathematics, and computation
- Advancing applied mathematics by developing and demonstrating early stage proof-of-concept tools intended to enable the electricity system operators and planners to improve reliability, resiliency, and security of the system
- Advancing resiliency with respect to recovery and restoration as well as optimizing the algorithms for extreme weather events and man-made attack mitigation
- Advancing risk-based quantification to improve methods and models used to study power system resiliency

TR has funded numerous researchers at the national laboratories, academia, and private organizations to improve the reliability and security of the U.S. energy infrastructure system. These funding activities included:

- Deploying measurement and communication systems for the high-voltage electricity system; as a result of these Recovery Act investments, the number of measurement devices on the electricity transmission system increased from 200 at the start of the program to almost 2,000 today, and near real-time wide-area visibility into the grid is a reality
- Developing innovative approaches to model the grid, successfully demonstrating computational advances that have sped computation times for certain grid planning models by more than two orders of magnitude

TR directly engages energy stakeholders and decision makers to disseminate research results and promote innovation, and risk-informed energy system decisions. TR activities also focus on advancing university-based power systems research, helping ensure an enduring strategic national capability for innovation in this essential area.

Highlights of the FY 2018 Budget Request

The FY 2018 Budget Request of $13 million will support TR's goals to:

- Develop and test methods for validating power system models using real-time data (such as synchrophasor measurement) in a real-world environment to support grid operations and improve electrical power infrastructure reliability and resiliency
- Develop machine learning and data mining algorithms to enable computationally efficient data analytics and visualization of multiple spatial-temporal datasets that are converted into actionable information and used to expand the observability in the distribution network for the identification and mitigation of system faults
- Expand the protection system modeling capabilities, as a platform for the study and coordination of protection devices and approaches to increase the system resiliency and adapt to dynamic system changes; applications could include regional system concerns (such as cascading event mitigation and special protection systems/remedial action schemes) or local objectives (such as feeder-level adaptive protection and intentional islanding/microgrids)
- Develop and test advanced computational capabilities for simulating power system behavior in a real-world environment

The FY 2018 Budget Request shifts TR's focus to concentrating on developing early stage algorithms, methods, and proof of concept tools to improve the resiliency and security of electric grid. These topics are not new to the TR program so the transition to this area of focus will be seamless and straightforward.

Centers[a]

TR continues support for the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT), which is jointly funded by the National Science Foundation (NSF) and the Department and based at the University of Tennessee, Knoxville. CURENT seeks to develop fundamental knowledge in monitoring and modeling methodologies, control theory and transmission network architectures, that supports a nationwide, resilient electric power grid that is fully monitored and dynamically controlled in real time for high reliability, high efficiency, and low cost, while educating a new generation of electric power and energy systems engineering leaders with a global perspective coming from diverse backgrounds. The FY 2018 budget request continues TR support for CURENT at $2,136,000, the same as in FY 2016. Additional activities may be considered depending on programmatic needs in related research areas and the Center's unique capabilities for effectively addressing them. CURENT's programmatic and technical goals are to:

- develop new systems methodologies to take advantage of advancements in wide-area measurement and communication
- flatten the control and information structure so it is less hierarchical and can replace, at all levels of the power grid, traditional inflexible operations strategies
- draw on high performance computing capability to realize large-scale and faster-than-real-time simulation for predictive control (and fast response) to ensure secure and reliable operation
- investigate use of widely allocated high power electronic actuator coupled with transmission level energy storage

[a] Per the guidance on inclusion of centers in budget justifications in H.Rpt. 113–135, the House report for the FY 2014 Energy and Water Development appropriations.

Transmission Reliability
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Transmission Reliability				
Transmission Reliability	17,000	–	13,000	-4,000
Advanced Modeling Grid Research	17,000	–	0	-17,000
Energy Systems Risk and Predictive Capability	5,000	–	0	-5,000
Total, Transmission Reliability	**39,000**	**38,926**	**13,000**	**-26,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $1,020; STTR: $153
- FY 2018 Request: SBIR: $416; STTR: $59

Transmission Reliability
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Transmission Reliability: Funding targeted to industry is eliminated and DOE activity is refocused on foundational work using the synchrophasor measurement for model validation to increase resiliency. Modeling activities, formerly included under the Advanced Modeling Grid Research subprogram, are reduced and the portfolio is refocused towards early stage cutting edge research into resiliency and security of the grid and moving away from funding commercial applications.	-4,000
Advanced Modeling Grid Research: This subprogram is eliminated. Some modeling activities will continue under Transmission Reliability, as described above.	-17,000
Energy Systems Risk and Predictive Capability: This subprogram is eliminated and no new activities are proposed.	-5,000
Total, Transmission Reliability	**-26,000**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Transmission Reliability $17,000,000	**$13,000,000**	**-$4,000,000**
• Install synchrophasor-based technology to perform on-line generator model validation that is required by NERC for all large generators. • Continue support of the North American Synchrophasor Initiative (NASPI) to advance information sharing and joint problem-solving among utilities, vendors, universities, and the government, including two annual workgroup sessions. • Co-fund National Science Foundation CURENT Engineering Research Center. • Develop synchrophasor-based algorithms that allow transmission operators to identify and react to incipient equipment malfunction, physical attacks, and geomagnetic disturbance events on the grid, thus improving system reliability and providing direct value to transmission system owners and operators.	• Continue support of NASPI to advance the model validation using synchrophasor measurement, increase of resiliency, and cyber-security as well as information sharing and joint problem-solving among utilities, vendors, universities, and the government, including two annual workgroup sessions. • Co-fund National Science Foundation CURENT Engineering Research Center. • Expand mathematics and computational research to include uncertainty quantification, model formulation and reduction, and controls. • Continue efforts in architecture and data analytics such as machine learning for identification and mitigation of system faults and turning the data into actionable information. • Characterize system performance after severe disturbance and identify methods and algorithmic approaches to proactively prevent the cascading outage. • Expand the program in the area of Protection System Operation and Misoperation. • Co-fund National Science Foundation to develop the next generation of mathematical and statistical algorithms for improvement of the security, reliability, and resiliency of the modern power grid.	• Reduction is due to technology maturity and the industry starting to develop synchrophasor applications. • Application software tools developed and tested using an industry partner such as ERCOT are no longer the focus of the program. • Activities are refocused on foundational work using the synchrophasor measurement for model validation to increase resiliency.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Modeling Grid Research $17,000,000	**$0**	**-$17,000,000**
• Expand mathematics and computational research to include uncertainty quantification, model formulation and reduction, and controls. • Continue efforts in architecture and data analytics. • Assess performance of open source mathematical methods and solvers (from the software repository) in prototype power system application. • Characterize system performance under dynamic and abnormal conditions. Release competitive solicitation focused on demonstrating the capability to forecast grid behavior under uncertainty thus improving the ability of operators to respond to changes in the system.	• None	• This subprogram is eliminated. Some modeling activities will continue under Transmission Reliability, as described above.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Energy Systems Risk and Predictive Capability		
$5,000,000	**$0**	**-$5,000,000**
• Advance predictive analytics on interconnected energy infrastructure systems to include understanding of how historical performance predicts future system performance. • Begin connecting research data from the Transmission Reliability and Advanced Modeling Grid Research subprograms to the ESRPC analytical platform. • Advance real-time predictive analytics to enhance Federal, state, local, and industry knowledge for events. • Continue to enhance and strengthen partnerships to ensure the program delivers value to all stakeholders. • Begin wide-scale deployment of a program to educate stakeholders on how to understand, assess, and communicate risk to the energy system. • Provide real time analysis support for all high profile events. • Deploy a capability to assess risks to interdependent energy infrastructure.	• None	• This subprogram is eliminated and no new activities are proposed.

Transmission Reliability
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Transmission Reliability—Demonstrate and implement technologies and tools that improve the monitoring of transmission system health and the ability of operators to respond quickly and effectively to address issues.**		
Target	Develop a prototype wide-area synchrophasor-based voltage stability tool	Develop and test methods for validating power system models using real-time data in a real-time environment to support operations and improve reliability	Continue developing and testing methods for validating power system models using real-time synchrophasor data in a real-time environment to support operations and improve reliability and resiliency
Result	Met	TBD	TBD
Endpoint Target	Realization of a nationwide synchrophasor network with 100% sensor coverage of the transmission system by 2020, allowing for complete, real-time monitoring of transmission system health.		
Performance Goal (Measure)	**Advanced Modeling Grid Research—Development of capabilities in understanding, modeling, and predicting grid behavior in real-time.**		
Target	Demonstrate simulation capabilities in a prototype operational tool that can be used in real-time to identify available operating margins	Develop and test advanced computational capabilities for simulating power system behavior in a real-world environment	N/A
Result	Met	TBD	N/A
Endpoint Target	Realization of advanced modeling capabilities, including dynamic operation, real-time analysis, and predictive response. This performance goal is not continued into FY 2018.		

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Energy System Risk and Predictive Capability—Provide Federal agencies, states, and sector stakeholders with independent and transparent analyses of risks to energy infrastructure systems and supply chain impacts.**		
Target	Release products to stakeholders incorporating advanced predictive analytics on interconnected energy infrastructure systems to include understanding of how historical asset performance affects overall system performance	Deploy initial analytical products assessing risk and improving decisions for energy infrastructure systems	N/A
Result	Met	TBD	N/A
Endpoint Target	This subprogram develops tools and robust predictive analytic products which assist decision makers in assessing current and future risks to interdependent energy systems. This performance goal is not continued into FY 2018.		

Resilient Distribution Systems (formerly Smart Grid Research and Development)

Overview

Reliable, safe, affordable electricity is a cornerstone for a strong economy and provides foundational support for communities to grow and attract new businesses. Today's electric grid is undergoing significant transformation. It provides new benefits and opens new opportunities, but at the same time is changing fundamental operational principles and threatens core ability to deliver safe, reliable, and affordable power to the consumers. The existing electrical distribution system—the infrastructure that takes power from the transmission system and delivers it to individual businesses and homes—was conceived over 100 years ago. Today it is facing increasing challenges maintaining reliable, resilient operations and meeting new demands of the 21st Century. As evident from recent events such as 2011 blackout, hurricane Sandy, and other significant service disruptions, utilities have growing problems operating and protecting the grid with existing outdated static operational systems. As the electricity distribution system continues to evolve and its complexity increases, these problems will continue to grow unless changes are made to the way electric grid is operated. In order for utilities to maintain reliable and resilient operations, they need to have the ability to perform dynamic protection and control of the distribution system to be able to handle growing complexity of this system. Utilities require infrastructure that will ensure the continuity of operations and will give them the capabilities to meet future societal needs, take advantage of technological advances, and achieve policy objectives.

The future distribution system will also need to coordinate effectively with technology evolution that is occurring within both utility and customer-based systems, including with respect to addressing emerging markets. As utilities and regulators across the country are facing these challenges, there is lack of consistent approach for developing the advanced operational capabilities to address this transformational change. The integration of information and communication technology (ICT), the digital superstructure, with the physical grid requires advanced systems and testing to ensure system reliability, security and coordination. Without a concerted effort to address this complexity, there is a significant risk for stranded and poorly integrated infrastructure investments, diminished reliability and resilience, and increased exposure to malicious cyber intrusion.

The Resilient Distribution Systems (RDS) (formerly Smart Grid Research and Development) program focuses on addressing the challenges facing electric power grid by developing the innovative technologies, tools, and techniques to modernize the distribution portion of the electric delivery system. RDS pursues strategic investments to improve reliability, resiliency, faster outage recovery, and operational efficiency, building upon previous and ongoing grid modernization efforts. Significant progress has been made towards grid modernization within the distribution infrastructure, but many technical research challenges requiring continued Federal investment remain.

One challenge driving distribution system modernization is the ever changing capabilities necessary to meet our Nation's evolving electricity needs. These needs include accommodating increasing customer-owned distributed generation and storage, supporting the shift towards the electrification of transportation, growing demands for power quality, enabling greater customer choice and control over electricity consumption, becoming more resilient to extreme weather events (such as Superstorm Sandy), reducing the duration and number of outages overall, and, at the same time, maintaining affordability.

The technological convergence of the electricity infrastructure with information and communication systems presents an enormous opportunity to improve overall system resilience and reliability through the integration of vast amounts of information/data from historically disparate systems. Information and communication technology advances have initiated opportunities to leverage increased data volumes as never before possible to begin addressing many distribution grid operation technical challenges, including increased demand and supply variability, bi-directional power flow, data management and security, interoperability between new and legacy technologies and devices, and the increasing interdependencies between distribution and transmission operations.

The focus of Advanced Distribution Management System (ADMS) early stage research is to explore an innovative, new approach to the management and control of utility distribution grids. ADMS will enable a new level of visibility and control across a utility's entire service territory. Microgrid research investments have shown success in addressing reliability, resilience, efficiency, and emissions reduction, and will continue to be a focus within the RDS program. New approaches and technologies will also be investigated, including Control, Communication, and Analysis R&D (CCA R&D) to enhance the Nation's electric distribution grid to withstand and recover from disruptions caused by extreme weather events and ensuring continuity of operations. Transformative approaches will be developed in engineering, economic, and hybrid

systems relying partially on customer-owned and controlled assets to support performance of the distribution system, and for new applications leveraging system data for improved utility operations and to stimulate new products and services for customers and industry. Exploring innovative, transformative, cutting-edge solutions based on data-driven applications is the cornerstone of OE's RDS program.

Results from the RDS research in ADMS, Microgrids, and CCA R&D will strengthen the resilience of electrical infrastructure against adverse effects of future extreme weather phenomena and other unforeseen natural and man-made occurrences.

Highlights of the FY 2018 Budget Request

The FY 2018 request includes a continued investment in the development of an ADMS to support grid modernization. The ADMS effort is developing a new distribution "operating system" along with the interface requirements that will lay the foundation for the private sector to develop new applications, products and services that expand utility capabilities. Existing Distribution Management Systems (DMS and ADMS) are closed, proprietary, vendor-specific products that are costly and difficult to implement limiting access to a handful of utilities. In addition, today's DMS/ADMS:

- struggle to manage the increased complexity of operating distribution grids required to meet increased levels of resilience and the growing levels of variability in both generation and load
- do not provide a holistic approach to coordinating and managing grid operations throughout the grid from transmission, to distribution, to local energy networks such as microgrids
- are limited in their use of real-time, spatial data of all connected devices to determine the grid state for improved operational planning, protection, control, and optimization
- in general, cannot easily and cost effectively integrate with legacy systems or new applications from different vendors

The open-source platform approach for distribution system control could help alleviate many of the shortcomings of existing DMS/ADMS products and reduce implementation costs making them accessible to all utilities. As in other industries, embracing an open-source methodology will foster competition among existing vendors, encourage new market entrants, spur innovation, lower the cost of deployment, and expand the customer base. Utilities would gain the visibility and controllability over assets and devices needed to achieve cost-effective solutions for increased resilience and more efficient and optimal system operations in general. Open platforms would also benefit all vendors and increase the overall market while providing the future operational capabilities utilities will need. In FY 2018, the ADMS program will complete the development of the core analytics engine for the open-source distribution system platform, and will finalize and release V1.0 under the name of GridApps-D.

Microgrid R&D activities in FY 2018 will continue national laboratory R&D in three foundational areas:

- Advanced control theory supports integrating new and emerging microgrid capabilities with distribution management platforms to enable distribution feeders to operate with high penetration of locally sourced energy, energy storage, and advanced system controls for enhanced resiliency. The new control theory developed will lead to novel control solutions for resilient distribution feeders by coordinating and managing all feeder connected distributed energy resources (DERs) and to achieve optimal microgrid resilient operations.
- System protection principles support microgrids under conditions of reverse power flow and variable power output. The R&D objective is to develop new microgrid protection algorithms and methods, capable of automatically adapting to real-time system conditions for microgrid protection system settings and for coordination of microgrid and distribution system protection schemes, so that microgrids can operate safely, reliably and resiliently under any fault conditions when grid-connected or islanded.
- Control architectures for networked microgrids capable of integrating multiple microgrids at the physical layer, control layer, or both, maximize expanded reliability/resilience benefits beyond those from operating microgrids individually. Development of new modeling, simulation, and optimization capabilities will be carried out, as these capabilities are necessary to address a wide range of functional requirements for optimal design, optimal operations, and system simulation that are associated with the new control architectures.

In aggregate, these activities aim toward achieving the end state of an integrated network of multiple microgrids as a building block for the smarter, more resilient grid of the future.

Control, Communication, and Analysis R&D activities in FY 2018 support priorities on grid resiliency to help harden and evolve critical distribution grid infrastructure. A resilient energy system is a system that supplies controlled energy under any circumstances, using the assets available to it. Resilience is the product of design and forethought, technology and assets,

and information. Information extends resilience beyond what a static system can achieve through flexibility, prediction, and adaptation—information allows systems to be dynamic. Design and planning allows the selection and placement of the most effective assets and technologies, tested in the lab and through simulation in a range of extreme and everyday scenarios.

In FY 2018, activities targeting control theory will be pursued. Historically, energy and information systems have relied on a centralized, hierarchical design that presents vulnerabilities in terms of resilience, thus both must be more distributed in the future. Information and energy must be available locally as the system devolves under stress to dynamically supply energy to critical services, which imposes new requirements on both communications networks and data itself. Activities will include research into engineering and economic transactive hybrid algorithms for distributed controls.

Communications networks with software defined networking, predictive data collection capabilities, and event-driven prioritization will be researched, which in turn may impose new meta-data requirements on sensors and assets. While enabling distributed, island-able and resilient controls, the availability of data during extreme events could enable new fault location, isolation, and service restoration (FLISR) capabilities that could take advantage of interconnected microgrids and other distributed generation and energy storage systems to assure continuity of operations.

Analysis activities will include efforts in several areas. A design/planning decision support tool will be released, resulting from prior activities, and development of the distribution restoration decision support tool will be completed for all known extreme weather hazards, along with validated test results and quantification of the tool benefits. Resilience planning is not just a technological exercise, since the system itself is the product of people, organizations (many requiring a profitable business model), and physical assets. In addition to design/planning, resilience also benefits from the use of a relatively new discipline called Grid Architecture which will be employed in FY 2018 to explore the theoretical implications of resilience on regulatory structures, organizational relationships, and the relationships between technologies and assets owned by multiple parties. Electric grid resilience will also be addressed though the enhancement of mathematical simulation and analytical capabilities using an open source distribution system tool (GridLAB-D) to support critical end-use loads in cities/communities under hazards, and extended co-simulation with behavioral, cybersecurity and communications simulators. The enhanced platform will be validated by exploring a scenario of dynamically sourced grid services, including blackstart and emergency load shed services. These efforts will contribute to achieving a 10 percent reduction in the economic costs of power outages by 2025.

Resilient Distribution Systems
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Resilient Distribution Systems	**35,000**	**34,933**	**10,000**	**-25,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $1,050; STTR: $158
- FY 2018 Request: SBIR: $320; STTR: $45

Resilient Distribution Systems
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
• Terminate R&D activities related to microgrid controller demonstrations, transactive-based control approaches including standards development and demonstration projects and Advanced Distribution Management System (ADMS) application development.	**-25,000**
• The FY 2016 appropriation included Congressional direction of $5,000 for development of advanced, secure, low-cost sensors that measure, analyze, predict, and control the future grid during steady state and under extreme conditions. Work related to low-cost sensors is completed using funding provided in FY 2016 and no further funding is requested in FY 2018.	

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Resilient Distribution Systems $35,000,000	**$10,000,000**	**-$25,000,000**
• Award new projects in networked microgrid R&D through a laboratory call to achieve full integration of a network of multiple microgrids with distribution systems. • Continue to support national laboratory microgrid R&D, including transitioning the Microgrid Design Toolset and a grid interactive microgrid controller to industry for microgrid planning/design and operations/control, respectively; prototyping design support tools for remote off-grid microgrids (AC and DC); and utilizing microgrids as a grid resource for reliability and resilience. • Support national laboratory R&D projects awarded through the Grid Modernization laboratory call for development of a design tool and system restoration tool to enhance distribution grid resilience against extreme weather hazards. • Continue to support the Resilient Electricity Delivery Infrastructure projects by providing technical assistance from national labs to awarded U.S. cities and tribal communities. • Develop the specifications for an open source ADMS platform for interconnection and interoperability with various systems and applications.	• Develop advanced control theory that supports integrating new and emerging microgrid capabilities with distribution management platforms to enable distribution feeders to operate with high penetration of locally sourced energy, energy storage, and advanced system controls for enhanced resiliency • Support new microgrid protection algorithms and methods, capable of automatically adapting to real-time system conditions for microgrid protection system settings and for coordination of microgrid and distribution system protection schemes, so that microgrids can operate safely, reliably and resiliently under any fault conditions when grid-connected or islanded. • Develop control architectures for networked microgrids capable of integrating multiple microgrids at the physical layer, control layer, or both, to maximize expanded reliability/resilience benefits. • Complete the development of core analytics engine within the open source distribution system platform. • Complete initial version of the full, open source application platform called GridApps-D for verification and validation.	• Complete Microgrid Design Toolset and release for use. • Discontinue second phase of industry microgrid controller demonstrations. • Cancel testing and business case analysis of existing ADMS products to provide key insights into future use cases/functionality needed by utilities to ensure safe, reliable and resilient distribution grids and provide technical requirements for open source platform under development. • Complete the development of the core analytics engine for the open-source distribution system platform, and finalize and release V1.0 under the name of GridApps-D. • No development of high priority distribution operation applications that integrate with and utilize the new, open source platform, GridApps-D; application development will be incumbent upon industry. • Terminate planned completion of an on-line tool for utilities that estimates the impacts of distribution system modernization technologies. • Terminate R&D activities related to transactive-based control approaches including standards development and demonstration projects. • Adapt control theory work to include Dynamic Distribution System Protection.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Begin work on ADMS test cases and an ADMS test bed for evaluation under operating environments; begin testing of ADMS platform utilizing the test bed and test cases. • Launch research activities to develop new applications compatible with the open-source ADMS platform that leverage the vast amounts of available system data for improved grid operations. • Establish a standard means of quantifying the value of various grid services and determining the net value provided by the distributed assets. • Develop control algorithms for end-use devices (water heaters, refrigerators, clothes dryers, and variable speed drives) to respond to transactive control signals for the provision of ancillary services. • Evaluate transactive approaches developed by research organizations and industry, and enhance existing simulation and modeling tools to attain stable, predictable response with increased efficiency. • Supports one-time funding to develop advanced, secure, low-cost sensors that measure, analyze, predict, and control the future grid during steady state and under extreme conditions.	• Support distribution grid control theory research into engineering and economic transactive hybrid algorithms for distributed controls. • Research and develop distribution communications networks with software defined networking, predictive data collection capabilities, and event-driven prioritization for improved grid reliability and resiliency. • Complete projects for the development of design tool and system restoration tool to enhance distribution grid resilience against extreme weather hazards. • Expand grid architecture concepts to explore the theoretical implications of resilience on regulatory structures, organizational relationships, and the relationships between technologies and assets owned by multiple parties. • Expand the program in the area of Dynamic Distribution System Protection. • Support enhancement of mathematical simulation and analytical capabilities using an open-source distribution system tool to model critical end-use loads in cities/communities under hazards, and extend co-simulation with behavioral, cybersecurity and communications simulators.	

Resilient Distribution Systems
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Smart Grid R&D—Increase in load factor, reduction in outage durations (system average interruption duration index, or SAIDI) of the distribution system, and reduction in outage time of critical loads on smart microgrids.**		
Target	Release the first generation of a microgrid controller (i.e., Complete System-Level Efficient and Interoperable Solution for Microgrid Integrated Controls, also known as CSEISMIC 1.0) with full documentation of the architecture, device controllers, and a use case with a distribution management system	Complete development of a design support tool that is used by at least one remote community for designing an AC or DC microgrid for off-grid applications	Complete development of the ADMS core analytics engine for the open-source distribution system platform
Result	Met	TBD	TBD
Endpoint Target	Achievement of a self-healing and resilient distribution grid, with integration of networked microgrids and transactive control signals operating under the ADMS, that allows for widespread deployment of distributed renewable and clean energy resources and demand response by 2030.		

Cybersecurity for Energy Delivery Systems

Overview

The Nation's energy infrastructure has become a major target of cyberattacks by criminals, terrorists, and nation-states. Over the past decade, the frequency, scale, and sophistication of cyber threats have increased and attacks have become easier to launch. Despite the energy sector's ever-improving defenses, the variety of threat actors and methods of attack are expanding, while the impact of incidents has shifted from exploitation to disruption to destruction. A major attack would have wide-ranging national security and economic consequences because government, businesses, and communities depend greatly on electricity and fuels to provide vital services. Cyber risks from unintentional acts such as operator error, software upgrades, and equipment failures, have also grown as the Nation's electricity and fuel delivery systems have become more sophisticated and complex. Today, any cyber incident has the potential to interrupt energy services, damage highly specialized equipment, and threaten human health and safety. As a result, energy cybersecurity and resilience is one of the Nation's most important security challenges.

The cyber-attack on the Ukraine electrical distribution system on December 23, 2015 demonstrated the vulnerability of power grids to cyber events as well as the advanced capabilities of our cyber adversaries. The attack knocked out power to 225,000 customers for several hours. Attackers used spear phishing emails to gain initial access to utility IT networks. The hackers then went undetected for nine months as they stole credentials using keystroke loggers, identified hosts and devices, and hijacked the SCADA (supervisory control and data acquisition) data management system (DMS) to systematically open breakers and cause a power outage. Though relatively small in scale, the attackers' ability to perform long-term reconnaissance operations and execute a highly synchronized, multistate, multisite attack represents a step change in sophistication and intent.

Securing cyber systems and ensuring reliable energy delivery has become very challenging. The dramatic increase in focused cyber probes, data exfiltration, and malware exploits has greatly strained the financial and technical resources of energy companies as they adjust to a new risk paradigm. The energy sector is also adjusting to the rapid pace of technology and market changes in their businesses. This is particularly true in the electricity sector, which requires high-speed, accurate control of complex transmission and distribution systems. While the North American Electricity Reliability Corporation (NERC) enforces mandatory reliability standards for the bulk power system, grid modernization is introducing new technologies that do not yet have well-defined standards. Advanced information and communications technologies, which are required to support variable and distributed energy resources, are being rapidly integrated into networks that include older, legacy devices that may not be able to accommodate sophisticated cybersecurity protocols. Simply put, the rapid pace of change in the cyber-physical control of energy systems has made it extremely difficult for the energy sector to stay ahead of the escalating cyber risks they face.

Recognizing that more than 90% of the Nation's energy infrastructure is owned and operated by the private sector, OE began collaborating with the energy sector nearly two decades ago in a voluntary public-private partnership to identify and mitigate physical and cyber risks to energy systems. Through this partnership, DOE has earned the trust of energy companies, which has helped to accelerate the mutual exchange of information and deployment of new technology to improve the security and resilience. For example, OE partnered with the energy sector and Federal agencies to develop the *2011 Roadmap to Achieve Energy Delivery Systems Cybersecurity*, which provides a strategic framework to guide public and private investments to achieve the common vision of resilient energy delivery control systems that are designed, installed, operated, and maintained to survive a cyber-incident while sustaining critical functions.[a]

DOE's role in energy sector cybersecurity is established in statute. In the 2015 Fixing America's Surface Transportation (FAST) Act, Congress assigned DOE as the Sector-Specific Agency (SSA) for cybersecurity for the energy sector, building upon previous Presidential Policy Directives (PPD). In its role as the SSA, DOE directly collaborates with energy sector utility owners, operators, and vendors to strengthen the cybersecurity of critical energy infrastructure against current and future threats and serve as a day-to-day Federal interface for the dynamic prioritization and coordination of sector-specific activities; carry out incident management responsibilities consistent with statutory authority and other appropriate policies,

[a] https://energy.gov/sites/prod/files/Energy%20Delivery%20Systems%20Cybersecurity%20Roadmap_finalweb.pdf

directives, or regulations; and provide, support, or facilitate technical assistance and consultations for each sector to identify vulnerabilities and help prevent or mitigate the effects of incidents, as appropriate.

The goal of the Cybersecurity for Energy Delivery Systems (CEDS) program is to reduce the risk of energy disruptions due to cyber events. OE's mission to enhance the reliability and resilience of the Nation's energy infrastructure cannot be achieved without both near- and long-term activities to strengthen cyber security across the Nation. The FY 2018 CEDS budget aligns with the priorities in the Roadmap and supports OE's mission by focusing on three key activities:

- Enhancing the speed and effectiveness of threat and vulnerability information sharing, including bi-directional machine-to-machine information sharing
- Developing an energy delivery system (EDS) testing and analysis laboratory to better understand systems and component vulnerabilities
- Accelerating game-changing R&D to mitigate cyber incidents in today's systems and to develop next-generation resilient energy delivery systems

CEDS has successfully accelerated information sharing with the private sector. The Cybersecurity Risk Information Sharing Program (CRISP) develops situational awareness tools and facilitates the timely sharing of cyber threat information, providing a near-real-time capability for energy owners and operators to voluntarily share cyber threat data, analyze this data, and receive machine-to-machine mitigation measures. Industry support for CRISP, which focuses on IT threats, has prompted OE to expand CRISP capabilities to monitor, analyze, and share operational technology threat indicators affecting control systems.

CEDS supports a research and development (R&D) portfolio to address the energy sector's key technology challenges as described in the Roadmap. National laboratory participation in CEDS projects also ensures critical skill sets remain current and sustains core capabilities, ensuring they can provide support to the energy sector in case of a cyber-event. CEDS efforts engage energy sector stakeholders from the earliest stages and align with the Roadmap strategy to ensure that CEDS is working the right problems. This approach enables the continuous transition of long-term innovative early-stage research from the national laboratories and academia into capabilities that the energy sector can put into practice to reduce cyber risk. The dynamic cyber threat landscape, continuous advances in energy delivery system technologies, and the use of legacy devices in ways not previously envisioned underscore the importance of this continuous transition. In addition, CEDS provides strategic leadership on cybersecurity aspects of the energy sector's operational security, asset protection, baseline practices, risk management, situational awareness, incident management, and other issues needed to achieve the Roadmap vision.

To effectively integrate energy cybersecurity efforts across DOE, OE is developing a *Multiyear Program Plan for the Energy Sector (MYPP)* that aims to reduce cyber risks in the U.S. energy sector through coordinated, focused activities. The MYPP will complement the energy sector-developed Roadmap and provide a common organizing framework that integrates government efforts in concert with energy sector owners and operators and key energy stakeholders. The MYPP is planned to be finalized and available to the public by the end of 2017.

Highlights of the FY 2018 Budget Request

The FY 2018 request reflects the critical need to accelerate and expand efforts to strengthen the energy infrastructure against cyber threats and mitigate vulnerabilities. Working closely with the energy sector and our government partners, the request includes a continued focus in the following key areas:

- **Enhance the speed and effectiveness of threat and vulnerability information sharing**
  DOE strives to strengthen the energy sector's cybersecurity preparedness posture through public and private sector partnerships that leverage DOE-supported tools, guidelines, outreach, training, and technical assistance.

  - The FY 2018 request supports the completion of Cybersecurity for the Operational Technology (OT) Environment (CYOTE) Pilot. The existing CRISP program focuses on the IT networks. The purpose of the CYOTE initiative is to apply information sharing techniques developed under CRISP to the OT environment. CYOTE pilots with utilities aim to design an industry-led approach for collecting and sharing OT data—one that allows operators to elicit special

insights from the U.S. intelligence community and the expertise of DOE national laboratories to deliver actionable information.

- The FY 2018 request will enhance the performance of CRISP. CRISP provides a platform to facilitate the timely sharing of cyber threat information and integrates situational awareness tools to enhance the energy sector's ability to identify, prioritize, and coordinate the protection of its critical infrastructure. Funding will support integration of advanced technologies and techniques developed under CYOTE.

- The FY 2018 request continues the Cyber Analytics Tools and Techniques (CATT) activity to improve CRISP's efficiency and effectiveness by using the secure government storage to share CRISP information from CRISP participants who have volunteered to participate. This initiative will also incorporate new analytic tools and techniques into the analytic product. This will enable a wider review of the CRISP information from the Intelligence community to enhance the classified enrichment of information.

- **Develop an energy delivery systems (EDS) testing and analysis laboratory**
  The FY 2018 request supports establishing an energy delivery system (EDS) cybersecurity testing and analysis laboratory. A robust cyber testing capability at national laboratories will support analyzing systems and component vulnerabilities, malware threats, and impacts of zero-day threats on energy infrastructure, as well as support initiatives to harden the supply chain. This will be accomplished by developing requirements and engaging early stage research at the national laboratories.

- **Accelerate game-changing R&D**
  DOE OE's portfolio of R&D aims to deliver game-changing tools and technologies that help utilities secure today's energy infrastructure from advanced cyber threats and design next-generation future systems that are built from the start to automatically detect, reject, and withstand cyber incidents, regardless of the threat. To make a difference, DOE will partner with the national laboratories to develop the next generation control systems and engineer in cybersecurity in all components, devices and systems. The Department will continue to develop continuous monitoring tools and secure control system communications.

  - The FY 2018 request supports national laboratory early stage R&D in energy delivery control system cybersecurity that will strengthen and maintain core capabilities for the energy sector. This approach advances the state of the art in today's systems, while recognizing that developing cybersecurity solutions to stay ahead of the latest threat is a reactionary cycle that must be broken. Innovative R&D to develop self-healing systems can disrupt this cycle and change the game for energy delivery system cybersecurity, even as the threat advances and the attack surface increases. Today is the time to design cybersecurity into future grid scenarios. Grid operations are rapidly evolving to integrate millions of new smart grid devices and distributed energy resources, and legacy devices are often being used in ways never previously envisioned. As operation of the grid becomes increasingly complex and distributed, new energy delivery system designs with built-in cyber resilience will be essential. CEDS R&D helps secure our Nation's energy infrastructure from cyber-attack, which is critical to national security, but for which an individual energy sector organization would likely be unable to support a business case.
    CEDS investments support early stage research that advances resilient energy delivery systems that are designed, installed, operated, and maintained to survive a cyber incident while sustaining critical functions. The national laboratories are OE's strategic partners in achieving this goal which requires the continuous transition of long-term innovative research—from research partnerships that engage the national laboratories, universities, suppliers, energy asset owners, operators, and utilities—into capabilities that the energy sector can put into practice today, and tomorrow, to reduce cyber risk. To date, DOE-funded cybersecurity R&D, which is building a foundation of early stage advances, has resulted in 35 advanced technologies and critical guidance documents that are being used today to reduce the risk of energy disruptions due to cyber events. Several of these advanced technologies are being deployed in the energy delivery system today across the Nation. The national laboratories' early stage research has laid this foundation for the energy sector community to advance next generation cybersecurity technologies that are today reducing the risk of an energy delivery disruption.
    The FY 2018 R&D focus areas include early stage technologies such as those that:

- Prevent a cyber-incident by decreasing the cyber-attack surface of energy delivery systems and components, blocking attempted misuse of the energy delivery system at every level, or decreasing the risk posed by malicious functionality that could be inserted as components and systems traverse the supply chain.
- Detect a cyber-incident by providing for real-time continuous cybersecurity situational awareness at all energy delivery system levels that recognizes attempts to execute unwanted functionality that the energy delivery system was not designed to support or attempts to misuse an EDS functionality that should never be executed under the immediate circumstances.

- Mitigate a cyber-incident by distinguishing a disruption of energy delivery resulting from a cyber incident, from a disruption resulting from a different cause, characterizing the extent and consequences of a cyber incident to support response actions and providing for automated response.

- Advance cyber resilience by designing cybersecurity into emerging power system device for future grid scenarios from the start or designing power systems and components to automatically recognize, and reject, attempted misuse.

Cybersecurity for Energy Delivery Systems
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Cybersecurity for Energy Delivery Systems	**62,000**	**61,882**	**42,000**	**-20,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $1,050; STTR: $158
- FY 2018 Request: SBIR: $960; STTR: $135

Cybersecurity for Energy Delivery Systems
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
• A $4,000 increase supports the establishment of an Energy Delivery System (EDS) cybersecurity testing and analysis laboratory with a focus on supply chain vulnerabilities and risks in FY 2018	**-20,000**
• A $4,000 decrease is due to completion of Cybersecurity Capability Maturity Model (C2M2) toolkit development; C2M2 is available online	
• A $10,000 reduction is for the Virtual Energy Sector Advanced Digital Forensics Analysis Platform, which was initially funded in FY 2016, and will complete implementation and begin transitioning to the private sector in FY 2017; no further funding is needed in FY 2018	
• The industry-scale electric grid test bed was initiated in FY 2014 as a 3-year project and was funded at $5,000 in FY 2016; no funding is requested in FY 2018	
• The FY 2016 appropriation also included $5,000 to develop cyber and cyber-physical solutions for advanced control concepts for distribution and municipal utility companies; no further funding is requested in FY 2018	

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Cybersecurity for Energy Delivery Systems		
$62,000,000	**$42,000,000**	**-$20,000,000**
• Issue a competitive solicitation for energy sector-led R&D to advance cybersecurity for energy delivery systems to transition mid-term R&D projects into real world cybersecurity capabilities that address the changing threat landscape • Continue to support mid-term as well as long-term high-risk/high-payoff research and strengthen the core capabilities at the national laboratories through competitive processes • Continue to fund the CRISP classified analytic and reporting functions • Issue a competitive solicitation to identify commercially available technologies and services to enhance CRISP capabilities • Expand online access to the C2M2 and RMP tools and conduct benchmarking and data analytics • Enhance situational awareness with relevant local and Federal agencies and informational analysis centers through information sharing development and practicing regional cybersecurity incident response communications • Establish a Virtual Energy Sector Advanced Digital Forensics Analysis Platform through a competitive solicitation • Continue development of the industry-scale electric grid test bed • Develop cyber and cyber-physical solutions for advanced control concepts for distribution and municipal utility companies	• Conduct game-changing R&D at national laboratories to develop resilient energy delivery systems. Research areas could include but are not limited to early stage technologies for prevention, detection, mitigation or resilience against cyber incidents in energy delivery systems and development of components with engineered-in cybersecurity solutions • Continue to develop continuous monitoring tools and enhance CRISP using the experience from the operational technology program • Enable the CATT effort to continue to improve CRISP efficiency and effectiveness • Complete the CYOTE Pilot • Establish a cybersecurity testing and analysis laboratory • Continue development of innovative secure control system communications	• A $4,000,000 increase supports the establishment of an Energy Delivery System (EDS) cybersecurity testing and analysis laboratory with a focus on supply chain vulnerabilities and risks in FY 2018 • A $4,000,000 decrease is due to completion of Cybersecurity Capability Maturity Model (C2M2) toolkit development • A $10,000,000 reduction is for the Virtual Energy Sector Advanced Digital Forensics Analysis Platform, which was initially funded in FY 2016, and will complete implementation and begin transitioning to the private sector in FY 2017; no further funding is needed in FY 2018 • The industry-scale electric grid test bed was initiated in FY 2014 as a 3-year project and was funded at $5,000,000 in FY 2016; no funding is requested in FY 2018 • The FY 2016 appropriation also included $5,000,000 to develop cyber and cyber-physical solutions for advanced control concepts for distribution and municipal utility companies; no further funding is requested in FY 2018

Cybersecurity for Energy Delivery Systems
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Cybersecurity—Develop new protective measures to reduce risks from cyber incidents.**		
Target	Demonstrate a tool that establishes a tailored trustworthy space for one energy delivery field device	Complete preliminary design of an early stage technology that establishes a tailored trustworthy space for one substation control system component	Complete preliminary design of an early stage technology for prevention, detection, mitigation, or resilience against cyber incidents in energy delivery systems
Result	Met	TBD	TBD
Endpoint Target	By 2020, resilient energy systems are designed, installed, operated, and maintained to survive a cyber incident while sustaining critical functions.		

Energy Storage

Overview

The Energy Storage program supports the strategy for a more resilient, secure, reliable, and economically competitive U.S. energy infrastructure. Energy storage is emerging as an integral component to the grid modernization strategy to provide a diverse range of services including energy management, backup power, load leveling, frequency regulation, voltage support, and grid stabilization. The Energy Storage program is designed to develop new and advanced technologies that will ensure the stability, reliability, and resiliency of the future electric utility grid, which is transforming as a result of changes in consumer demand, changes in composition of generation sources and types of loads, and the continuing proliferation of distributed energy resources. Primarily, the Energy Storage program focuses on accelerating the development of new materials and device technologies that can lead to significant improvements in the cost and performance of energy storage systems and accelerated adoption of the energy storage solutions.

In 2014, worldwide electricity generation was 24 million GWh with an operating storage reserve of less than 170 GWh. Less than 2 percent of this reserve is provided by discrete, highly flexible storage assets (such as batteries and flywheels) that offer the greatest potential to improve the local resiliency and efficiency of the grid infrastructure. Further research is required to reduce the costs of storage systems, improve their reliability and safety, and develop analytic models that can facilitate greater understanding of the technical and economic benefits of energy storage. FY 2018 R&D efforts will be refocused around three categories:

- Energy Storage Technology Development—perform research on novel materials and system components to resolve key cost and performance challenges with respect to novel flow, lithium, sodium, magnesium, and thermo-electrochemical batteries and associated electrodes, dielectrics, membranes, electrolytes, interconnects, and supporting power electronics
- Reliability and Safety—continue establishing a scientifically derived knowledge base that will improve the understanding and predictability of energy storage systems and components and enable more reliable materials and safer systems to be developed
- Storage Analytics—develop analytic tools for utility customers and regulatory agencies to facilitate planning and implementation of energy storage onto the grid. Support development of high fidelity theoretical models refined with data derived from state- and industry-supported deployments to ensure energy storage is appropriately used and valued

Highlights of the FY 2018 Budget Request

Grid energy storage is a key component for the development of a flexible and resilient electric grid infrastructure. The FY 2018 request supports materials research on the next generation of battery chemistries, development of new device technologies for efficient power conversion, development of optimization and control architectures for integration of energy storage into the grid infrastructure, and development of storage utilization models for system level energy storage planning and evaluation.

The Energy Storage program's materials research has been successful in developing new electrochemical materials, device, and component technologies. FY 2018 efforts will focus on the development of high energy density electrolytes for flow batteries, synthesis and development of polymeric and ceramic ionic conductors, membranes with fast ion kinetics and enhanced mechanical and chemical stability, and the development of advanced materials and device topologies for power electronics and power conversion systems. Redox flow battery research efforts will support innovative chemistries such as aqueous soluble organic electrolytes. The program will focus on the synthesis and development of low cost polymeric membranes as well as ceramic membranes to enable the development of safer, metal electrode batteries.
The program will continue to develop new wide-bandgap materials for power electronics and advanced dielectric materials for high voltage capacitors. New R&D activities will be initiated for development of new topologies for optimization and efficient coupling between batteries and power electronics.
For grid energy storage, the fundamental reliability and safety of batteries is critical. The program will support fundamental investigations into the degradation mechanisms affecting the safety and reliability of energy storage systems. New activities will be initiated for the development of integrated physical electrochemistry models for improved performance, safety, and reliability protocols. The DOE Energy Storage Program will disseminate critical scientific discoveries in reliability and safety to the storage industry at large.

To fully elucidate the role of energy storage in the future grid, the program will focus on the development of distributed optimization algorithms and control architectures for the optimum design and operation of energy storage in distributed grids with resilience to handle uncertainties, cyber threats, and variability in generation and consumption. The program will continue to support R&D on the development of multi-functional storage utilization models for transmission and distribution level storage planning and evaluation tools along with efforts to refine techno-economic models based on field experience for improved valuation and planning tools.

Energy Storage
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Energy Storage	**20,500**	**20,461**	**8,000**	**-12,500**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $615; STTR: $92
- FY 2018 Request: SBIR: $256; STTR: $36

Energy Storage
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
The FY 2018 request discontinues grid scale field validation support engagements with states and utilities (WA, OR, VT, AK, CA, HI, NY, and TN), eliminates State and Federal regulatory body policy engagements to understand regional market barriers to energy storage deployment (FERC, WA, OR, OH, CA, NV, and NM), reduces the number of university subcontracts (OH, PA, TX, WV, NM, ND, WY, CA, and WA), eliminates OE participation in industry led Safety Codes and Standards development, and discontinues the biannual Safety Forum.	**-12,500**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Energy Storage $20,500,000	**$8,000,000**	**-$12,500,000**
• Accelerate development of next generation redox flow batteries (RFBs), with significant potential to provide lower cost systems • Conduct grid-scale tests and collaborative field trials with states, utilities, and storage providers, to elucidate energy storage benefits, understand grid integration issues, and implement safety and performance protocols • Provide enhanced tools and data to U.S. industry for development and use of grid-scale batteries • Organize a Stationary Energy Storage Reliability workshop with industry, developer, and utility stakeholders • Demonstrate various capabilities and optimization of Distributed Energy Storage System aggregation in large-scale electrical distribution model • Develop characterization methods, test procedures, and understanding of failure and degradation phenomena enabling improved design and accelerated aging tests • Develop industry standards for safety, reliability, testing and evaluation, and promulgation to international standards bodies • Support and organize quarterly Energy Storage Safety Forum meetings for the energy storage community to increase acceptance of storage technologies • Continue development of power conversion systems (primarily power electronics) specifically for grid energy storage applications	• Synthesize and test aqueous-based, earth-abundant chemistries for next-generation static and flow battery systems including new aqueous soluble organic (ASO) flow battery system • Investigate innovative chemistries for: high energy density electrolytes, reversible zinc, lithium, magnesium-based batteries, solid state electrolytes, and low cost polymeric membranes • Develop novel energy storage architectures and computational methodologies for exploring next generation energy storage • Determine fundamental degradation mechanisms of storage materials though in-situ characterization and predictive modeling and develop integrated physical electrochemistry models for improved performance, safety, and reliability protocols • Investigate novel soft magnetic materials and high energy density dielectrics for improved power conversion systems • Formulate distributed optimization algorithms and control architectures for storage operation and develop multi-functional storage utilization models to improve valuation and planning tools • Develop optimized storage control architectures that are more resilient to system uncertainties and cyber threats	• Discontinue support for engagements with states, utilities, and storage providers for conducting grid-scale field tests and trails. (WA, OR, VT, AK, CA, HI, NY, and TN) • Eliminate Regulatory Environment thrust area and discontinue support for engagement with State and Federal regulatory officials on efforts to understand regional market barriers to energy storage deployment. (FERC, WA, OR, OH, CA, NV, and NM) • Eliminate Industrial Acceptance thrust area and validation of system performance and analysis of regional use-cases • Discontinue support to States and regional entities on the procurement, commissioning, and techno-economic analysis of deployed systems • Eliminate support for new collaborative test-bed and field trials • Discontinue support for development of enhanced tools and data to U.S. industry for development and use of grid-scale batteries • Eliminate participation in industry led Safety Codes and Standards development • Eliminate DOE participation in international codes and standards development (IEC TC120) • Eliminate biannual Safety Forum • Reduce the number of university subcontracts (OH, PA, TX, WV, NM, ND, WY, CA, and WA)

Energy Storage
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Energy Storage—Lower the cost of grid-scale (> 1 MW) energy storage technologies.**		
Target	300 $/kWh for a 4 hour system (vanadium/ vanadium electrolyte)	Transition to new aqueous soluble organic flow systems with the goal of substantial future cost reductions. $350/kWh for a 4 hour system (aqueous soluble organic electrolyte)	$250/kWh for a 4 hour system (aqueous soluble organic electrolyte)
Result	Met—300	TBD	TBD
Endpoint Target	By 2020, improve the cost-benefit ratio of storage to compete with current peak generation resources and increase the commercial use of grid scale storage to buffer renewables to 5%.		

Transformer Resilience and Advanced Components

Overview

The Transformer Resilience and Advanced Components (TRAC) program supports modernization, hardening, and resilience of the grid by addressing the unique challenges facing transformers and other critical grid components (grid hardware) that are responsible for carrying and controlling electricity from where it is generated to where it is needed. As the electric power system evolves and the threat environment changes, early stage R&D can help understand the physical impact these changes have on vital grid components to enable a more resilient and secure energy future. In the March 2017 Report to Congress on a Strategic Transformer Reserve, large power transformers (LPTs) are identified as one of the most vulnerable components of the grid, posing a significant risk to the Nation in the event of multiple failures, requiring innovative and cost-effective solutions beyond the spares, shares, and pooling that industry is pursuing on its own.[a] Research in advanced materials, components, and devices will provide the fundamental physical capabilities required in the future grid and encourage the adoption of new technologies and approaches.

Transformers, power lines, and substation equipment are often exposed to the elements and are vulnerable to an increasing number of natural and man-made threats. To ensure a reliable, robust, and resilient electric power system, the next-generation of grid hardware needs to be designed and built to withstand and rapidly recover from the impact of extreme terrestrial or space weather events, electrical disturbances, equipment failures, accidents and deliberate attacks, and other unknowns. Another important transformer characteristic that should be emphasized is flexibility and adaptability to address the wide range of designs and specifications across these critical assets, facilitating interchangeability and sharing in emergency situations. Greater deployment of distributed energy resources also introduces new stresses from reverse power flows, increased harmonics, and protection coordination that can impact the reliability and lifetimes of current generation grid hardware, requiring new and expanded capabilities in the next-generation.

The TRAC program addresses these challenges associated with transformers and other grid equipment by focusing on materials research, analytical designs, and exploratory concepts that are inherently more secure and resilient, in close coordination with industry, to fill fundamental R&D gaps. The age of existing grid hardware degrades its ability to withstand physical stresses and may result in higher failure rates that can lead to widespread outages and long restoration times. For example, failure of a LPT (with 70% aged 25 years or older) can disrupt power to the equivalent of 500,000 homes and take over 12 months to procure an optimized replacement due to their custom engineering and design. As a large percentage of these assets will be replaced in the near future, the timing is ripe for innovation to avoid reinstalling outdated technologies that are long-lived, expensive, and less resilient. Results of the TRAC program will help prepare and harden the next-generation of critical grid infrastructure by catalyzing advances in resilient materials, equipment, and devices.

Highlights of the FY 2018 Budget Request

Following FY 2016 work on improving the understanding of transformer vulnerabilities to geomagnetic disturbances (GMD) and electromagnetic pulses (EMP) through multi-physics modeling and laboratory testing, and drawing on the outcomes of five awards made for more flexible and adaptable transformer designs, OE will refocus on applied materials research to address some of the fundamental gaps identified for insulators, magnetics, and metals required for building next-generation transformers and other grid components. Research to improve asset monitoring capabilities and equipment performance under stress will enhance the portfolio of solutions needed to increase grid security, reliability, and resilience.

To ensure that research addresses the most critical grid components, activities will also support exploration of innovative concepts and designs for solid-state power substations (SSPS) based on R&D gaps identified in the SSPS roadmap being developed in 2017. Greater utilization of high voltage power electronics within a substation, including hybrid and solid-state transformers, can provide power flow control capabilities, limit fault currents, and increase system reliability and resilience. Research into this cutting-edge technology concept can enable more flexible and adaptable designs that are interoperable with legacy systems and help reduce the criticality of substations.

[a] https://www.energy.gov/oe/downloads/strategic-transformer-reserve-report-congress-march-2017

Transformer Resilience and Advanced Components
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Transformer Resilience and Advanced Components	**5,000**	**4,990**	**5,000**	**0**

SBIR/STTR:

- FY 2016 Transferred: SBIR: $150; STTR: $22
- FY 2018 Request: SBIR: $160; STTR: $23

Transformer Resilience and Advanced Components
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
The FY 2018 request reflects a transition from assessing transformer GMD and EMP vulnerabilities through modeling and laboratory testing to catalyzing material and design innovations that can be utilized to harden and protect critical grid equipment from these threats and others. As aging grid assets are being replaced, there is a small window to accelerate the development of advanced resilient materials and devices needed for more flexible and adaptable transformer designs. Research efforts will focus on overcoming the unique challenges associated with the high-voltage, high-temperature, and high-reliability requirements (25–40 years of field operations) associated with these technologies. Federal investment can enhance the fundamental physical capabilities of grid hardware to increase the security and resilience of the electric power system.	0

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Transformer Resilience and Advanced Components

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs. FY 2016
Transformer Resilience and Advanced Components		
$5,000,000	**$5,000,000**	**$0**
• Begin modeling and testing of transformers to evaluate vulnerability to GMD/EMP • Evaluate next-generation transformer designs that are more resilient	• Applied research to increase performance of materials for more resilient grid equipment and devices including flexible and adaptable large power transformers • Analytical and exploratory research on designs and components for cutting-edge solid-state power substation concepts that enable power flow control capabilities and increase protection	• Refocus program and accelerate progress toward material and design innovations that can be utilized to harden, protect, and increase the resilience of critical grid equipment such as large power transformers

Transmission Permitting and Technical Assistance (formerly National Electricity Delivery)

Overview

The Transmission Permitting and Technical Assistance, or TPTA, (formerly National Electricity Delivery) program assists state, regional, and tribal entities that wish to develop, refine, or otherwise change their electricity-related laws, regulations, policies, and programs. The scope of this work includes all facets of the electric system, including generation, transmission, storage, distribution, or demand-side electricity resources. TPTA will analyze reforms necessary to reduce barriers to private sector investment in the United States.

TPTA also implements a number of legal authorities, such as coordination of transmission permitting by Federal agencies, periodic transmission congestion studies, permitting of cross-border transmission lines, authorization of electricity exports, and supporting actions by the Secretary of Energy during electricity emergencies.

The electricity system and markets in the United States are undergoing significant changes for a number of reasons. The changes arise from a range of challenges and opportunities created by new or improved technologies, changing customer and societal expectations, and structural changes in the electric industry. Some of these technologies are at the wholesale (bulk power) level, some are at the retail (distribution and customer) level, and some blur the line between the two. Other key factors driving current discussions include the tension between the continuing need for substantial utility investments and low load growth in many regions, changing state and Federal policies and regulations, and new concerns about the structure of wholesale electricity markets. All of these challenges and opportunities must be balanced by regulators and other policy officials overseeing the electric system against the continuing need for reliability, resiliency (including both physical security and cybersecurity), and affordability.

Highlights of the FY 2018 Budget Request

TPTA electricity policy technical assistance (to states, regions, and tribes), which is available upon their request, respects their sovereign authority over electricity system decision-making. TPTA does not advocate particular electricity policies or technology solutions, but rather provides assistance in a neutral, unbiased, and informational manner.

Traditionally, steady growth in electricity demand has enabled utilities to raise the capital needed for new investment. Now, however, many parts of the U.S. are experiencing lower growth in electricity sales, in part due to increasing energy efficiency and customer- or third-party-owned generation technologies. At the same time, the need for new infrastructure investment by utilities is increasing to address aging assets, take advantage of new technologies, and respond to changing customer interests. Since many utilities' revenues are dependent chiefly on electricity sales volume, it can be difficult to finance new investments when revenues are stagnant or declining. Regulators in some states have begun to consider alternative ratemaking concepts to cover fixed costs and new regulatory and market regimes that link utility revenues to other performance indices, but this is a complex and challenging subject that will require attention and analysis over the next several years. In FY 2018, efforts in this area include continued assistance to those states that are considering these changes for their jurisdictional electric utilities.

For the past decade, TPTA has supported transmission planning and related analysis by both electric industry planners and state-based groups in each of the three electricity interconnections. Much of this work and corresponding discussions among utility planners and state officials had never been done on such a wide geographic footprint. The Eastern Interconnection Planning Collaborative, Eastern Interconnection States Planning Council, Western Electricity Coordinating Council, Western Governors' Association (and its associated Western Interstate Energy Board) and Electric Reliability Council of Texas are continuing their efforts to inform future transmission and other electricity plans and policies that will shape the future of the electricity grid in their respective interconnections. TPTA will continue to support the work of these regional interconnection-wide bodies through technical assistance, such as planning tool development and additional topical studies that are helpful to their efforts.

TPTA will conduct work identified in the *National Electric Grid Security and Resilience Action Plan* (December 2016), a product of the National Security Council, which includes work on better understanding how to incorporate grid security and resiliency in state regulation of electricity.

Additional technical and policy expertise provided to states, regions, localities, and tribal entities spans a wide variety of current and future electricity-related issues, such as:

- Understanding the implication of interdependencies (such as gas/electric, electric/IT, and energy/water) on grid reliability and how that might inform electric utility planning and operations;
- State, regional, local, and tribal policies and regulations affecting the energy sector and new approaches to transmission planning and private sector infrastructure investment;
- Management of risks (including electricity policy uncertainty, changing markets, and extreme weather) by state electricity regulators and other state officials;
- Addressing resiliency and cybersecurity concerns in electric system processes; and
- Examining approaches to rate design and compensation to ensure robust industry models that can maintain a viable, dependable and affordable electric grid while increasing resilience.

Work in these issue areas will result in the development of tools, reports, workshops, analyses, and interstate discussions that, together, can help state electricity regulators, as well as other state, regional, and tribal electricity officials, make better informed decisions about their respective elements of the electricity system.
In FY 2018, TPTA will continue to work with experts from industry, the national laboratories, electricity sector state organizations, and universities to develop and deliver its electricity policy technical assistance.

TPTA will also continue to carry out its regulatory responsibilities and evaluate regulatory reform to reduce Federal burden associated with investing in our Nation's electricity infrastructure in these areas:

- Preparing and publishing DOE's annual *Transmission Data Review* and triennial national electric transmission congestion studies;
- Conducting environmental review and technical analyses needed for Federal authorization of transmission projects that cross the U.S. international borders;
- Coordinating Federal permitting by other agencies of new transmission infrastructure that involves Federal authorizations, as required by Section 216(h) of the Federal Power Act and in coordination with title 41 of the Fixing America's Surface Transportation (FAST) Act;
- Evaluating any new applications under Section 1222 of the Energy Policy Act of 2005, which authorizes DOE to participate in third-party-financed transmission projects within the Western Area Power Administration (WAPA) and the Southwestern Power Administration (SWPA) regions;
- Continuing the expansion of a Regulatory and Permitting Information Desktop (RAPID) toolkit to include more states. The RAPID toolkit provides a wealth of data on state permitting and siting regulations for electric transmission siting for use by transmission project developers as well as state and Federal permitting agencies; and
- Supporting the Secretary of Energy during electricity emergencies when implementing Section 202(c) of the Federal Power Act.

Transmission Permitting and Technical Assistance
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Transmission Permitting and Technical Assistance	**7,500**	**7,486**	**6,000**	**-1,500**

Transmission Permitting and Technical Assistance
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
The decrease results in fewer states, regions, and tribes receiving technical assistance. Underlying tool development, reports, workshops and other forms of work to inform the technical assistance will either be delayed or eliminated.	**-1,500**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Transmission Permitting and Technical Assistance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Transmission Permitting and Technical Assistance **$7,500,000**	**$6,000,000**	**-$1,500,000**
• Expand suite of tools for grid scenario discussions at the Federal, state, and local levels. • Provide technical assistance on electricity-related topics, upon request, to states, public utility commissions, tribes, and other regional and Federal entities. • Conduct studies related to Performance Based Regulation (by states) and grid planning in the Eastern and Western Interconnections. • Implement Integrated Interagency Pre-application process to improve Federal permitting of transmission infrastructure pursuant to Section 216(h). • Conduct activities leading to publishing the triennial *National Transmission Congestion Study.*	• Maintain the suite of tools for grid scenario discussions at the Federal, state, and local levels. • Provide technical assistance on electricity-related topics, upon request, to states, tribes, and other regional state and Federal entities. • Continue transmission permitting coordination requirements pursuant to Section 216(h) of the Federal Power Act and under title 41 of Fixing America's Surface Transportation Act. • National review of transmission plans and assess barriers to their implementation. • Produce white papers highlighting different viewpoints as part of a Future Electric Utility Regulation effort.	• Smaller number of states, regions, and tribes receive technical assistance. • Underlying tool development, reports, workshops and other forms of work to inform the technical assistance are delayed or eliminated.

Transmission Permitting and Technical Assistance
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Technical Assistance—Number of states to which the program provides, upon request, assistance in designing and implementing electricity policies, statutes and regulations.**		
Target	50 states/tribes assisted	45 states/tribes assisted	40 states/tribes assisted
Result	Met—50	TBD	TBD
Endpoint Target	Increased access to reliable, affordable, and sustainable energy sources.		

Infrastructure Security and Energy Restoration

Overview

The Infrastructure Security and Energy Restoration (ISER) program coordinates a national effort to secure U.S. energy infrastructure against all hazards, reduce impacts from disruptive events, and assist industry with restoration activities. ISER works closely with the electricity and oil and natural gas industries, other Federal agencies, and State, Local, Tribal, and Territorial (SLTT) communities to advance national energy security and prepare for, respond to, and adapt to evolving threats.

ISER is responsible for executing DOE's Energy Sector Specific Agency (SSA) and Emergency Support Function-12 (ESF-12) (Energy) roles and providing DOE's support to the Infrastructure Systems Recovery Support Function (IS-RSF).[a] ISER also serves as the point of entry to DOE and the Federal Government for all energy infrastructure security and resilience stakeholders, including those from the private sector.

To deliver on its mission and support its stakeholders, ISER delivers critical capabilities including energy sector emergency response and recovery (including cyber incident response coordination); near-real-time situational awareness and information sharing about the status of the electric grid; training and exercises, which strengthen Federal, regional, state, tribal, and territorial abilities to work together to prepare for and mitigate the effects of an energy sector emergency; and analysis of evolving threats and hazards to energy systems including cyber, electromagnetic pulses, and space weather.

Highlights of the FY 2018 Budget Request

The FY 2018 budget request reflects ISER's commitment to expand Energy Sector security and resilience through full coordination with our government and industry partners in the delivery of emergency response coordination, energy sector situational awareness, and cyber preparedness and incident coordination as stipulated in the 2015 FAST Act, as well as by seeding public private partnerships at National Laboratories.

Build Emergency Support Function 12 Capacity: ISER will implement a regionalized approach to provide volunteer emergency responders with an opportunity to build stable, long-term expertise and relationships. This approach will be rolled out in cooperation with the Department of Homeland Security (DHS) Office of Infrastructure Protection and the Federal Emergency Management Agency (FEMA) to take full advantage of each of our agencies' different strengths and mission, and ensure that we are coordinated, even before the event. ISER will continue to maintain a stable cadre of about 100 responders, and ensure they are well trained by integrating them into our annual exercise program to the extent possible.

Improve Energy Sector Situational Awareness Capabilities: ISER is home to EAGLE-I, the Federal Government's situational awareness tool for national power outages. EAGLE-I's awareness of distribution outages has been growing, but it lacks the abilities to illustrate how outages affect other aspects of critical lifeline sectors or model potential impacts of various hazards, and would benefit from increased access to more varied sources of data. The FY 2018 request will continue enhancing EAGLE-I capabilities for data acquisition, collection, modeling, analysis, and visualization services. This will establish a collaborative platform for historic and real time data collection, assimilation, integration, and curation across the public and private sectors. It will continue to be the Federal focal point for collecting and sharing energy infrastructure information, linked with other Federal efforts.

Ensure Cybersecurity Incident Coordination: ISER will lead an effort to develop an effective, timely, and coordinated cyber incident management capability as part of its all-hazards approach to incident response for the energy sector. In collaboration with DHS, the Federal Energy Regulatory Commission (FERC), the Electricity Sector Information Sharing and Analysis Center (ES-ISAC), industry, and international stakeholders, and in concert with work performed under the CEDS program, ISER will continue to develop and formalize incident management processes and procedures (such as communications and coordination of activities, roles, and responsibilities) that align with the National Incident Management System and National Response Framework.

[a] The Infrastructure Systems Recovery Support Function is described at https://www.fema.gov/pdf/recoveryframework/infrastructure_system_rsf.pdf.

Build National Laboratory-Industry Partnerships. In its role as the SSA, ISER works with the Electricity Sector Coordinating Council and the Oil and Natural Gas Sector Coordinating Council to identify gaps in their ability to address cyber, physical and supply chain vulnerabilities that require the capabilities of DOE National Laboratories. In FY 2018, ISER will clarify a public-private partnership approach to establishing these capabilities.

Infrastructure Security and Energy Restoration
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Infrastructure Security and Energy Restoration	**9,000**	**8,983**	**9,000**	**0**

Infrastructure Security and Energy Restoration
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
The FY 2018 ISER budget proposal supports on-going efforts and maintains capability to respond to energy sector emergencies through a regionalized volunteer delivery model. It supports improving the Federal national energy infrastructure situational awareness and visualization capability provided by EAGLE-I, sponsors one annual exercise (Clear Path VI), and engages SLTT partners in information sharing activities through EAGLE-I and workshops. ISER will continue work on evolving threats and hazards including electromagnetic pulses and space weather, and will explore public-private partnerships to focus and support capabilities at DOE National Laboratories that address cyber, physical, and supply chain vulnerabilities.	**0**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Infrastructure Security and Energy Restoration		
$9,000,000	**$9,000,000**	**$0**
• ESF-12 Responsibilities: Train 100 percent of Regional Coordinators and 85 percent of Voluntary Responders on regional energy infrastructure; test training by participating in National Level Exercise 2016 and selected Regional Exercises.	• Implement a regionalized approach to providing volunteer emergency responders that builds stable, long-term expertise and relationships. Continue to maintain a stable cadre of about 100 responders and ensure they are well trained by integrating them into our annual exercise program to the extent possible.	• Due to evolving threats and hazards, ISER is updating the approach for Federal energy response to build stronger ESF-12 relationships and specialized knowledge.
• SSA Responsibilities: Continue implementation of National Preparedness and Critical Infrastructure Security and Resilience mandates and the coordination of other national energy preparedness policies; develop a Physical Security Capability and Maturity Model (PSCM2) and perform PSCM2 Assessments; support NERC Reliability Standard to Enhance Physical Security Measures; continue development of technical specifications for security systems for high valued, critical energy assets; and facilitate the necessary actions to expand the Oil and Natural Gas ISAC from cyber-focus to all-hazards focus.	• Continue work with the Electricity Sector Coordinating Council and the Oil and Natural Gas Sector Coordinating Council to identify gaps in their ability to address cyber, physical and supply chain vulnerabilities that require the capabilities of DOE National Laboratories. Clarify a public-private partnership approach to establishing these capabilities.	• ISER is advancing sector interaction to provide advanced capabilities through public-private collaboration in response to industry requests for Federal capabilities.
• Exercises: Increase the breadth and number of energy emergency preparedness exercises by expanding focus to address all hazards impacting the energy critical assets. In addition the request will support energy-focused exercises for SLTT entities to assess and strengthen their Energy Assurance Plans.	• Conduct Clear Path VI and continue to engage SLTT entities and enhance their access to situational awareness information through EAGLE-I. In addition, develop security and resilience enhancements to state energy assurance.	• Work enabling enhanced coordination of energy emergencies across Federal and SLTT boundaries continues.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Situational Awareness and Emergency Response Tools: Increase the ability for the monitoring and visualization technology to rapidly adapt, when possible, to new emerging threats.	• Maintain EAGLE-I as the Federal source for near-real-time situational awareness of energy infrastructure. Build out additional capability to address industry interest in damage assessments and for SLTT coordinated situational awareness.	• The request builds on the updated platform for energy sector situational awareness based on feedback and advancing R&D in the field.
• New and Emerging Threats: Identify strategies and conduct analysis on methods to improve the resilience of critical energy infrastructure components, such as the potential impacts of geomagnetic disturbances (GMD) and electromagnetic pulses (EMP) on the electric grid.	• Continue work on evolving threats and hazards including electromagnetic pulses, space weather, cyber, physical, and supply chain vulnerabilities.	• ISER improves the sector knowledge base and science of threats and hazards impacting energy systems.

Infrastructure Security and Energy Restoration (ISER)
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**ISER—Informational Awareness—Improve information sharing among energy sector stakeholders as measured by the number of active accounts in the EAGLE-I platform; both the total number and the diversity of participation from mission partners, e.g., state Emergency Operations Centers.**		
Target	N/A	500 active accounts, with more than 5% from state and local partners	1,000 active accounts, with more than 10% from state, local, and private sector partners
Result	N/A	TBD	TBD
Endpoint Target	EAGLE-I is the predominant source for energy situational awareness for mission partners during an emergency as measured by having more than 2,000 active accounts from all types of stakeholders.		

Performance Goal (Measure)	**ISER—Situational Awareness—Improve awareness of near real-time monitoring situational awareness tool, across the Federal Government ensuring that this tool is available to interagency partners for use in their operations centers and other appropriate situations.**		
Target	70% situational awareness capability availability	80% situational awareness capability availability	N/A
Result	Met—70	TBD	N/A
Endpoint Target	Maintain the availability to near-real-time energy situational awareness tools to interagency partners at greater than 90%.		

Program Direction

Overview

Program Direction provides for the costs associated with the Federal workforce, including salaries, benefits, travel, training, building occupancy, IT services, and other related expenses. It also provides for the costs associated with contractor services that, under the direction of the Federal workforce, support OE's mission.

Salaries and Benefits support 99 full-time equivalent employees (FTEs) that provide executive management, programmatic oversight, and analysis for the effective implementation of the OE program. Of these, 77 FTEs are planned for Headquarters and 22 FTEs are planned at the National Energy Technology Laboratory (NETL). While OE funds 22 FTEs at NETL within its budget, the FTEs are considered Fossil Energy employees.

OE provides FTEs to support Federal Emergency Management Agency (FEMA) Emergency Support Function 12 (ESF-12) mission events and all required ESF-12 training activities. During FEMA mission events, OE FTE base pay is funded by Program Direction funding, while OE is reimbursed by FEMA for overtime and travel expenses. OE also provides FTE support for international energy issues at the request of the Department of State, which reimburses OE for all salary and benefit expenses associated with the work.

Travel includes transportation, subsistence, and incidental expenses that allow OE to effectively manage research and development programs and projects in the field; to provide the Department's electricity-related outreach to regions, states, and tribes with regard to planning needs and issues, policies, siting protocols, and new energy facilities through NED; and to assist the Department of Homeland Security, the Department of State and local governments, and the private sector to help protect against and recover from disruptions in the energy infrastructure by providing ESF-12 and readiness training for DOE emergency responders, who are coordinated through ISER. The Department of State and the private sector reimburse OE for all travel related to their tasks.

Support Services includes contractor support directed by the Federal staff to perform administrative tasks and provide analysis to management. These efforts include issue-oriented support on science, engineering, environment, and economics that benefit strategic planning; technology and market analysis to improve strategic and annual goals; development of management tools and analyses to improve overall office efficiency; assistance with communications and outreach to enhance OE's external communication and responsiveness to public needs; development of program-specific information tools that consolidate corporate knowledge, performance tracking and inventory data, improve accessibility to this information, and facilitate its use by the entire staff; and also may include support for post-doctoral fellows (e.g., American Association for the Advancement of Science [AAAS] fellows) and Intergovernmental Personnel Act (IPA) assignments.

Other Related Expenses includes corporate IT support (DOE's Energy Information Technology Services [EITS] desktop services) and working capital fund (WCF) expenses, such as rent, supplies, copying, graphics, mail, printing, and telephones. It also includes equipment upgrades and replacements, commercial credit card purchases using the simplified acquisition procedures to the maximum extent possible, and other needs.

Highlights of the FY 2018 Budget Request

The funding request for Program Direction provides for implementation and oversight of the range of program activities in support of OE's critical mission.

Program Direction
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	13,562	–	13,665	103
Travel	650	–	400	-250
Support Services	2,864	–	2,364	-500
Other Related Expenses	4,004	–	5,032	1,028
Total, Washington Headquarters	**21,080**	**–**	**21,461**	**381**
National Energy Technology Laboratory				
Salaries and Benefits	5,720	–	4,339	-1,381
Travel	300	–	300	0
Support Services	550	–	550	0
Other Related Expenses	350	–	350	0
Total, National Energy Technology Laboratory	**6,920**	**–**	**5,539**	**-1,381**
Total Program Direction				
Salaries and Benefits	19,282	–	18,004	-1,278
Travel	950	–	700	-250
Support Services	3,414	–	2,914	-500
Other Related Expenses	4,354	–	5,382	1,028
Total, Program Direction	**28,000**	**27,947**	**27,000**	**-1,000**
Federal FTEs	**89**	**–**	**77**	**-12**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Additional FE FTEs at NETL supporting OE[b]	29	–	22	-7
Total OE-funded FTEs	118	–	99	-19
Support Services and Other Related Expenses				
Support Services				
Technical Support	1,384	–	1,129	-255
Management Support	2,030	–	1,785	-245
Total, Support Services	**3,414**	**–**	**2,914**	**-500**
Other Related Expenses				
Other Services	600	–	600	0
EITS Desktop Services	603	–	600	-3
WCF	3,151	–	4,182	1,031
Total, Other Related Expenses	**4,354**	**–**	**5,382**	**1,028**

[b] OE funds FTEs at FE's National Energy Technology Laboratory who are FE employees, but support OE activities. The FTEs are in FE's FTE totals and are not included in the OE FTE totals shown on the "Federal FTEs" line.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Program Direction $28,000,000	**$27,000,000**	**-$1,000,000**
Salaries and Benefits $19,282,000 • Salaries and Benefits support 118 FTEs at HQ and NETL that provide executive management, programmatic oversight, and analysis for the effective implementation of the OE program.	**$18,004,000** • Salaries and Benefits support 99 FTEs at HQ and NETL that provide executive management, programmatic oversight, and analysis for the effective implementation of the OE program.	**-$1,278,000** • Salaries and Benefits include the 2017 pay increase and assume a 1.9% pay increase in 2018. The increases are offset by a reduction of 19 FTEs in 2018.
Travel $950,000 • Travel includes transportation, subsistence, and incidental expenses that allow OE to effectively facilitate its mission.	**$700,000** • Travel includes transportation, subsistence, and incidental expenses that allow OE to effectively facilitate its mission.	**-$250,000** • Travel Reduction due to the reduction in number of FTEs and reduction in overall mission scope.
Support Services $3,414,000 • Support Services includes contractor support directed by the federal staff to perform administrative tasks and provide analysis to management. Support Services may include support for post-doctoral fellows and Intergovernmental Personnel Act (IPA) assignments.	**$2,914,000** • Support Services includes contractor support directed by the federal staff to perform administrative tasks and provide analysis to management. Support Services may include support for post-doctoral fellows and Intergovernmental Personnel Act (IPA) assignments.	**-$500,000** • Support Services decrease due to reduction in Contractual Service required to perform Mission.
Other Related Expenses $4,354,000 • Other Related Expenses includes EITS desktop services and WCF expense, such as rent, supplies, copying, graphics, mail, printing, and telephones. It also includes equipment upgrades and replacements, commercial credit card purchases using the simplified acquisition procedures to the maximum extent possible, and other needs.	**$5,382,000** • Other Related Expenses includes EITS desktop services and WCF expense, such as rent, supplies, copying, graphics, mail, printing, and telephones. It also includes equipment upgrades and replacements, commercial credit card purchases using the simplified acquisition procedures to the maximum extent possible, and other needs	**+$1,028,000** • Other Related Expenses increase due to increases in the WCF expenses.

Electricity Delivery and Energy Reliability
Research and Development ($K)[a]

	FY 2016 Enacted	FY 2017 Annualized CR[b]	FY 2018 Request	FY 2018 vs FY 2016
Basic	5,844	–	8,290	+2,446
Applied	79,235	–	59,516	-19,719
Development	56,401	–	17,355	-39,046
Total, R&D	141,480	–	85,161	-56,319

[a] R&D reporting includes a proportional share of program direction funding in addition to direct R&D funding. Program direction funding was not included in the R&D reporting in the FY 2016 and prior year budget justifications.
[b] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Electricity Delivery and Energy Reliability
Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR) ($K)

	FY 2016 Transferred	FY 2018 Request Projected Transfer	FY 2018 vs FY 2016 Projected
Transmission Reliability			
SBIR	1,020	416	-604
STTR	153	59	-94
Resilient Distribution Systems			
SBIR	1,050	320	-730
STTR	158	45	-113
Cybersecurity for Energy Delivery Systems			
SBIR	1,050	960	-90
STTR	158	135	-23
Energy Storage			
SBIR	615	256	-359
STTR	92	36	-56
Transformer Resilience and Advanced Components			
SBIR	150	160	10
STTR	22	23	1
Total, SBIR	**3,885**	**2,112**	**-1,773**
Total, STTR	**583**	**298**	**-285**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Ames Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	120	120	0
Total, Ames Laboratory	**120**	**120**	**0**
Argonne National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	2,989	2,983	1,050
Resilient Distribution Systems	3,341	3,335	1,755
Cybersecurity for Energy Delivery Systems	808	806	0
Energy Storage	143	143	0
Transformer Resilience and Advanced Components	35	35	50
Transmission Permitting and Technical Assistance	305	304	277
Total, Electricity Delivery and Energy Reliability	**7,621**	**7,606**	**3,132**
Total, Argonne National Laboratory	**7,621**	**7,606**	**3,132**
Brookhaven National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	346	345	300
Resilient Distribution Systems	160	160	85
Cybersecurity for Energy Delivery Systems	111	111	0
Energy Storage	4	4	0
Transmission Permitting and Technical Assistance	7	7	0
Total, Electricity Delivery and Energy Reliability	**628**	**627**	**385**
Total, Brookhaven National Laboratory	**628**	**627**	**385**
Chicago Operations Office			
Electricity Delivery and Energy Reliability			
Energy Storage	60	60	0
Total, Chicago Operations Office	**60**	**60**	**0**
Idaho National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	396	395	0
Resilient Distribution Systems	13	13	0
Cybersecurity for Energy Delivery Systems	5,263	5,253	0
Energy Storage	23	23	0
Transformer Resilience and Advanced Components	514	513	150
Infrastructure Security & Energy Restoration	500	499	500
Total, Electricity Delivery and Energy Reliability	**6,709**	**6,696**	**650**
Total, Idaho National Laboratory	**6,709**	**6,696**	**650**

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Idaho Operations Office			
Electricity Delivery and Energy Reliability			
Transmission Permitting and Technical Assistance	75	75	46
Total, Idaho Operations Office	**75**	**75**	**46**
Lawrence Berkeley National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	3,917	3,910	250
Resilient Distribution Systems	2,255	2,251	250
Cybersecurity for Energy Delivery Systems	521	520	0
Energy Storage	34	34	0
Transformer Resilience and Advanced Components	29	29	50
Transmission Permitting and Technical Assistance	3,001	2,995	1,606
Total, Electricity Delivery and Energy Reliability	**9,757**	**9,739**	**2,156**
Total, Lawrence Berkeley National Laboratory	**9,757**	**9,739**	**2,156**
Lawrence Livermore National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	936	934	800
Resilient Distribution Systems	189	189	0
Cybersecurity for Energy Delivery Systems	539	538	0
Energy Storage	56	56	0
Transformer Resilience and Advanced Components	388	387	0
Transmission Permitting and Technical Assistance	56	56	0
Total, Electricity Delivery and Energy Reliability	**2,164**	**2,160**	**800**
Total, Lawrence Livermore National Laboratory	**2,164**	**2,160**	**800**
Los Alamos National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	1,385	1,382	1,360
Resilient Distribution Systems	429	428	600
Cybersecurity for Energy Delivery Systems	164	164	0
Transmission Permitting and Technical Assistance	15	15	0
Total, Electricity Delivery and Energy Reliability	**1,993**	**1,989**	**1,960**
Total, Los Alamos National Laboratory	**1,993**	**1,989**	**1,960**

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
National Energy Technology Lab			
Electricity Delivery and Energy Reliability			
Transmission Reliability	4,071	4,063	700
Resilient Distribution Systems	852	850	0
Cybersecurity for Energy Delivery Systems	49,639	49,545	36,500
Transformer Resilience and Advanced Components	34	34	500
Transmission Permitting and Technical Assistance	1,818	1,815	1,200
Infrastructure Security & Energy Restoration	715	714	0
Program Direction	6,920	6,907	6,200
Total, Electricity Delivery and Energy Reliability	**64,049**	**63,928**	**45,100**
Total, National Energy Technology Lab	**64,049**	**63,928**	**45,100**
National Renewable Energy Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	1,481	1,478	0
Resilient Distribution Systems	4,656	4,647	250
Cybersecurity for Energy Delivery Systems	583	582	0
Energy Storage	239	239	0
Transformer Resilience and Advanced Components	74	74	0
Transmission Permitting and Technical Assistance	636	635	443
Program Direction	307	306	0
Total, Electricity Delivery and Energy Reliability	**7,976**	**7,961**	**693**
Total, National Renewable Energy Laboratory	**7,976**	**7,961**	**693**
Oak Ridge Institute for Science & Education			
Electricity Delivery and Energy Reliability			
Transmission Reliability	15	15	0
Infrastructure Security & Energy Restoration	39	39	0
Program Direction	20	20	0
Total, Electricity Delivery and Energy Reliability	**74**	**74**	**0**
Total, Oak Ridge Institute for Science & Education	**74**	**74**	**0**
Oak Ridge National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	2,843	2,838	3,700
Resilient Distribution Systems	3,618	3,611	900
Cybersecurity for Energy Delivery Systems	207	207	0
Energy Storage	2,817	2,812	600
Transformer Resilience and Advanced Components	1,425	1,422	1,500
Transmission Permitting and Technical Assistance	236	236	143
Infrastructure Security & Energy Restoration	2,243	2,239	2,500
Total, Electricity Delivery and Energy Reliability	**13,389**	**13,365**	**9,343**
Total, Oak Ridge National Laboratory	**13,389**	**13,365**	**9,343**

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Pacific Northwest National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	7,148	7,134	3,265
Resilient Distribution Systems	11,361	11,339	5,160
Cybersecurity for Energy Delivery Systems	1,236	1,234	0
Energy Storage	6,416	6,404	3,400
Transformer Resilience and Advanced Components	614	613	0
Transmission Permitting and Technical Assistance	308	307	323
Infrastructure Security & Energy Restoration	100	100	500
Program Direction	250	250	0
Total, Electricity Delivery and Energy Reliability	**27,433**	**27,381**	**12,648**
Total, Pacific Northwest National Laboratory	**27,433**	**27,381**	**12,648**
Richland Operations Office			
Electricity Delivery and Energy Reliability			
Infrastructure Security & Energy Restoration	1,151	1,149	850
Total, Richland Operations Office	**1,151**	**1,149**	**850**
Sandia National Laboratories			
Electricity Delivery and Energy Reliability			
Transmission Reliability	1,101	1,099	1,100
Resilient Distribution Systems	1,127	1,125	500
Cybersecurity for Energy Delivery Systems	1,191	1,189	0
Energy Storage	9,129	9,112	4,000
Transformer Resilience and Advanced Components	69	69	500
Transmission Permitting and Technical Assistance	381	380	185
Infrastructure Security & Energy Restoration	300	299	0
Total, Electricity Delivery and Energy Reliability	**13,298**	**13,273**	**6,285**
Total, Sandia National Laboratories	**13,298**	**13,273**	**6,285**
Savannah River Operations Office			
Electricity Delivery and Energy Reliability			
Resilient Distribution Systems	125	125	0
Cybersecurity for Energy Delivery Systems	106	106	0
Energy Storage	115	115	0
Transformer Resilience and Advanced Components	125	125	250
Total, Electricity Delivery and Energy Reliability	**471**	**471**	**250**
Total, Savannah River Operations Office	**471**	**471**	**250**
SLAC National Accelerator Laboratory			
Electricity Delivery and Energy Reliability			
Cybersecurity for Energy Delivery Systems	47	47	0
Total, SLAC National Accelerator Laboratory	**47**	**47**	**0**

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Electricity Delivery and Energy Reliability			
Transmission Reliability	12,252	12,230	475
Resilient Distribution Systems	6,874	6,860	500
Cybersecurity for Energy Delivery Systems	1,585	1,580	5,500
Energy Storage	1,464	1,459	0
Transformer Resilience and Advanced Components	1,693	1,689	2,000
Transmission Permitting and Technical Assistance	662	661	1,777
Infrastructure Security & Energy Restoration	3,952	3,944	4,650
Program Direction	20,503	20,464	20,800
Total, Electricity Delivery and Energy Reliability	**48,985**	**48,887**	**35,702**
Total, Washington Headquarters	**48,985**	**48,887**	**35,702**
Total, Electricity Delivery and Energy Reliability	**206,000**	**205,608**	**120,000**

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Ames Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	120	120	0
Total, Ames Laboratory	**120**	**120**	**0**
Argonne National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	2,989	2,983	1,050
Resilient Distribution Systems	3,341	3,335	1,755
Cybersecurity for Energy Delivery Systems	808	806	0
Energy Storage	143	143	0
Transformer Resilience and Advanced Components	35	35	50
Transmission Permitting and Technical Assistance	305	304	277
Total, Electricity Delivery and Energy Reliability	**7,621**	**7,606**	**3,132**
Total, Argonne National Laboratory	**7,621**	**7,606**	**3,132**
Brookhaven National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	346	345	300
Resilient Distribution Systems	160	160	85
Cybersecurity for Energy Delivery Systems	111	111	0
Energy Storage	4	4	0
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Transmission Reliability	396	395	0
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Electricity Delivery and Energy Reliability			
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Electricity Delivery and Energy Reliability			
Transmission Reliability	2,843	2,838	3,700
Resilient Distribution Systems	3,618	3,611	900
Cybersecurity for Energy Delivery Systems	207	207	0
Energy Storage	2,817	2,812	600
Transformer Resilience and Advanced Components	1,425	1,422	1,500
Transmission Permitting and Technical Assistance	236	236	143
Infrastructure Security & Energy Restoration	2,243	2,239	2,500
Total, Electricity Delivery and Energy Reliability	**13,389**	**13,365**	**9,343**
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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Pacific Northwest National Laboratory			
Electricity Delivery and Energy Reliability			
Transmission Reliability	7,148	7,134	3,265
Resilient Distribution Systems	11,361	11,339	5,160
Cybersecurity for Energy Delivery Systems	1,236	1,234	0
Energy Storage	6,416	6,404	3,400
Transformer Resilience and Advanced Components	614	613	0
Transmission Permitting and Technical Assistance	308	307	323
Infrastructure Security & Energy Restoration	100	100	500
Program Direction	250	250	0
Total, Electricity Delivery and Energy Reliability	**27,433**	**27,381**	**12,648**
Total, Pacific Northwest National Laboratory	**27,433**	**27,381**	**12,648**
Richland Operations Office			
Electricity Delivery and Energy Reliability			
Infrastructure Security & Energy Restoration	1,151	1,149	850
Total, Richland Operations Office	**1,151**	**1,149**	**850**
Sandia National Laboratories			
Electricity Delivery and Energy Reliability			
Transmission Reliability	1,101	1,099	1,100
Resilient Distribution Systems	1,127	1,125	500
Cybersecurity for Energy Delivery Systems	1,191	1,189	0
Energy Storage	9,129	9,112	4,000
Transformer Resilience and Advanced Components	69	69	500
Transmission Permitting and Technical Assistance	381	380	185
Infrastructure Security & Energy Restoration	300	299	0
Total, Electricity Delivery and Energy Reliability	**13,298**	**13,273**	**6,285**
Total, Sandia National Laboratories	**13,298**	**13,273**	**6,285**
Savannah River Operations Office			
Electricity Delivery and Energy Reliability			
Resilient Distribution Systems	125	125	0
Cybersecurity for Energy Delivery Systems	106	106	0
Energy Storage	115	115	0
Transformer Resilience and Advanced Components	125	125	250
Total, Electricity Delivery and Energy Reliability	**471**	**471**	**250**
Total, Savannah River Operations Office	**471**	**471**	**250**
SLAC National Accelerator Laboratory			
Electricity Delivery and Energy Reliability			
Cybersecurity for Energy Delivery Systems	47	47	0
Total, SLAC National Accelerator Laboratory	**47**	**47**	**0**

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FY 2018 Congressional Budget

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Electricity Delivery and Energy Reliability	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Electricity Delivery and Energy Reliability			
Transmission Reliability	12,252	12,230	475
Resilient Distribution Systems	6,874	6,860	500
Cybersecurity for Energy Delivery Systems	1,585	1,580	5,500
Energy Storage	1,464	1,459	0
Transformer Resilience and Advanced Components	1,693	1,689	2,000
Transmission Permitting and Technical Assistance	662	661	1,777
Infrastructure Security & Energy Restoration	3,952	3,944	4,650
Program Direction	20,503	20,464	20,800
Total, Electricity Delivery and Energy Reliability	**48,985**	**48,887**	**35,702**
Total, Washington Headquarters	**48,985**	**48,887**	**35,702**
Total, Electricity Delivery and Energy Reliability	**206,000**	**205,608**	**120,000**

Fossil Energy Research and Development

Fossil Energy Research and Development

Fossil Energy Research and Development

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Fossil Energy Research and Development
(INCLUDING USE OF PRIOR YEAR BALANCES)
Proposed Appropriation Language

For Department of Energy expenses necessary in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition of interest, including defeasible and equitable interests in any real property or any facility or for plant or facility acquisition or expansion, and for conducting inquiries, technological investigations and research concerning the extraction, processing, use, and disposal of mineral substances without objectionable social and environmental costs (30 U.S.C. 3, 1602, and 1603), $280,000,000, to remain available until expended: Provided, That of such amount $58,478,000 shall be available until September 30, 2019, for program direction: Provided further, That $55,178,000 from funds appropriated under this heading in prior Acts shall be deobligated, if necessary, and shall be made available for activities under this heading without regard to the provisions in the Act in which the funds were originally appropriated: Provided further, That no amounts may be repurposed pursuant to this paragraph from amounts that were designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

The FY 2018 Budget Request proposes to use $55,178,000 of prior year balances from funds appropriated in prior Acts under the headings ''Fossil Energy Research and Development''.

Public Law Authorizations
CCS and Power Systems:
- Public Law 95-91.

Natural Gas Technologies:
- Public Law 91-91, “Department of Energy Organization Act”, 1977
- Public Law 109-58, “Energy Policy Act of 2005”.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies:
- Public Law 95-91, “Department of Energy Organization Act”, 1977
- Public Law 109-58, “Energy Policy Act of 2005”.

NETL Infrastructure and Operations/Plant and Capital Equipment (formerly Plant and Capital Equipment)
- Public Law 95-91, “Department of Energy Organization Act”, 1977
- Public Law 108-153, “21st Century Nanotechnology Research and Development Act 2003”
- Public Law 109-58, “Energy Policy Act of 2005”.
- Public Law 110-69, “America COMPETES Act of 2007”
- Public Law 110-140, “Energy Independence and Security Act 2007”
- Public Law 111-358, “America COMPETES Act of 2010”

NETL Infrastructure and Operations /Environmental Restoration (formerly Environmental Restoration)
- Public Law 95-91, ”Department of Energy Organization Act”, 1977
- Public Law 108-153, “21st Century Nanotechnology Research and Development Act 2003”
- Public Law 109-58, “Energy Policy Act of 2005”.
- Public Law 110-69, “America COMPETES Act of 2007”
- Public Law 111-358, “America COMPETES Act of 2010”

Special Recruitment Programs

- Public Law 95-91, ”Department of Energy Organization Act”, 1977
- Public Law 108-153, “21st Century Nanotechnology Research and Development Act 2003”
- Public Law 109-58, “Energy Policy Act of 2005”.
- Public Law 110-69, “America COMPETES Act of 2007”
- Public Law 111-358, “America COMPETES Act of 2010”

Fossil Energy Research and Development (FER&D) ($K)

FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request[2]
$632,000	$630,799	$280,000

Overview

The Fossil Energy Research and Development (FER&D) program advances transformative science and innovative technologies that enable the reliable, efficient, affordable, and environmentally sound use of fossil fuels. Fossil energy sources constitute over 80% of the country's total energy use,[3] and are important to the nation's security, economic prosperity, and growth.

The FY 2018 Budget Request for the Department of Energy is guided by the reassertion of the proper federal role as a supporter of early-stage R&D—in which the private sector has less incentive to invest—and an increased reliance on the private sector to fund later-stage R&D including demonstration and commercial deployment. The FER&D FY 2018 Budget Request is also informed by guiding principles of energy security, strong domestic energy production, and advancing clean coal technologies. This Request is committed to maintaining and supporting highly effective operations at the federal National Laboratories, particularly FER&D's National Energy Technology Laboratory, and ensuring funding for a robust cybersecurity program as it applies to the fossil energy sector, resources and assets.

As such, the FER&D budget focuses on cutting edge, early-stage research and development that will prepare innovative new technologies for the private sector to further develop, scale-up, and deploy. As a result, the FER&D FY 2018 budget provides a limited level of funding for cost-shared financial assistance projects with industry. The majority of funding, however, is aligned with lab- and university-led early-stage research.

FER&D encompasses the Federal research and development effort on advanced Carbon Capture Utilization and Storage (CCUS) technologies, advanced fossil energy systems, and crosscutting fossil energy research. FER&D also conducts research related to the prudent and sustainable development of domestic oil and gas resources, with a focus on natural gas technologies and unconventional resources. Finally, FER&D includes funding for the research, operations, and infrastructure of the National Energy Technology Laboratory.

Highlights and Major Changes in the 2018 Budget Request

The FY 2018 FER&D Budget Request re-focuses the portfolio towards impactful early-stage research and development that supports domestic energy production and energy security and independence. After initial investment by FER&D, these technologies will then be poised for further advancement, development, and/or scale-up by industry. These investments will drive innovation to support economic growth and provide affordable, reliable, and environmentally sustainable energy. The Fossil Energy Program will also initiate steps to evaluate how to pragmatically reduce staffing levels in the FER&D organization, including staff both at HQ and at the National Energy Technology Laboratory (NETL). The budget also proposes consolidating NETL's infrastructure and footprint to reflect reductions in Fossil R&D Program funding and to enhance operational efficiency.

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[2] This reflects the total new Budget Authority funding; the total request is $335,178 with $55,178 of use of prior year balances to reach the requested amount of $280,000.

[3] https://www.llnl.gov/news/americans-used-more-clean-energy-2016; percentage calculated from data shown in figure.

Carbon Capture and Storage and Power Systems ($114.8 million)

- Carbon Capture: The Request provides $16 million to focus on lab research and bench-scale development of transformational carbon capture technologies such as advanced membranes and metal organic frameworks (MOF) that can significantly reduce the cost of capture from fossil fuel-fired power plants and industrial facilities. Transformational capture systems are considered to be a set of disruptive technologies that can significantly reduce the cost of capture, targeting a cost of electricity at least 30% less than state-of-the-art (~$30/tonne). These transformational technologies will be able to adapt to the operational demands of advanced power systems and adjust to the increasing need for fossil fuel power plants to be load-following electricity generators. The Subprogram supports capture from sources in addition to coal, mindful that early-stage R&D successes can be accretive across a number of sectors and are not limited by commodity. In addition to post-combustion capture, the subprogram also supports pre-combustion bench- and lab-scale R&D that focuses on CO2 separation from syngas. While the Carbon Capture subprogram has previously focused on 1st generation separation technology demonstrations and 2nd generation pilots, these large, more mature efforts are no longer central to the R&D portfolio. In FY 2018, the program discontinues funding for large-scale demonstrations, pilot projects and similar projects addressing technology scale-up as industry is capable of advancing these technologies to commercial deployment.

- Carbon Storage: The Request provides $15 million to focus on early-stage research focusing on carbon utilization and adaptive reservoir management of carbon storage systems. The Storage infrastructure activity will focus on early-stage research efforts to understand the potential for offshore oil, gas, and saline bearing formations to be serve as future storage reservoirs. The Advanced Storage R&D activity will focus on developing and validating storage monitoring, simulation and risk assessment technologies, and novel wellbore technologies to detect and mitigate wellbore issues from both short- and long-term exposure to CO2. Carbon Use and Reuse will focus on technologies, other than enhanced hydrocarbon recovery, by developing beneficial uses for captured CO2 and other waste hydrocarbon streams. The Sub-Disciplinary Storage R&D activity will focus on assessment and validation of system models and their integration for quantifying risks through the National Risk Assessment Partnership and the collection and distribution of research data through the NETL EDX database.

- Advanced Energy Systems (AES): The Request provides $46 million to explore new technology applications (i.e., pulse combustion, flameless combustion, toping cycles) at both new and existing plants, with full development, demonstration, and implementation of these technologies to be funded solely by industry. This reflects the fact that industry—including electric utilities, manufacturers, and suppliers—does not have the in-house facilities and capability to test these early-stage technologies. Funding will also support early-stage lab research on advanced turbines that can withstand new stresses placed on the sector by the need for demand-response performance, and on materials for solid oxide fuel cells and advanced modular gasification systems. Two new activities will focus on early-stage research, development and analysis related to 1) the beneficiation of coal for U.S. producers by developing a R&D database of coal combustion properties and development of early-stage technologies that improve the quality of U.S. coals (i.e., waterless sulfur removal) and 2) early-stage R&D to generate a new knowledge base regarding fuel interactions with plant components such as pulverizers, economizers, and air heaters that could be further developed and applied by industry to improve plant reliability and efficiency.

- Cross-cutting Research: The request of $37.8 million is for early-stage technology R&D in advanced materials, computational science, and advanced analytical tools, with particular attention to high pressure/high temperature applications. It includes early-stage R&D on low-cost and reliable multi-sensing sensors capable of detecting temperature, gas species and pressure that—with additional development and scale-up by industry—could ultimately be capable of providing real-time measurements critical to the operation, optimization, reliability and efficiency of the next-generation of power systems. This subprogram also includes modest funding for universities and international engagements that align with early stage R&D. Work in Crosscutting Materials R&D will focus on efforts to use computational tools to discover and design novel materials for fossil fuel applications. The Water Management activity will continue working on early-stage innovative cooling technologies that offer potential increases in overall plant efficiencies through the use of nano-hydrophobic materials and advanced design concepts. Finally, the University R&D sub-activity will merge the University Coal Research and University Turbines Advanced Research sub-activity to make more effective use of resources.

Natural Gas Technologies ($5.5 million):

- The Gas Hydrates subprogram, through DOE National Laboratory and university-led efforts, will continue early-stage R&D to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates and the resulting resource, hazard, and environmental implications.
- The Natural Gas Infrastructure Research and Development subprogram will focus on early-stage, foundational research on materials, coatings and sensors to improve the operational efficiency and safety of natural gas supply and delivery infrastructure, which is needed to support the increased reliance on gas as both a domestic energy source and a vital export market. The federal government will continue to have a significant role in addressing areas of public interest and concern, to include pipeline safety and reliability, resource stewardship, and infrastructure security.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies ($15 million):

- The Request will continue early-stage R&D in the current field laboratories in the Marcellus and Utica basins in the eastern United States. The Request includes funding to establish a new field site project in an emerging play that has strong resource potential, thereby supporting U.S. energy security. R&D at these field sites addresses fluid flow and physio-chemical interactions in unconventional reservoirs, with a focus on improving the technical understanding of fracturing dynamics that can contribute to game-changing increases in recovery factor from the typical single-digit range. Success would also decrease the footprint of shale development and lower water use.

- The Program will also analyze data to gain knowledge about the detailed causal factors for induced seismicity, an operational risk that pertains to both large volume water and CO2 injection into critically stressed subsurface environments. The program will address areas of public interest to include reducing the impacts from development and improving the amount of resource recovered per well by conducting research to understand the precise factors that will allow improved injection practices including real-time, dynamic management and manipulation of the subsurface environment, and reduced risk to critical national infrastructure.

National Energy Technology Laboratory ($167.0 million for NETL; and an additional $32.7 million for HQ Program Direction):

- The Office of Fossil Energy is committed to supporting the National Energy Technology Laboratory's (NETL) capabilities and competitiveness. NETL, whose primary funding source is the Office of Fossil Energy, is the only federally owned and operated laboratory in the DOE National Laboratory system. In FY 2018, as part of the Department's effort to operate more efficiently, this request includes a phased approach to consolidation of NETL's Albany research operations into NETL's Eastern sites and commissioning of a Mission Alignment study beginning in Q3 FY 2017 that includes: (1) Evaluation of alternatives for locating NETL's Alloy Metallurgy Capabilities; (2) Study of Environmental Impacts Responsibility & Remediation at the Albany site; and (3) Analysis of Alternatives for Configuration of NETL's Eastern Sites. The Budget Request includes funds for voluntary early retirement and voluntary separation incentives as well as funding to support relocation of necessary staff and laboratory equipment. Finally, funding is provided for site remediation activities.

- NETL Research and Development: The Request of $78.1 million supports all NETL science and technology development functions, including in-house research, technical program management, and strategic scientific planning and partnerships. Specifically, funding supports the NETL staff of scientists, engineers, and technical project managers who conduct both in-house and extramural research activities for FER&D programs, including salaries and benefits, travel, personal protective equipment and other employee costs. This subprogram also funds contractor costs targeted toward performing R&D at NETL. FY 2018 will focus $10 million on R&D on the Feasibility of Recovering Rare Earth Elements, an effort established by Congress to assess and analyze the feasibility of economically recovering rare earth elements from coal and coal byproduct streams such as fly ash, coal refuse, and aqueous effluent. In FY 2018, that work will advance transformational separation R&D, support continued geological and characterization activities, and fund associated in-house R&D.

- NETL Infrastructure and Operations: The Request of $63.1 million supports the upkeep of a lab footprint currently valued at nearly $600 million in three geographic locations: Morgantown, WV; Pittsburgh, PA; and Albany, OR. These

sites include more than 240 acres of land, including 112 buildings with over 1,000,000 square feet of space, supporting more than 1,200 Federal and contractor employees. NETL also leases office space and maintains a small presence in strategic energy locations in Texas and Alaska. While the Request proposes initiating steps in FY 2018 to integrate the Albany site with NETL's eastern campuses, because of the time frame and costs involved in planning and executing the consolidation, infrastructure costs are not expected to decline until FY 2019.

- NETL and HQ Program Direction: The request of $58.5 million ($32.7 million for headquarters and $25.8 million for NETL) provides for the FER&D organization's federal workforce and contractor support in the Washington, D.C. area including salaries and benefits, support service contracts, travel, training, the working capital fund, and other employee costs. These staff are responsible for the oversight and administration of the FER&D Programs and Natural Gas regulatory activities. Also included in this line is funding for NETL federal technical staff and contractor support that provide Acquisition, Finance and Legal functions. Funding to advance FER&D workforce reshaping is also included in this funding line.

Cybersecurity: DOE is engaged in two categories of cyber-related activities: protecting the DOE enterprise from a range of cyber threats that can adversely impact mission capabilities and improving cybersecurity in the electric power subsector and the oil and natural gas subsector. The Cybersecurity Crosscut supports central coordination of the strategic and operational aspects of cybersecurity and facilitates cooperative efforts such as the Joint Cybersecurity Coordination Center (JC3) for incident response and the implementation of Department-wide Identity, Credentials, and Access Management (ICAM).

FY 2018 Crosscuts ($K)

	Cybersecurity
NETL Infrastructure and Operations	3,183
Total, Crosscuts	**3,183**

Fossil Energy Research and Development

Funding by Congressional Control ($K)

(Non-Comparable)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Coal				
CCS and Power Systems				
Carbon Capture	101,000	100,809	16,000	-85,.000
Carbon Storage	106,000	105,800	15,000	-91,000
Advanced Energy Systems	105,000	104,800	46,000	-59,000
Crosscutting Research	50,000	49,905	37,800	-12,200
Supercritical Transformational Electric Power (STEP)	15,000	14,971	0	-15,000
NETL Coal Research and Development	53,000	52,899	0	-53,000
Total, CCS and Power Systems	**430,000**	**429,184**	**114,800**	**-315,200**
Total, Coal	**430,000**	**429,184**	**114,800**	**-315,200**
Natural Gas Technologies	**43,000**	**42,918**	**5,500**	**-37,500**
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies	**20,321**	**20,282**	**15,000**	**-5,321**
Plant & Capital Equipment	**15,782**	**15,752**	**0**	**-15,782**
FE Environmental Restoration	**7,995**	**7,980**	**0**	**-7,995**
Special Recruitment Programs	**700**	**699**	**200**	**-500**
Program Direction	**114,202**	**113,984**	**58,478**	**-55,724**
NETL Research and Development	**0**	**0**	**78,100**	**+78,100**
NETL Infrastructure and Operations	**0**	**0**	**63,100**	**+63,100**
Subtotal, Fossil Energy Research & Development	**632,000**	**630,799**	**335,178**	**-296,822**
Use of Prior Year Balances	0	0	-55,178	NA
Total, Fossil Energy Research & Development	**632,000**	**630,799**	**280,000**	**-352,000**
Federal FTEs[2]	**638**	**638**	**615**	**-23**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[2] Includes Federal FTEs in the following Programs: NETL Coal R&D, NETL Research and Operations, and Program Direction. FTEs are discussed in further detail in NETL Infrastructure and Operations.

Fossil Energy Research and Development

Funding by Congressional Control ($K)

(Comparable)

	FY 2016 Enacted	FY 2017 Annualized CR[3]	FY 2018 Request	FY 2018 vs FY 2016
CCS and Power Systems				
Carbon Capture	101,000	100,809	16,000	-85,000
Carbon Storage	106,000	105,800	15,000	-91,000
Advanced Energy Systems	105,000	104,800	46,000	-59,000
Crosscutting Research and Analysis	50,000	49,905	37,800	-12,200
Supercritical Transformational Electric Power (STEP)	15,000	14,971	0	-15,000
Total, CCS and Advanced Power Systems	**377,000**	**376,285**	**114,800**	**-262,200**
Natural Gas Technologies	**43,000**	**42,918**	**5,500**	**-37,500**
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies	**20,321**	**20,282**	**15,000**	**-5,321**
Special Recruitment Program	**700**	**699**	**200**	**-500**
NETL Research and Development	**73,713**	**73,573**	**78,100**	**+4,387**
NETL Infrastructure and Operations	**64,348**	**64,225**	**63,100**	**-1,248**
Program Direction	**52,918**	**52,817**	**58,478**	**+5,560**
Subtotal, Fossil Energy Research & Development	**632,000**	**630,799**	**335,178**	**-296,822**
Use of Prior Year Balances	0	0	-55,178	NA
Rescission of Prior Year Balances	0	0	0	0
Total, Fossil Energy Research & Development	**632,000**	**630,799**	**280,000**	**-352,000**
Federal FTEs[4]	**638**	**638**	**615**	**-23**

SBIR/STTR[5]:

- FY 2016 Transferred: SBIR $12,269; STTR: $1,839
- FY 2017 Annualized CR Projected: SBIR $13,061; STTR: $1,837
- FY 2018 Request: SBIR $3,912; STTR: $550

[3] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[4] Includes Federal FTEs in the following Programs: NETL Coal R&D, NETL Research and Operations, and Program Direction. FTEs are discussed in further detail in NETL Infrastructure and Operations.

[5] The SBIR amount goes up in the 2017 CR Annualized calculation because the percentage increased to 3.2% from the FY 2016 percentage of 3%. The STTR percentage stayed the same from FY 2016 to FY 2017 so that amount decreases.

Budget Structure Crosswalk FY2018 Request ($k)

Proposed 2018 Budget Structure

	NETL Infrastructure and Operations			Program Direction			NETL Research and Development		
FY 2016 Budget Structure	Site Operations & Maintenance	Plant & Capital Equipment	Environmental Restoration	Washington HQ	NETL	Import / Export	Research and Development	Feasibility of Recovering Rare Earth Elements	Total Budget Authority
Program Direction									
Salaries and Benefits	14,916	-	-	16,358	16,913	1,617	17,133	-	66,937
Travel	276	-	-	470	331	20	783	-	1,880
Support Services	13,008	-	-	650	2,637	250	2,199	-	18,744
Other Related Expenses	14,105	-	-	11,700	5,919	613	2,110	-	34,447
Total, Program Direction	42,305	-	-	29,178	25,800	2,500	22,225	-	122,008
NETL Coal Research & Development									
Salaries and Benefits	-	-	-	-	-	-	28,880	-	28,880
Travel	-	-	-	-	-	-	1,000	-	1,000
Other Services	-	-	-	-	-	-	7,995	-	7,995
Other Related Expenses	-	-	-	-	-	-	2,500	-	2,500
Recovery of Rare Earth Elements	-	-	-	-	-	-	-	10,000	10,000
Total, NETL Coal Research & Development	-	-	-	-	-	-	40,375	10,000	50,375
Plant & Capital Equipment									
General Plant Projects		13,800	-	-	-	-	-	-	13,800
Total, Plant & Capital Equipment	-	13,800	-	-	-	-	-	-	13,800
Fossil Energy Environmental Restoration									
CERCLA Remedial Actions	-	-	600	-	-	-	-	-	600
RCRA Remedial Actions	-	-	1,700	-	-	-	-	-	1,700
Other ESS&H Actions	4,695	-	-	1,000	-	-	-	-	5,695
Total, Fossil Energy Environmental Restoration	4,695	-	2,300	1,000	-	-	-	-	7,995
Super Computer									
SuperComputer	-	-	-	-	-	-	5,500	-	5,500
Total, Super Computer	-	-	-	-	-	-	5,500	-	5,500
Total	**47,000**	**13,800**	**2,300**	**30,178**	**25,800**	**2,500**	**68,100**	**10,000**	**199,678**

Budget Structure Crosswalk FY2018 Request ($k)

Proposed 2018 Budget Structure

Program Direction

FY 2016 Budget Structure	NETL Infrastructure and Operations			Program Direction			NETL Research and Development		Total Budget Authority
	Site Operations & Maintenance	Plant & Capital Equipment	Environmental Restoration	Washington HQ	NETL	Import / Export	Research and Development	Feasibility of Recovering Rare Earth Elements	
Program Direction									
Washington Headquarters									
Salaries and Benefits	-	-	-	16,358	-	-	-	-	16,358
Travel	-	-	-	470	-	-	-	-	470
Support Services	-	-	-	650	-	-	-	-	650
Other Related Expenses	-	-	-	11,700	-	-	-	-	11,700
Total, Washington Headquarters	-	-	-	29,178	-	-	-	-	29,178
National Energy Technology Laboratory									
Salaries and Benefits	14,916	-	-	-	16,913	-	17,133	-	48,962
Travel	276	-	-	-	331	-	783	-	1,390
Support Services	13,008	-	-	-	2,637	-	2,199	-	17,844
Other Related Expenses	14,105	-	-	-	5,919	-	2,110	-	22,134
Total, National Energy Technology Laboratory	42,305	-	-	-	25,800	-	22,225	-	90,330
Import/Export Authorization									
Salaries and Benefits	-	-	-	-	-	1,617	-	-	1,617
Travel	-	-	-	-	-	20	-	-	20
Support Services	-	-	-	-	-	250	-	-	250
Other Related Expenses	-	-	-	-	-	613	-	-	613
Total, Import/Export Authorization	-	-	-	-	-	2,500	-	-	2,500
Total Program Direction									
Salaries and Benefits	14,916	-	-	16,358	16,913	1,617	17,133	-	66,937
Travel	276	-	-	470	331	20	783	-	1,880
Support Services	13,008	-	-	650	2,637	250	2,199	-	18,744
Other Related Expenses	14,105	-	-	11,700	5,919	613	2,110	-	34,447
Total, Program Direction	42,305	-	-	29,178	25,800	2,500	22,225	-	122,008

Carbon Capture and Storage (CCS) and Power Systems

Overview

The Carbon Capture and Storage (CCS) and Power Systems Program supports secure, affordable, reduced emission fossil energy through early-stage research into technologies that can be further developed and scaled by industry to improve the cost competitiveness and performance of both new and existing plants. The current coal power generation fleet is faced with degrading performance as equipment ages. Government-supported early-stage research and development in areas such as materials, fluid dynamics, and a new generation of plant controls can lead to new knowledge that industry can use to develop technologies that can improve efficiency and performance in components that can replace these aging systems.

CCS and Advanced Power Systems will continue to support early-stage transformational R&D in coal gasification, advanced turbines, solid oxide fuel cells, CCS, advanced materials for high efficiency/low emissions energy systems, advanced sensors and modeling, and water management. This R&D could result in industry development of technologies that modernization of our fossil fuel infrastructure, providing economic benefits and a lower environmental footprint.

Highlights of the FY 2018 Budget Request

The CCS and Power Systems program will pursue the following major activities in FY 2018:

Carbon Capture

In FY 2018, the Carbon Capture subprogram will focus on early-stage R&D on transformational gas separation technologies that can significantly reduce the cost of carbon dioxide (CO_2) capture. Transformational capture systems are a set of innovative technologies that can significantly reduce the cost of capture, targeting a cost of electricity (COE) at least 30% less than state of the art (SOTA; ~$30/tonne). These transformational technologies will be able to adapt to the operational demands of advanced power systems and adjust to the increasing need for fossil fuel power plants to be load following electricity generators. These activities represent a shift away from 2nd generation capture technologies as such R&D is in the later stages of development, such as small- and large-scale pilot projects.

Carbon Storage

In FY 2018, Carbon Storage will focus on early-stage research across the portfolio of the subprogram. The Storage Infrastructure activity will focus on early-stage research to understand the potential for offshore oil, gas, and saline bearing formations to serve as future storage reservoirs. The Advanced Storage R&D activity will focus on developing and validating storage monitoring, simulation and risk assessment technologies, and novel wellbore technologies to detect and mitigate wellbore issues from both short and long term exposure of CO_2. The Carbon Use and Reuse activity will focus on beneficial use of CO_2 other than through enhanced hydrocarbon recovery. The Sub-Disciplinary Storage R&D activity will focus on assessment and validation of system models and their integration for quantifying risks through the National Risk Assessment Partnership and the collection and distribution of research data through the NETL EDX database.

Advanced Energy Systems (AES)

In FY 2018, the Advanced Energy Systems subprogram will shift its focus to early-stage R&D for turbines, fuel cells, and gasification. Turbines and fuel cells will focus primarily on new materials and components that can withstand variable operating conditions and strengthen these assets for grid reliability. Gasification systems will focus on the development of new materials and computational modeling that can be adapted by industry to design smaller, more reliable and efficient reactors. Two new activities are proposed: one that will focus on the R&D and process integration of advanced technologies to existing facilities that can be further advanced by industry to improve the plant's performance, reliability, and economic competitiveness. The second new activity will advance the beneficiation of coal for U.S. producers by developing a R&D database of coal combustion properties and properties on other plant process equipment, and development of early-stage technologies that improve the quality of the U.S. Coals (i.e. waterless sulfur removal).

Cross-cutting Research

In FY 2018, this subprogram will focus on innovative early-stage R&D for improving reliability, availability, efficiency, and environmental performance of advanced fossil based power systems. The program bridges basic and applied research by targeting concepts with the greatest potential for transformational breakthroughs. As such, the subprogram focuses on advancing early-stage research in areas such as materials, fluid dynamics, fuel preparation characteristics, and obtaining new knowledge regarding plant phenomena and operation that industry could incorporate into a new generation of plant controls. Research and funding will advance four activities and associated sub-activities: 1) Plant Optimization Technologies (e.g., sensors, controls and other novel concepts; crosscutting materials R&D; and water management), 2) Coal Utilization Science (e.g., the Focus Area on Computation Energy Science); 3) University Training and Research (e.g., University Coal Research; funding for Historically Black Colleges and Universities (HBCU), and the University Turbine Systems Research), and 4) International activities.

Supercritical Transformational Electric Power (STEP)

No funding is requested for this effort in FY 2018 due to the program's prioritized focus on early-stage research and development.

Fossil Energy Research and Development
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Coal				
CCS and Power Systems				
Carbon Capture				
Post-Combustion Capture Systems	89,000	---	13,000	-76,000
Pre-Combustion Capture Systems	12,000	---	3,000	-9,000
Total Carbon Capture	**101,000**	**100,809**	**16,000**	**-85,000**
Carbon Storage				
Storage Field Management	66,000	---	2,000	-64,000
Advanced Storage R&D	21,500	---	6,000	-15,500
Carbon Use and Reuse	10,000	---	3,000	-7,000
Risk and Integration Tools	8,500	---	4,000	-4,500
Total Carbon Storage	**106,000**	**105,800**	**15,000**	**-91,000**
Advanced Energy Systems				
Advanced Combustion Systems	30,000	---	0	-30,000
Gasification Systems	25,000	---	9,000	-16,000
Advanced Turbines	15,000	---	3,000	-12,000
Coal and Coal Biomass to Liquids	5,000	---	0	-5,000
Solid Oxide Fuel Cells	30,000	---	2,000	-28,000
Coal Beneficiation	0	---	2,000	+2,000
Transformative Power Generation	0	---	30,000	+30,000
Total Advanced Energy Systems	**105,000**	**104,800**	**46,000**	**-59,000**
Cross-cutting Research				
Plant Optimization Technologies				
Sensors, Controls and Other Novel Concepts	4,500	---	8,000	+3,500
Crosscutting Materials R&D	1,000	---	15,500	+14,500
Advanced Ultrasupercritical Materials R&D	9,000	---	0	-9,000
Water Management R&D	6,000	---	4,000	-2,000
Subtotal Plant Optimization Technologies	**20,500**	**20,461**	**27,500**	**+7,000**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Coal Utilization Science				
Computational System Dynamics	12,000	---	0	-12,000
Focus Area for Computational Energy Science	12,000	---	5,000	-7,000
Subtotal Coal Utilization Science	**24,000**	**23,954**	**5,000**	**-19,000**
Energy Analyses				
Environmental Activities	700	---	0	-700
Technical and Economic Analysis	700	---	0	-700
Subtotal Energy Analyses	**1,400**	**1,398**	**0**	**-1,400**
University Training and Research				
University Coal Research	2,000	---	4,000	+2,000
HBCU's, Education, and Training	1,000	---	1,000	0
Subtotal University Training and Research	**3,000**	**2,994**	**5,000**	**+2,000**
International Activities				
Coal Technology Export	500	---	0	-500
International Program Support	600	---	300	-300
Subtotal International Activities	**1,100**	**1,098**	**300**	**-800**
Total Cross-cutting Research	**50,000**	**49,905**	**37,800**	**-12,200**
Supercritical Transformational Electric Power	**15,000**	**14,971**	**0**	**-15,000**
TOTAL CCS AND POWER SYSTEMS	**377,000**	**376,285**	**114,800**	**-262,200**

SBIR/STTR:

- FY 2016 Transferred: SBIR $10,483; STTR: $1,571
- FY 2017 Annualized CR Projected: SBIR $11,159; STTR: $1,569
- FY 2018 Request: SBIR $3,295; STTR: $463

CCS and Power Systems
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
CCS and Power Systems	
Carbon Capture: The decrease in funding reflects the cessation of work related to 2nd generation post-combustion small- and large-scale pilot projects including those at the National Carbon Capture Center, as these efforts constitute later-stage research and development activities (-76,000). It also eliminates support for pre-combustion R&D at the pilot scale and efforts at the gasifier section of the National Carbon Capture Center as these activities are also later-stage R&D (-9,000). Remaining funding supports early-stage R&D on transformational capture technologies.	**-85,000**
Carbon Storage: The decrease in funding reflects a shift toward supporting early-stage research and away from field activities at the later-stage of research and development. The Storage Infrastructure activity decrease (-64,000) reflects that less funding is required to support field injection projects such as the Brine Extraction Storage Tests and Regional Carbon Sequestration Partnerships or large scale field characterization activities through CarbonSAFE which are either now complete (BEST and RCSP) or are being terminated (CarbonSAFE). The activity will focus on early-stage research to characterize the offshore potential for geologic storage. Advanced Storage R&D (-15,500), will now focus on early stage research to increase understanding of geomechanical effects/induced seismicity, and to better characterize geologic formations and understand and quantify CO_2 plume and pressure fronts within the reservoir. Work on later stage projects and R&D related to commercial scale implementation of carbon storage will be eliminated. The Carbon Use and Reuse funding decreases (-7,000) to focus on early-stage research related to catalytic conversion of carbon (CO_2 and methane) to higher value products; this also eliminates work on integration of biological process and mineralization conversion due to higher funding priorities in other Subprograms. Carbon Sequestration Science efforts to improve data infrastructure and management, related to the Energy Data Exchange (EDX) and National Risk Assessment Partnership (NRAP), are at a reduced level of effort (-4,500) due to the shift to early-stage research activities and away from field projects.	**-91,000**
Advanced Energy Systems: The decrease in funding for AES (-$59,000) reflects the cessation of work supporting the Supercritical Transformational Electric Power (STEP) effort as the subprogram shifts its focus to early-stage R&D activities for turbines, fuel cells, and gasification to address reliability and grid stability issues. Turbines (-12,000) and fuel cells (-28,000) will focus primarily on early-stage research on new materials and components that can withstand variable operating conditions and strengthen these assets for grid reliability. Gasification systems (-16,000) will focus on the development of new materials and computational modeling that industry could use to design smaller more reliable and efficient reactors to support remote and distributed power generation. The program will no longer support work on Advanced Combustion Systems activity (-30,000) as these systems are at later stages of research and can be adopted by industry for scale up. The subprogram will also no longer support Coal and Coal biomass to Liquids (-5,000) as this is also considered a more mature technology. A new activity in Transformative Power Generation (+30,000) will be initiated to focus on early-stage R&D on advanced technology, such as topping cycles, advanced high temperature/pressure materials, control systems with dynamic data analysis, that the industry could utilize in existing facilities to improve the plants' performance and efficiency. Finally, the program will start an activity on the beneficiation of coal (+2,000) for the United States producers.	**-59,000**

	FY 2018 vs FY 2016
	-12,200
Cross-cutting Research: In FY 2018, the decrease in funding (-$12,200) reflects re-scoping of the subprogram to focus on early-stage R&D. There are 5 activities under Crosscutting Research – *Plant Optimization and Other Novel Concepts, Coal Utilization Sciences, Energy Analyses, University Training and Research, and International Activities.* Under *Plant Optimization and other Novel Concepts* activity the Sensors and Control sub-activity (+3,500) will start a new effort on cybersecurity at power plants to harden these assets grid reliability and protect them from cyber-attacks. Crosscutting materials sub-activity (+14,500) will focus on extreme environment materials and specifically on materials to address impacts of cycling on existing coal fired units due to balancing of intermittent renewables. Advanced AUSC materials sub-activity (-9,000) will be terminated and issues with these materials will be addressed in the crosscutting materials sub-activity. Water management R&D sub activity (-2,000) will shift its focus to early-stage R&D and away from brine treatment processes that are at later-stages of R&D. The computational systems dynamics sub-activity (-12,000) will be eliminated and Focus area for computational Energy Science (-6,000) will reduce its level of effort to early-stage R&D and for multi-physics simulation of advanced energy systems. The Energy Analysis activity (-1,400) requests no funding in FY 2018. The University Training Research activity (1,000) will increase its support of university research supporting the applied R&D programs across the Coal office. The International (-800) activity requests no funding in FY 2018	
Supercritical Transformational Electric Power: Funding for STEP will conclude in FY 2017, and work on the pilot facility will be de-scoped to reflect no additional funding past FY 2017.	**-15,000**
Total, CCS and Power Systems	**-262,200**

CCS and Power Systems
Carbon Capture

Description

Despite changes in U.S. electricity generation in recent years, coal continues to play—and is forecasted to do so for the foreseeable future—a critical role in powering the Nation's electricity generation, providing part of the necessary base loading capacity.[1] Over the decades, power plants have made significant progress in reducing emissions of sulfur dioxide, nitrogen oxide (contributors to acid rain), particulate matter, and mercury—and advancements in carbon capture technologies can put the United States within closer reach of cost-competitive, low emission power generation. The Carbon Capture subprogram supports Administration interests including clean coal technologies, reviving America's coal industry, and domestic energy production.

Carbon capture from fossil fuel-fired generation is a technology solution for mitigating CO_2 emissions, and for concentrating CO_2 for high-value applications such as enhanced oil recovery. R&D that reduces the cost of carbon capture technologies can be applied to both the existing fleet of fossil fuel-fired power plants and new advanced generation power systems. Cost-competitive carbon capture technologies have the potential to support the coal and natural gas sector while advancing U.S. leadership in reduced-emission generation technology innovation. Many of the same CO_2 capture technologies can be adapted by industry and applied to other industrial sources and natural gas fired power plants to address unique challenges such as differences in pollution control systems, oxygen content, and CO_2 concentrations, which will demand modifications to both the materials and systems configurations.

The Carbon Capture subprogram is focused on early-stage research and development on post-combustion and pre-combustion CO_2 capture and novel compression technologies for new and existing fossil fuel-fired power plants.[2] Significant improvements are required to reduce parasitic energy load, and lower capital costs that can support the market potential for large quantities of CO_2 for economic utilization in enhanced oil recovery (EOR) operations and conversion to high-value products. Low cost CO_2 can strengthen U.S. energy security by enabling the production of up to 60 billion barrels of stranded oil that would otherwise be uneconomic with current recovery practices.[3] Next generation EOR technology could increase recoverable domestic oil to over 130 billion barrels if "next generation" EOR techniques and transformational low cost CO_2 are available. [4] There is not enough low cost CO_2 available from natural sources or natural gas processing facilities to facilitate this recovery to occur. Transformational, low cost CO_2 capture could be adopted by industry through research and development conducted in this subprogram and will enable this important domestic energy resource to be recovered by allowing economic recovery of CO_2 from power plants and other industrial sources.

In FY 2018, the Carbon Capture subprogram will focus on early-stage R&D on transformational gas separation technologies that can significantly reduce the cost of CO_2 capture. Transformational capture systems are a set of disruptive technologies that can significantly reduce the cost of capture, targeting a Cost of Electricity (COE) at least 30% less than state of the art (~$30/tonne). These transformational technologies will be designed to adapt to the operational demands of advanced power systems and adjust to the increasing need for fossil fuel power plants to at times be load-following/demand responsive electricity generators.

The subprogram has completed its efforts in 1st generation technology through successful demonstration projects. The proposed FY 2018 activities represent a purposeful shift away from later-stage R&D such as development of 2nd generation

[1] U.S. Energy Information Administration, *Annual Energy Outlook 2017 with projections to 2050*, p. 69, www.eia.gov/aeo

[2] Post-combustion CO_2 capture technology R&D is focused on capturing CO_2 from flue gas after the fuel has been consumed/combusted. Pre-combustion CO_2 capture is applicable to systems that capture and separate the CO_2 from mixed gas streams prior to combustion or utilization of the synthesis gas.

[3] ARI. (2011). Improving Domestic Energy Security and Lowering CO2 Emissions with "Next Generation" CO2-Enhanced Oil Recovery (CO2-EOR).

[4] ARI. (2011). Improving Domestic Energy Security and Lowering CO2 Emissions with "Next Generation" CO2-Enhanced Oil Recovery (CO2-EOR).

capture technologies through small and large pilot projects, as industry is expected to adapt, develop, and scale these technologies for cost-competitive deployment.

Post-Combustion Capture Systems

The Post-Combustion Capture Systems activity will focus on early-stage R&D on transformational technologies that separate CO_2 after the fuel is combusted, at both new and existing fossil fuel-fired power plants, and can achieve a 30% reduction in COE compared to a facility operating with current state of the art amine systems. Critical research and development milestones have been achieved since 2008 in laboratory through pilot-scale testing of 2nd generation CO_2 capture approaches through multiple small-scale (0.5-1 MWe) slipstream tests; it is expected that industry will now continue the development, adoption, and commercialization of these technologies.

Proposed activities in FY 2018 will focus on the early-stage R&D that will lead to discovery of novel CO_2 separation technologies such as non-aqueous solvents, membranes, advanced sorbents, and cryogenic processes. This will be achieved through the use of advanced computational tools for rational material discovery, design of advanced capture systems components, and synthesis of these materials with characterization of their physical properties. A competitive funding solicitation, complemented with existing laboratory R&D will expand efforts on early-stage research with DOE national laboratories, academia, and industry research organizations.

Pre-Combustion

The Pre-Combustion Capture Systems activity will focus on generating knowledge that enables industry to develop transformational technologies for pre-combustion capture that achieve a 30% reduction in the COE relative to state of the art capture technologies. Technologies for pre-combustion capture complement research that is ongoing in creating new fundamental knowledge of advanced gasification systems, and could be applied to other industrial processes in the chemical industry. Lowering the cost of CO2 separation from pre-combustion systems is a critical step toward enabling industry to develop and commercialize technologies that open markets for the use of this captured CO_2 for EOR and conversion to higher value products or enabling long term storage.

Requested FY 2018 funds will continue to support discovery of new gas separation materials and laboratory- and bench-scale tests of transformational technologies such as advanced solvents, sorbents, and membranes, including process intensification efforts that combine two or more technology concepts. Funding will support both existing early-stage R&D projects and new technology approaches through a competitive funding solicitation.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Carbon Capture $101,000,000	**$16,000,000**	**-$85,000,000**
Post-Combustion Capture Systems $89,000,000	**$13,000,000**	**-$76,000,000**
• Supports at least two large scale pilot projects, selected in FY 2016 from the Phase I preliminary design awards made in FY 2015, for post combustion capture that are applicable to both coal and natural gas power systems. These activities validate the performance and operations of second generation capture technologies on coal and natural gas power systems in order to gather data and knowledge. • Supports lab, bench, and small-scale slipstream transformational carbon capture projects selected in FY 2015 focused on developing advanced second generation post-combustion capture technologies and adapting technologies for natural gas power systems. • Supports projects selected in FY 2014 for second generation post-combustion capture systems that are field testing technologies from the bench to small slipstream pilot-scale.	• Funding will be used to support the Discovery of Carbon Capture Substances and Systems (DOCCSS) initiative focused on the use of computational chemistry and rational design of novel CO2 separation materials, rapid synthesis and testing, and manufacturing to accelerate the discovery of transformational capture materials and systems. A new FOA will be issued to select projects that represent a partnership between industry and academia to develop these transformational CO2 capture processes.	• The decrease in funding reflects a reprioritized focus on transformational carbon capture technologies at the early R&D stages of development. Previously funded later-stage efforts such as 2nd generation technology development including small- and large-scale pilot tests at the National Carbon Capture Center will be left to industry to continue to develop, adopt, and commercialize.
Pre-Combustion Capture Systems $12,000,000	**$3,000,000**	**-$9,000,000**
• Continue advanced laboratory scale and small slipstream R&D for transformational pre-combustion capture technologies. • Support projects selected in FY 2014 that are field testing technologies from the bench to small slipstream pilot-scale. • Support previously selected laboratory and bench scale projects which are focused on developing advanced pre-combustion capture technologies.	• Advanced computational materials discovery, laboratory scale and bench scale slipstream research and development for pre-combustion capture technologies will continue. Funding will be used to support the projects selected in FY 2015 for pre-combustion capture systems that are field testing technologies from the lab and bench scale and issue a FOA to select a limited number of projects focused on the discovery of new pre-combustion capture processes.	• The decrease in funding reflects a reprioritized focus on early-stage research and development; no funding is requested for the National Carbon Capture Center (NCCC) as the NCCC supports later-stage technology testing that is now being left to industry to advance.

CCS and Power Systems
Carbon Storage

Description

The Carbon Storage subprogram is focused on development of technologies for the safe and permanent geologic storage of captured CO_2. Federal government sponsored research and development in this area is critical to validating and increasing confidence in the safety, economically feasibility, and permanence of CO_2 injection and storage. This area of research is in the National interest as it has long-term economic and environmental benefits for the United States and industry. Further advancements in this area will help ensure that industry has sound information to economically and safely assess and monitor long-term storage of CO_2, ensuring the viability of geologic carbon storage as an effective technology solution that can be implemented on a large-scale.

Captured CO_2 can be stored in deep saline formations and/or injected for enhanced oil recovery (EOR) operations. For example, over 60 billion barrels of known U.S. oil reserves exist that could be produced with EOR if large quantities of low cost CO_2 were available. The production of additional tens of billions of barrels could be enabled by advancements in CO_2 storage technologies that optimize pore space utilization and could optimize retention of the CO_2 in the subsurface.[1]

The subprogram is focused on early-stage R&D in five primary storage types—saline formations, oil and natural gas reservoirs, unmineable coal seams, basalts, and organic shales—and in geologic reservoirs across eleven different geologic storage depositional classes. Coupled simulation tools, characterization methods, and monitoring technologies developed and validated through the Carbon Storage subprogram will improve storage efficiency, reduce overall cost, decrease subsurface uncertainties, and identify ways to ensure that operations are safe, economically viable, and environmentally benign.

Storage Infrastructure

The Storage Infrastructure activity is focused on early-stage R&D to identify geologic storage resources across various depositional environments; evaluate mitigation strategies associated with future injection projects that have existing wellbores, faults, and fractures; and assess features that affect the probability and mitigation of local and regional seismic events from changes in the state of stress during injection.

Proposed efforts in FY 2018 will focus on early-stage R&D to understand the potential for offshore oil, gas, and saline bearing formations to serve as future storage reservoirs. Regional offshore characterization activities are focused on identifying regional opportunities for carbon capture, utilization, and storage (CCUS), CO_2 sources, and priority opportunities for field sites. Resource assessment is critical for understanding storage opportunities and can aid industry in developing future associated storage projects in offshore EOR and saline formations. Non-proprietary information collected from these projects will continue to be made available to the public through the DOE's National Carbon Sequestration Database and Geographic Information System (NATCARB). The funding will support existing projects selected in FY 2017 with industry and academia.

Existing field projects have conducted regional and site-specific characterization and validation; simulation and risk assessment; and applied monitoring, verification, accounting, and assessment technologies (MVAA) to various onshore storage reservoirs, including both EOR and saline. These projects have been successful in improving our understanding of CO_2 injection, fluid flow and pressure migration, and geochemical impacts from CO_2 injection. They have also aided development of cost-effective monitoring technologies in all storage types. In FY 2018, existing later-stage R&D projects funded in prior years–such as the Brine Extraction Storage Tests (BEST) projects, Regional Carbon Sequestration Partnerships (RCSP) field projects, and CarbonSAFE projects–will be reviewed to capture and transfer their lessons learned to industry partners. Future activities will focus only of carbon storage capacity assessments which is considered early-stage R&D.

[1] ARI. (2011). Improving Domestic Energy Security and Lowering CO_2 Emissions with "Next Generation" CO_2-Enhanced Oil Recovery (CO_2-EOR).

Advanced Storage R&D

The Advanced Storage R&D activity is focused on developing and validating storage monitoring, simulation and risk assessment technologies, and advanced wellbore technologies to detect and mitigate wellbore issues from both short and long term exposure of CO_2. These advanced technologies have the potential to safely, permanently, and cost effectively manage the injection and associated storage of CO_2 in geologic reservoirs in both onshore and offshore project settings.

Proposed activities in FY 2018 include early-stage research focused on developing tools for improved monitoring, detection, mapping and simulation of fractures and faults, ensuring wellbore integrity through advanced measurement and mitigation techniques, and increasing our ability to monitor and manage geochemical and geophysical changes in the subsurface (e.g., induced seismicity and stress state of the subsurface) at field and basin-scales. This work will be implemented though a targeted competitive funding solicitation and existing work with the DOE National Laboratories.

Carbon Use and Reuse

The Carbon Use and Reuse activity focuses on developing technologies for beneficial use of CO_2 other than through EOR. Beneficial uses include the conversion of CO_2 to higher-value products such as chemicals, plastics, building materials, curing for cement, and the integration of carbon utilization technologies with fossil fuel power plants, such as biological conversion systems (i.e., algae). The primary objective of carbon use and reuse technology development is to lower the near-term cost of CCUS through the creation of value-added products from the conversion of CO_2.

In FY 2018 this subprogram activity area will select new projects focused on the catalytic conversion to chemicals and polymers, mineralization to building products, and biological processes optimized for the conversion of coal based carbon (CO_2 and methane) to higher value products such as nutraceuticals, bio plastics, and animal feed. Specific focus on catalysts made from low- cost materials, using nano-manufacturing and rational design, will be pursued to lower the energy penalty and capital cost of the conversion process. This work will be implemented though a targeted competitive funding solicitation and existing work with the DOE National Laboratories.

Sub-Disciplinary Storage R&D

The Sub-Disciplinary Storage R&D activity centers primarily on assessment and validation of subsurface coupled system models and ability to quantifying risks. The activity focuses on assessment and model validation for long-term and system-wide modeling, including uncertainty quantification; integration of monitoring within assessment models; development of capabilities to test assessment and monitoring capabilities; studies on storage performance and efficiency; and evaluations of mitigation options.

Proposed activities in FY 2018 continue to support the National Risk Assessment Partnership (NRAP) with a focus on verifying and validating its integrated assessment and reduced order models, monitoring network design and basin-scale (multi-site) storage risk tools, and risk-based testing of monitoring and mitigation approaches. Additionally, FY 2018 will include continued development of the Energy Data Exchange (EDX) system, which will be expanded from an NETL-centric resource to an Office of Fossil Energy-wide intramural and extramural resource supporting subsurface science R&D. This work will be conducted through the existing agreements with the DOE National Laboratories.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Carbon Storage $106,000,000	**$15,000,000**	**-$91,000,000**
Storage Infrastructure $66,000,000	**$2,000,000**	**-$64,000,000**
• Continue implementation of eight large-scale field projects that will cumulatively inject seven million metric tons of CO2 since 2009 to evaluate methodologies and validate technologies (system integration) at a large-scale demonstrating safe and permanent storage. In FY 2016, additional RCSP projects will have transitioned into post-injection monitoring to understand CO2 long-term storage. • Continue to support the existing small-scale field tests to evaluate methodologies and technologies to ensure safe and permanent storage of CO2. • Continue offshore storage site characterization research projects from the FY 2015 solicitation. • Continue support and/or selection of small-or large-scale and fit-for-purpose field projects. • Continue projects selected in FY 2014 and FY 2015, with FY 2014 and FY 2015 funding, to evaluate associated CO2 storage in enhanced oil recovery (EOR) fields/operations and improve EOR technologies to increase storage efficiency.	• Focus on characterization and modeling of opportunities for geologic storage in offshore resources • All field projects including BEST, RCSP field sites, CarbonSAFE, and international collaboration activities will be phased out of the program and evaluated to gather knowledge gained and transfer to industry.	• The decrease in funding represents a shift toward early-stage research, reprioritizations across the Program, and proposed close-out of later-stage R&D field projects.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Storage R&D $21,500,000	**$6,000,000**	**-$15,500,000**
• In FY 2016, Geologic Storage Technologies was renamed to Advanced Storage R&D and now also incorporates the MVAA activity budget line. This consolidation improves the integration of the technologies developed in these previously separated budget lines. This will improve the development of future MVAA plans by linking advanced geologic storage modeling and simulation activities with development of advanced MVAA technologies. • Continue existing projects on wellbore integrity and stress state of subsurface in support of DOE's cross-functional SubTER Technical Team. • Continue to develop MVAA tools and technologies to increase efficiency of injecting and monitoring CO2 in subsurface. • Select new projects on geologic storage or MVAA technologies that will obtain new subsurface signals from geologic formations to provide a clearer picture of the subsurface to improve characterization and tracking of CO2 post injection. • Continued support for NRAP to validate system models and quantify uncertainty around risks related to the long-term behavior of storage sites for developing risk management protocols.	• Funding will support early-stage research on plume behavior, pressure front, stresses, geomechanical deformation, simulations and reservoir performance and storage efficiency for associated storage in hydrocarbon bearing and saline field projects; as well as mechanical and flow properties for reservoirs, seals, and fracture networks on various reservoirs. • Funding will support early-stage research tools for improved mapping and characterization of fractures and faults; and develop novel tools for quantification of plume volume in subsurface. • Funding will support early stage research on technologies that can detect and mitigate wellbore issues from both short and long term exposure of CO2.	• Early-stage research will focus on technologies that will have significant impact on the program goals to ensure permanent storage and negligible risk. No funding is requested for later-stage research or for technology validation at field sites.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Monitoring, Verification, Accounting, and Assessment ($0)	**$0**	**$0**
• In FY 2016, Monitoring, Verification, Accounting and Assessment is moved into the Advanced Storage R&D (formerly Geologic Storage Technologies) activity budget line to better improve the integration between the technologies developed in these two budget lines.		• No change.
Carbon Use and Reuse $10,000,000	**$3,000,000**	**-$7,000,000**
• Select up to 7 new projects focused on lab and bench-scale R&D in mineralization of CO2 and biological and chemical conversion pathways.	• Early-stage research projects focused on catalysis of carbon wastes from coal will focus on catalytic materials made from low cost materials and nano-manufacturing to reduce capital and energy costs for conversion to useful products.	• The decrease in funding reflects a reprioritized focus on early-stage research.
Sub-Disciplinary Storage R&D $8,500,000	**$4,000,000**	**-$4,500,000**
• Continue funding existing projects addressing targeted research needs such as: 1) Reservoir and seal performance; 2) Geologic storage site optimization and operations; 3) Reservoir capacity and storage efficiencies; 4) Reservoir modeling and monitoring technologies; 5) Resource assessment and geospatial data management; and 6) CO2 use re-use and conversion.	• Research focused on storage assessment and model validation for long-term and system-wide modeling including uncertainty quantification; integration of monitoring within risk assessment models; development of capabilities to test risk assessment and monitoring capabilities; studies on conformance; and evaluation of mitigation options will be supported.	• The decrease in funding reflects a reprioritized focus on early-stage research and a reduced level of effort that is focused on the development of models for NRAP.
• Continue development of Energy Data Exchange (EDX), which supports the Carbon Storage subprogram's goals of addressing data management and technology transfer.	• Expansion of EDX from a NETL-centric resource to an Office of Fossil Energy-wide intramural and extramural resource in support of subsurface science R&D will be supported.	

Description

Coal plays a critical role in powering the Nation's electricity generation, especially for baseload power plants. However, aging coal generation assets are faced with decreased performance due to the state of the equipment, a challenge exacerbated by the current market pressures on the coal sector. Opportunities exist to advance early-stage technologies that can retrofit or replace these equipment components, eventually resulting in significant improvements in plant performance once further developed and deployed by industry. Research and development in areas such as materials, fluid dynamics, fuel properties and preparation characteristics, and a new generation of plant controls can lead to new components and systems that can help improve the efficiency and reliability of coal-fired power plants significantly, allowing these assets to continue to provide baseload power.

The mission of the Advanced Energy Systems (AES) subprogram is to increase the availability, efficiency, and reliability of fossil energy power systems while maintaining environmental standards through early-stage R&D. Specific efforts will focus on five activities: 1) Advanced Turbines Systems, 2) Gasification, 3) Solid Oxide Fuel Cells, 4) a new activity in Coal Beneficiation, and 5) a new activity in Transformative Power Generation. While the primary focus is on coal-based power systems, improvements to these technologies will result in spillover benefits that can reduce the cost of converting other carbon-based fuels, such as natural gas, biomass, or petroleum coke into power and other useful products in an environmentally-acceptable manner.

Advanced Turbines

In FY 2018, this activity will focus on early-stage R&D to provide new knowledge on turbine component technologies that withstand the high temperatures and aggressive environments predicted for high-hydrogen content syngas combustion, including advanced materials, ceramics, and coatings. In FY 2018, turbine R&D activity will focus on continuing bench-scale projects with the DOE National Laboratories. These activities will include research on key turbine system components that, with additional development by industry, could be capable of achieving a 4-5 percentage point efficiency increase relative to existing combined cycle turbines. Specifically, research will focus on rig pilot testing of materials and components, reducing the risk of scale-up for use in commercial scale machines, including combustor components, rotating parts, and cooling systems. With additional development by industry, these technologies could reduce inter-stage leakage via improved sealing designs, optimize airfoil heat flux with reduced cooling flows, improve material architectures for higher temperature operation, and result in superior airfoils for more efficient expansion with higher throughput.

Gasification Systems

Coal gasification offers one of the most versatile and clean ways to convert coal into electricity, hydrogen, and other valuable energy products. Rather than burning coal directly, gasification—a thermo-chemical process—breaks down coal or another carbon-based feedstock into its basic chemical constituents. In a modern gasifier, coal is typically exposed to steam and carefully controlled amounts of air or oxygen under high temperatures and pressures. Under these conditions, molecules in coal break apart, initiating chemical reactions that typically produce a mixture of carbon monoxide, hydrogen and other gaseous compounds. This molecular separation results in the production of syngas. This syngas can be further converted (or shifted) to nothing but hydrogen and carbon dioxide (CO_2) by adding steam and reacting over a catalyst in a water-gas-shift reactor. When hydrogen is burned, it creates nothing but heat and water, resulting in the ability to create electricity with no carbon dioxide in the exhaust gases.

In FY 2018, this activity will pursue early-stage R&D in modular gasification, advanced reactor designs, and methods to use syngas from coal to produce value-added products that in turn increase the value of coal. Hydrogen-enriched syngas can be used to make gasoline, diesel fuel and other valuable products that would enable plants to produce multiple product streams. In addition the produced CO_2 can be efficiently captured from syngas, preventing its emission to the atmosphere and enabling its utilization for enhanced oil recovery or safe storage. These activities will include early-stage high risk research on the development of a proof-of-concept and lab-scale modular systems. With additional development by industry, advanced design/manufacturing methods will allow for technology cost and risk reductions and its application to many rural or remote areas in the United States that have available coal resources at the 500kW to 20MW scale.

Advancements in this area will also benefit stranded gas assets and provide generating capabilities in the event of a natural disasters such as Hurricanes Katrina and Sandy.

Modularity will utilize early-stage research on the development of new materials and advanced computational design/modeling methods (e.g., parametric design) that industry can further develop and scale up to design smaller, more efficient and reliable reactors that can then be manufactured with advanced techniques, opening up new domestic and global market opportunities for fossil energy systems.

Solid Oxide Fuel Cells (SOFC)

This activity focuses on early-stage R&D to enable efficient, cost-effective SOFC electricity generation from coal or natural gas with near-zero atmospheric emissions of CO_2 and air pollutants, as well as minimal waster use in both distributed generation and central power generation applications. FY 2018 activities will continue existing early-stage R&D with universities to reduce cost and improve stack reliability. The program's long-term focus is on coal or natural gas fueled central power generation, with transformational SOFC technology.

Coal Beneficiation

This new activity proposes to develop a national coal database, drawing on data and expertise at the DOE National Laboratories and academia to provide detailed technical information on the impact of coal properties and composition on the performance and emissions of power generation facilities. The research will focus on synthesizing available coal combustion phenomena data and their impact on plant efficiency and reliability into a common database. The results will centralize detailed information on U.S.-produced coal and help users understand the impacts of its use in a wide variety of applications. The activity combines basic chemistry and combustion science along with basic and fundamental research on thermo-physical properties, materials interactions, and heat transfer.

The activity will also support early-stage development of technologies that reduce the moisture content of high-moisture U.S. coals, which could ultimately be used by industry to improve overall power plant efficiency and reduce the cost of power generation from coal. In FY 2018, the activities will include early-stage R&D that will focused on improved coal combustion, reduce specific power consumption (electrode improvements), and development of domestic alumina feedstocks.

Transformative Power Generation

The existing coal power generating fleet plays a critical role providing reliable on-demand power generation required for power grid stability, and it is important that these existing units can continue to operate in an efficient and reliable manner. FER&D is initiating this new activity in FY 2018 and prioritizing funding for it because there are opportunities to improve the efficiencies and reliablity of existing plants through focus on transformational early-stage high risk research and development. DOE has a key role in early-stage energy research and development focused on the important tasks of investing in technology development that generates public benefits using the competitive market forces and addressing the market's inherent limits to respond to public needs. Expertise and equipment such as computational modeling, high performance computing (HPC), super computers, materials development, testing and manufacturing, ect. exist at a number of DOE National Labs that are not available elsewhere and which can generate vital insights on performance upgrades to existing pulverized coal plants, circulating fludized bed plants, and repowering of coal-fired generating assets with high efficiency supercritical cycles. DOE has a role to play in early-stage high risk technologies development that would otherwise emerge far more slowly, if at all by the private sector.

This new FY 2018 R&D activity proposes R&D specifically focused on enhancing existing unit performance through development of advanced materials, energy cycles, monitoring equipment, dynamic data analysis, and advanced process controls. The activity will fund competitively awarded early-stage research in areas such as materials, fluid dynamics, fuel preparation, and instrumentation and control systems that can subsequently be developed further by industry for deployment at existing units. Funding will focus on improving plant efficiency through topping cycles, advanced materials, recovery of low grade waste heat, improvements in water usage, lower parasitic losses and the development of advanced sensors, instrumentation, and artificial intelligence control systems based on dynamic data analysis. Transformational

research opportunities include building a new knowledge base regarding fuel interactions with plant components such as pulverizers, refractory, steam raising and superheat/reheat surfaces, economizers, and air heaters. Artificial intelligence systems and other technologies will also be advanced to improve predictive maintenance required to optimize economic and environmental performance and maximize plant reliability.

Advanced Combustion Systems

No FY 2018 funding is requested for this activity due to the subprogram's refocusing on early-stage R&D and other program priorities. Current Advanced Combustion R&D have achieved the technology readiness level of pilot-scale.

Coal and Coal-Biomass to Liquids

No FY 2018 funding is requested for this activity due to the subprogram's refocusing on early-stage R&D and other program priorities. Current projects are co-funded by DOE and the Department of Defense and, once completed, will be at a later-stage of technology maturity.

Advanced Energy Systems
Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Energy Systems $105,000,000	**$46,000,000**	**-$59,000,000**
Advanced Turbines $15,000,000 FY 2016 funding is for the development of component technologies for high pressure ratio and high temperature turbine technologies. This includes: • Identification and development of innovative turbomachinery components for advanced combustion turbines in combined cycle applications. • Continued research through the University Turbines System Research (UTSR) program on high temperature, high pressure combustion and materials development. • Continued turbine R&D related to directly-fired sCO2 based power cycles. Phase 2 down-selection process of a suite of projects for development and testing at the laboratory/bench scale.	**$3,000,000** • FY 2018 request will be used to advance component technologies for high pressure ratio and high temperature turbine technologies. • Continues NETL in-house activities on pressure gain combustion.	**-$12,000,000** • The decrease in funding reflects a reprioritized focus on early-stage research and development; no funding is requested for the supercritical CO2 turbine as industry is expected to support later-stage turbine development. • Existing projects will discontinue after completing their currently funded stage. • Funding is also decreased because the University Turbines System Research program is moved to the University Training and Research activity under the Cross-cutting Research subprogram, for which funding experiences a corresponding increase. This change makes more effective use of resources by aligning all FER&D university training R&D under one Funding Opportunity Announcement.
Gasification Systems $25,000,000	**$9,000,000**	**-$16,000,000**
Funding supports continued testing of advanced oxygen production technology, multiphase reacting flow model development applicable to commercial gasification systems, and refractory development activities.	• FY 2018 request will continue funding for small-scale R&D and modeling and support modularity of systems.	• Decrease in funding reflects a rescoping in program priorities; no funding is requested for R&D on bio-gasification.
Solid Oxide Fuel Cells $30,000,000	**$2,000,000**	**-$28,000,000**
• Funding accelerates the commercialization of SOFC technology while retaining the program's long term focus on efficient, cost-	• FY 2018 request will focus on continuation of early stage and	• Reduction in funding reflects a de-scoping of R&D to focus more narrowly on the most promising next generation SOFC technologies.

effective SOFC electricity that minimizes water consumption in central power generation applications and produces a pure, CO2 exhaust stream to reduce the costs of carbon capture and storage.	transformational R&D projects with academia.	• Existing projects will discontinue after completing their currently funded stage.
Coal Beneficiation (NEW) $0	**$2,000,000**	**+$2,000,000**
• New program in FY 2018.	• Development of a national coal database, drawing on data and expertise in the DOE National Laboratory system and academia that provides detailed technical information on the impact of coal properties and composition on the performance and emissions of power generation facilities. • Early-stage research on coal combustion phenomena and their impact on plant efficiency and reliability. • Early-stage R&D to develop methods for producing high value products from coal such a carbon fibers.	• Funding increase reflects new activity to improve understanding of the impact of coal properties and composition on the performance and emissions of power generation facilities.
Transformative Power Generation (NEW) $0	**$30,000,000**	**+$30,000,000**
• New program in FY 2018.	FY 2018 request will support: • Materials research to maximize steam pressures and temperatures for new power cycles. • Early-stage research on the incorporation of advanced power generation cycles that can be further developed and scaled up by industry to increase plant efficiency or lead to the repowering of existing coal power generation assets. • Early-stage research on the development and incorporation of advanced monitoring instrumentation, artificial intelligence control systems that maximize plant operating efficiency, minimize	• Funding increase reflects new activity focusing on R&D to reduce risk of the introduction of transformational technologies. This R&D effort involves the development of advanced materials, energy cycles, monitoring equipment, dynamic data analysis and advanced process control systems. Although the current coal power plant fleet is aging and has been decreasing due to the advent of renewable sources, it continues to play a strategic role in the power generation infrastructure. • Knowledge on advanced technologies and systems will be gained by DOE that industry can develop to increase reliability, add operational flexibility and improve efficiency

	unscheduled outages, and provide increased reliability. • Early-stage research that will allow the incorporation of advanced materials, control methods and instrumentation to improve power plant efficiency at partial load operation.FY 2018 request will be used to advance early-stage component technologies for high pressure ratio and high temperature turbine technologies. • Continues NETL in-house activities in pressure gain combustion.	thereby providing a more robust power generation infrastructure.
Advanced Combustion Systems $30,000,000	**$0**	**-$30,000**
• Continues the development of "transformational" technologies that will be ready for demonstration in the next 10 years using high performance materials that allow for high temperature operations. • Fully funds two FEED studies (one oxy-combustion, one chemical looping) for advanced combustion systems.	• No funding requested.	• No funds requested due to the subprogram's refocusing on early-stage R&D and other program priorities. • Several of the technologies are at a later-stage of technology maturity and are now being evaluated by Industry for commercialization. • Existing projects will discontinue after completing their currently funded stage.
Coal and Coal Biomass to Liquids $5,000,000	**$0**	**-$5,000,000**
• The Coal and Coal/Biomass to Liquids program focuses on technologies to foster the commercial adoption of coal and coal biomass gasification and the production of affordable liquid fuels and hydrogen with excellent environmental performance.	• No funding requested.	• No funding is requested. Current coal to liquids technology is later-stage technology and testing is now being left to industry to advance. Existing projects will discontinue after completing their currently funded stage.

CCS and Power Systems
Cross-cutting Research

Description

Despite changes in U.S. electricity generation in recent years, coal continues to play—and is forecasted to do so for the foreseeable future—a critical role in powering the Nation's electricity generation, providing part of the necessary base loading capacity.[1] Aging coal generation assets are currently faced with decreased performance due to the state of the equipment and transient operating conditions—a challenge exacerbated by the current economic pressures on the coal sector. To address the challenges of an aging coal fleet, opportunities exist to explore early-stage technologies that could be further advanced by industry and ultimately integrated into new plant designs and used to repower or retrofit existing facilities with new components, resulting in significant improvements to existing plant performance.

Fossil Energy Research and Development's Crosscutting Research subprogram supports innovative early-stage R&D for improving reliability, availability, efficiency, and environmental performance of advanced fossil-based power systems. The program bridges basic and applied research by targeting concepts with the greatest potential for transformational breakthroughs. As such, the program focuses on advancing early-stage research in areas such materials, fluid dynamics and fuel preparation characteristics (i.e., coal particle sizing and drying). The program also aims to obtain new knowledge regarding plant phenomena and operation that can be incorporated into a new generation of plant control technologies. Research is focused on four activities and associated sub-activities: 1) Plant Optimization Technologies (e.g., sensors, controls and other novel concepts; crosscutting materials R&D; and water management), 2) Coal Utilization Science (e.g., the Focus Area on Computation Energy Science); 3) University Training and Research (e.g., University Coal Research; funding for Historically Black Colleges and Universities (HBCU), and the University Turbine Systems Research), and 4) International Activities.

Plant Optimization Technologies

Sensors, Controls and Other Novel Concepts*:* This sub-activity focuses on early-stage R&D on low-cost and reliable multi-sensing technologies capable of reading temperature, gas species and pressure that, with additional investment by industry, could be capable of providing real-time measurements critical to the operation, optimization, reliability and efficiency of the next-generation of power systems. Advanced sensors and controls enable a shift from the current preventive maintenance model to one focused on condition-based maintenance with improved operability and overall plant economics. Advanced sensors can also be used to monitor and identify transients associated with a cyber-attack, providing increased grid reliability.

Proposed activities in FY 2018 will continue R&D on transformational sensing, process control, and novel control architectures that enable model-based, real-time control of plant systems and components to help improve power plant integrity. This area also explores other novel concepts such as the utilization of additive manufacturing in constructing complex components with the potential to improve plant performance (e.g. embedded sensing capability), use of dynamic data analysis and artificial intelligence.

Crosscutting Material R&D: This sub-activity encompasses the spectrum of fundamental materials design through qualification of functional materials that support the next generation of advanced power generation. New computational techniques will continue to be developed to design materials needed for advanced combustion, fuel cells, turbines and gasification systems. This computational work decreases the time and cost to develop the new materials and is projected to lead to classes of improved high performance materials.

Proposed activities in FY 2018 continue existing R&D with DOE National Laboratories, academia and industry on development of new computational techniques to design materials. This field is on the threshold of important breakthroughs, building on emerging advances across many fields of science and technology. For example, planned activities include development of validated, science-based predictive tools that accurately describe a component's performance at service conditions. Models will also consider the impacts of multi-material interfaces on overall component

[1] U.S. Energy Information Administration, *Annual Energy Outlook 2017 with projections to 2050*, p. 69, www.eia.gov/aeo

performance, including the material's chemical and structural integrity. In addition, advanced characterization tools and rapid test and characterization methodologies will be developed to validate model predictions and to reduce uncertainty. Investments in this sub-activity will also develop digital data repositories by material class that can be networked and are machine discoverable and accessible to allow algorithms to crawl the broad sets of data and identify unique trends or correlations. Issues relating to open-source and/or open-access standards, data privacy, intellectual property integrity, cyber secure integrity and experimental integrity for datasets both within and between materials and applications need to be addressed to ensure utility and public value from the resulting research. Methods will be developed to analyze the large volume of data generated during the manufacture and testing of materials components and to incorporate that learning to improve the predictive capability of simulations that are developed, as well as to reduce uncertainty. Further, this sub-activity will advance early-stage R&D for extreme environments. Specifically, early-stage research and development will be focused on advanced materials and component testing in laboratory environment.

Advanced Ultrasupercritical: No R&D activities are planned in this area.

Water Management R&D: This sub-activity supports reduced freshwater usage and improved water efficiency in thermoelectric plants, focusing on the treatment and use of non-traditional waters and improving cooling processes of a plant. Proposed activities in FY 2018 will focus on new competitively funded early-stage R&D on innovative cooling geometries and materials that offer potential increases in overall plant efficiencies. Modeling efforts in this area continue to link state-by-state water availability and are used to improve understanding of the complex regional water issues facing the nation as it relates to energy production. Furthermore, early-stage, emerging treatment technologies that may be able to economically and selectively remove low-level contaminants found in plant waste streams (e.g. Selenium, Boron) will be explored.

Coal Utilization Science

Focus Areas for Computational Energy Science: This sub-activity introduces first principle and physics-based modeling of the coal conversion processes. Proposed activities in FY 2018 will include multi-scale, multi-physics simulation capabilities that couple fluid flow, heat and mass transfer, and complex chemical reactions for optimizing the design and operation of heat engines, combustors, gasifiers, chemical reactors, and other unit processes in advanced power generation systems. This element further supports tools and techniques to transform computationally intensive models into reduced order and fast user enabled models for the purposes of study, development, and validation.

Computational System Dynamics: No R&D activities are planned in this area.

Energy Analyses

Environmental Activities: No R&D activities are planned in this area.

Technical and Economic Analysis: No R&D activities are planned in this area.

University Training and Research

University Coal Research: This sub-activity provides small-scale grants to colleges and universities to support early-stage research consistent with the goals of the CCS and Power Systems program. This sub-activity provides a two-fold benefit: conducting directed energy research in a cost-effective environment, and expanding the research capabilities and education of the next generation of scientists and engineers. Proposed FY 2018 research areas will include power generation concepts specifically focused on computational based R&D; advanced high performance materials; novel sensing and control concepts; advanced power cycle concepts that support CCS; combustion, aerodynamics, heat transfer, materials, technology development for supercritical carbon dioxide based power cycles, and oxy-combustion turbine based systems and technology.

The Historical Black Colleges and Universities (HBCU) and Other Minority Institutions (OMI): This sub-activity provides small-scale grant to qualifying universities and institutions. The sub-activity targets education programs that conduct

research related to advanced energy systems with carbon capture and storage capability. This is an area consistent with the goals of the Cross-cutting Research subprogram. Key FY 2018 research areas include advanced power generation with carbon capture capability; computationally based initiatives; advanced high performance materials; novel sensing and control concepts; and advanced power cycle concepts. Grants awarded under this program are intended to maintain and upgrade the educational, training and research capabilities of HBCUs/OMIs in the fields of science and technology, with project results being used to further DOE's commitment to fossil energy research.

International Activities

International Program Support: This activity promotes activities such as international partnerships for the advancement of emerging fossil technologies; coordination with international functions within the U.S. Government; and coordination on opportunities to partner with State and Tribal governments and engage industry, universities and non-governmental organizations.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Cross-cutting Research $50,000,000	**$37,800,000**	**-$12,200,000**
Sensors, Controls and Other Novel Concepts $4,500,000	**$8,000,000**	**+$3,500,000**
• Developing sensor technologies critical to the operation and optimization of advanced power systems. • Developing control systems for advanced power systems.	• Early stage R&D (TRL 2-3) on new sensors capable of taking measurements in the high temperature, high pressure, and/or corrosive environments of a power system or underground injection system. • Continues R&D on transformational research in process control and optimization centered on self-organizing information networks and distributed intelligence. • Explores other novel concepts such as additive manufacturing toward construction of complex components (e.g. turbine blades) with embedded sensing capability.	• Provides additional funding for testing of early-stage research for sensor technology that can be further developed by industry for future application in power plants to improve efficiency and reliability.
Cross-cutting Materials R&D $1,000,000	**$15,500,000**	**+$14,500,000**
• Supports modeling and acceleration of new classes of alloys required for advanced power systems. • Refocuses materials development on high-temperature component parts needed for a directly fired-supercritical carbon dioxide fuel cycle. While the focus of this activity will shift in FY 2016, materials development for a sCO2 fuel cycle will have spillover benefits for high temperature steam cycles. Funding for R&D focused on seizing the opportunity of water-limited cooling provided by a directly-heated sCO2 fuel cycle will be used to support the Supercritical Transformational Electric Power (STEP) pilot for which a solicitation is to be issued in FY 2016.	• Extreme environment materials development and testing will focus on early-stage technology development of advanced materials for extreme environments. • Development of digital data repositories by material class that can be networked and are machine discoverable and accessible for algorithms to crawl the broad sets of data and identify unique trends or correlations. • Develop models to increase the temperature of ferric alloys by 50°C.	• Increased funding supports materials development, modeling, and testing of high nickel alloys at the proof of concept level. • Develop data informatics to validate creep models. • Initiate development early stage TRL 2-3 level ferric alloy that can operate in environment 50° C higher.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Ultrasupercritical $9,000,000	**$0**	**-$9,000,000**
• Refocus materials development on high-temperature component parts needed for directly fired-supercritical carbon dioxide fuel cycle. While the focus of this sub-program will shift in FY 2016, materials development for a supercritical CO2 fuel cycle will have the spillover benefits for high temperature steam cycles. Funding for R&D focused on seizing the opportunity of water-limited cooling provided by directly-heated supercritical CO2 fuel cycle will be used to support the STEP pilot for which a solicitation is to be issued in FY 2016.		• No funding requested. Current supercritical technology is later-stage technology and testing is now being left to industry to advance. • Existing mortgaged projects will discontinue after completing their currently funded stage.
Water Management R&D $6,000,000	**$4,000,000**	**-$2,000,000**
• Research focuses on treatment of non-traditional water produced through CCS.	Funding will support: • Early-stage R&D on innovative multi-stage filtration technologies including membrane-based, evaporative, chemical, electrochemical and biological systems for both effluent from the plant and water treatment and reuse within the plant. • Early-stage development of highly efficient heat exchangers and other transformational cooling systems.	Decrease in funding reflects: • Discontinues support for the Water Energy track within U.S.-China Clean Energy Research Center. • Discontinues funding for treatment technologies for water produced through CO2 injection in deep saline aquifers, and field testing of these treatment technologies in coordination with the Brine Extraction Storage Test due to program's rescoped focus on early-stage R&D and reprioritizations within the program.
Coal Utilization Science $24,000,000	**$5,000,000**	**-$19,000,000**
• Provides support for National Risk Assessment Partnership (NRAP) modeling projects. Funding will enable development of key products such as tools for risk-profile determination of carbon storage sites and post-injection site care technical decision support. • Supports the development of interactive visualization technology and data communication optimization	• Implements the next generation of enabling computational formats for domain specific solution sets, enhancing both speed and capabilities. • Uses fundamental models to reduce risk of employing novel concepts by developing a framework for uncertainty quantification and model hierarchy.	• Decrease in funding reflects discontinuation of funding for Computational Science sub-activity and for the Carbon Capture and Simulation Initiative (CCSI) due to reprioritizations within the program.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
methods to improve the design and operation of advanced power systems with carbon capture and sequestration. • Provides first principle and physics based modeling of phenomenon for complex energy conversion and carbon capture processes. • Maintains funding for Carbon Capture and Simulation Initiative (CCSI) modeling projects. • Implements the next generation of enabling computational formats for domain specific solution sets.		
Energy Analyses $1,400,000	**$0**	**-$1,400,000**
• Carry out analyses of options and barriers for incorporating CCS on gas-fueled power plants.		• Decrease in funding reflects no funding requested for this area due to reprioritizations within the program.
University Training and Research $3,000,000	**$5,000,000**	**+$2,000,000**
• Supports 8-10 grants to HBCU and University Coal Research universities to help incubate transformational and next generation concepts while training the next generation of scientists and engineers.	• Select and award up to 6 -10 university-based research projects focused on developing concepts related to advanced power. • Reflects a move of the University Turbine System Research activity to this line to better align university research programs.	• The increase reflects the inclusion of the University Turbine Systems Research training that was previously funded within the Turbine activity under the Advanced Energy Systems subprogram.
International Activities $1,100,000	**$300,000**	**-$800,000**
• Organize the 2016 CLSF Ministerial conference and coordinate international activities within the Office of Fossil Energy that fall under the Office of the Deputy Assistant Secretary for Clean Coal and Carbon Management.	• Supports the Office of Fossil Energy international activities that fall under the Office of the Deputy Assistant Secretary for Clean Coal and Carbon Management.	• Decrease in funding reflects discontinued funding for the Coal Export Activity and funding to support the Carbon Sequestration Leadership Forum Ministerial conference will be reduced due to reprioritizations within the program.

CCS and Power Systems
Supercritical Transformational Electric Power (STEP)

Description

The STEP activity line was created within CCS and Power Systems by FY 2015 Enacted appropriations. No funding is requested in FY 2018 due to the subprogram's refocusing on early-stage R&D. As a pilot test facility for supercritical CO_2 electricity generation, STEP fits the later-stage research, development, and commercialization activities that the Budget relies on the private sector to fund.

Supercritical Transformational Electric Power (STEP)

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Supercritical Transformational Electric Power (STEP) $15,000,000	**$0**	**-$15,000,000**
• In FY 2016 this activity issued a competitive FOA, cost shared with industry, for the 10 MWe Supercritical Transformational Electric Power (STEP) pilot scale facility.	• No funding requested.	• No funding is requested due to the subprogram's refocusing on early-stage R&D and other program priorities.

Fossil Energy Research and Development
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**CCS Demonstrations - Initiate operation of CCS demonstration projects - Initiating operation of CCS demonstration projects will help to establish that carbon capture, compression of CO2 and injection, combined with long term monitoring, verification, accounting, and assessment (MVAA), can be performed at commercial scale at both power plants and industrial sites while continuing to maintain reliable plant operations.**		
Target	3 CCS projects initiated operation	4 CCS projects initiated operation	N/A: This goal is no longer relevant as the program is now focused on early-stage R&D.
Result	Not Met –1	TBD	N/A
Endpoint Target	Operations initiated at a minimum of four commercial CCS demonstrations including the Clean Coal Power Initiative (CCPI) and the Industrial CCS Demonstration projects (funded by both annual appropriations and the American Recovery and Reinvestment Act). Two of the four demonstrations to initiate operations by end of FY 2017 will be CCPI projects and two will be ICCS projects. This goal will be completed in FY 2017 and will no longer will be tracked in FY 2018 and beyond since this no longer aligns with the program's efforts focused on early stage R&D.		
Performance Goal (Measure)	**Carbon Capture and Advanced Energy Systems - Achieving the target signifies that the Carbon Capture & Advanced Energy Systems programs are continuing to make progress in meeting the goal of developing cost-effective, reliable carbon capture technologies for pre-combustion, post-combustion, natural gas carbon capture and advanced combustion capture applications.**		
Target	49 $ per tonne of CO2 captured	47 $ per tonne CO2 captured	N/A: This goal is no longer relevant as the program is now focused on early-stage research for transformational energy conversion and capture technologies.
Result	Met - 49	TBD	N/A
Endpoint Target	Advanced Energy Systems with CO_2 capture at no more than $40 per tonne of CO_2 captured ready for demonstration by 2020 and less than $40 per tonne of CO_2 captured ready for demonstration by 2030. This goal will no longer will be tracked in FY 2018 and beyond since this no longer aligns with the program's efforts focused on early stage R&D.		

Performance Goal (Measure)	**Carbon Storage - Inject CO2 in large-volume field test sites to demonstrate the formations' capacity to permanently and safely store carbon dioxide.**		
Target	7 MMTs injected (since 2009)	8 MMTs injected (since 2009)	N/A: The Regional Carbon Sequestration Partnerships (RCSPs) will be terminated starting in 2018 and therefore this goal is no longer relevant since the injection operations at these projects will cease. The RCSP activities do not align with the program's focus on early-stage R&D.
Result	Met - 13.2	TBD	N/A
Endpoint Target	Inject 9.0 million metric tons of CO_2 between January 2009 and 2020 in large-volume field test sites representing different storage classes to demonstrate and monitor for the formations' capacity to permanently and safely store carbon dioxide. A long-term goal is to ensure the cost-effective ability to measure and account for the injected CO_2 to ensure 99 percent storage permanence in all storage types while minimizing the environmental footprint of carbon storage activities. This program goal is no longer relevant as the program has shifted to early-stage R&D and the RCSP will be terminated starting in 2018.		

Performance Goal (Measure)	**Cost of Energy and CO_2 Capture from Advanced Power Systems - Develop cost-effective, efficient, and reliable CO_2 separation technologies and energy conversion technologies that inherently capture CO_2, for both new and existing coal-fired power plants.**		
Target	N/A	N/A	Identify material properties to meet transformational goals.
Result	N/A	N/A	TBD
Endpoint Target	By 2030, R&D technologies are available to support a new coal-fired power plant with CO2 capture with a cost of electricity at least 30% lower than a supercritical PC with CO2 capture, or approximately $30 per tonne of CO2 captured. By 2030, for retrofitting an existing coal-fired power plant with CO2 capture, capture technologies are available to reduce the cost of capture by 30% (actual cost of capture varies for each unit). (Baseline: NETL Cost and Performance Baseline Series; 2012 Capture Technology).		

Performance Goal (Measure)	**Power Plant Efficiency Improvements - Develop cost-effective, reliable technologies to improve the efficiency of new and existing coal-fired power plants.**		
Target	N/A	N/A	Complete Efficiency Improvement Roadmap to 2030.
Result	N/A	N/A	TBD
Endpoint Target	TBD. Will be informed by road mapping process proposed in FY 2018.		

Natural Gas Technologies

FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request
43,000	42,918	5,500

Overview

Natural gas sourced from shales has the potential to significantly increase America's security of energy supply, reduce greenhouse gas emissions, and lower prices for consumers. Along with oil and natural gas liquids, natural gas from shales is the foundation of America's newly emergent global energy dominance. Although shale gas has been produced in the United States for many decades, domestic reserves were relatively modest, such that as recently as 2006, the Energy Information Administration was projecting significant U.S. imports from international sources. It has only been over the last decade that new horizontal drilling and hydraulic fracturing technologies have facilitated economic production. It is important to note that the "shale revolution" had its early start in technology R&D and field tests conducted by the DOE, leading to subsequent adoption and advancement by industry.[2]

The Natural Gas Technologies Program addresses critical and emergent issues pertaining to the safe and environmentally sustainable use of domestic natural gas. Specifically, the Program's mission is to conduct early-stage R&D that supports the prudent development, distribution and storage of our vast natural gas energy resources. The Program comprises two subprograms: Natural Gas Infrastructure Research and Development (new in FY 2018), and Gas Hydrates. Given the importance of natural gas in our energy system, it is critical to ensure the safety and reliability of related infrastructure to protect energy access, public health, and the environment. To that end, the new Natural Gas Infrastructure Research and Development subprogram will develop new sensors and materials that will be used to detect and reduce waste and improve the reliability and operational efficiency of natural gas transmission, distribution, and storage facilities. The subprogram will conduct research in electrochemical point sensors for quantification of corrosion rates and environmental monitoring (e.g. pH), as well as distributed optical sensors for measuring temperature, pressure, natural gas composition, vibration and strain.

In addition, while shale gas has been discovered in sufficient quantities to now support and warrant U.S. liquefied natural gas (LNG) exports, the most plentiful supplies of natural gas throughout the world may in fact be the methane molecules trapped in ice-like structures called hydrates. The Gas Hydrates subprogram supports unique early-stage research to evaluate the occurrence, nature, and behavior of the potentially enormous naturally-occurring gas hydrate resources within the United States, with particular focus on the Arctic and Gulf of Mexico regions.

Highlights of the FY 2018 Budget Request

The Natural Gas Technologies Program will pursue the following major activities in FY 2018:

- Evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates. The subprogram will assess the fundamental physio-chemical properties of hydrate bearing sediments for this potentially vast resource (see Fig. 1). In FY 2018, the subprogram intends to translate potential hydrate resources into latent energy assets via numerical simulations and pore scale visualization of hydrate bearing sediments. The subprogram will also review and analyze materials obtained through field investigations conducted during FY 2017 through existing projects under the FY 2016 funding opportunity announcement in the Gulf of Mexico to confirm the nature and regional context of gas hydrate

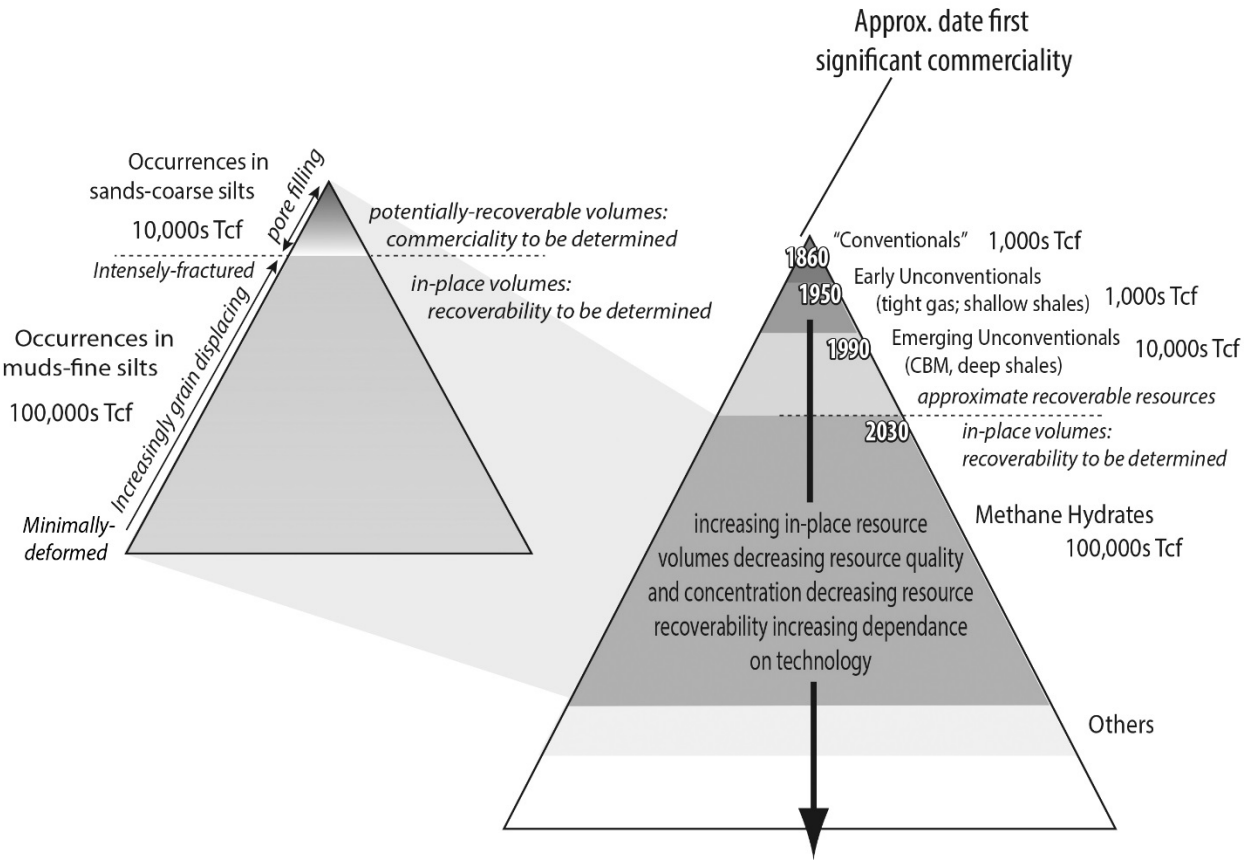
[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

[2] "Where the Shale Gas Revolution Came From: Government's Role in the Development of Hydraulic Fracturing in Shale," by Michael Shellenberger, Ted Nordhaus, Alex Trembath, and Jesse Jenkins; Breakthrough Institute Energy & Climate Program; May 2012.

deposits. This research is largely lab-focused and does not represent a field-scale testing protocol as the FY 2018 Budget Request relies on industry to fund this type of later-stage R&D.

- Proposes a new Natural Gas Infrastructure Research and Development (R&D) subprogram to support energy independence and strong economic growth. The new subprogram will focus efforts on early-stage research that will provide knowledge that can help industry to improve U.S. natural gas infrastructure. The FY 2018 request will fund early-stage technologies in targeted areas such as advanced materials and sensor research and development. When these technologies are further developed and deployed by industry they will improve the operational efficiency of natural gas transmission, distribution, and storage facilities.
- Proposes closeout and termination of the Environmentally Prudent Development subprogram.
- Proposes closeout and termination of the Emissions Mitigation and Quantification subprogram.

Figure 1: Resource potential of gas hydrates and comparison with other hydrocarbon resources in trillions of cubic feet (Tcf)



Natural Gas Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[3]	FY 2018 Request	FY 2018 vs FY 2016
Natural Gas Technologies				
Environmentally Prudent Development	11,200	---	0	-11,200
Emissions Mitigation and Quantification	12,000	---	0	-12,000
Gas Hydrates	19,800	---	3,500	-16,300
Natural Gas Infrastructure Research (New)	0	---	2,000	+2,000
Total, Natural Gas Technologies	**43,000**	**42,918**	**5,500**	**-37,500**

SBIR/STTR:

- FY 2016 Transferred: SBIR $1,213: STTR: $182
- FY 2017 Annualized CR Projected: SBIR $1,292: STTR: $182
- FY 2018 Request: SBIR $166: STTR: $23

[3] FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that, a dash (-) is shown.

Natural Gas Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Natural Gas Technologies	
Environmentally Prudent Development: No funding is requested in FY 2018 for this subprogram. Early-stage research on the prudent development of the Nation's vast unconventional resources is requested under the Unconventional Fossil Energy Technologies budget line. These efforts include research to improve understanding of shale geology and fracture dynamics, as well as fluid flow and chemical interactions in unconventional reservoirs. Later-stage research and development focused on the environmental performance of oil and natural gas production is more appropriate for private sector funding.	**-11,200**
Emissions Mitigation and Quantification: No funding is requested in FY 2018 for this subprogram. FY 2017 funding supports the orderly closeout and completion of research focused on emissions mitigation and quantification. Collaborative efforts in recent years between the federal government, industry, and academia have advanced technologies to locate and measure methane emissions associated with natural gas production. Coalitions of private-sector companies have emerged to address the operational and technical challenges associated with methane emissions across the natural gas value chain.	**-12,000**
Gas Hydrates: The decrease in funding is due to the completion of the current phase of the Gulf of Mexico field research and re-scoping the portfolio to exclude later-stage research, field flow testing, and development activities.	**-16,300**
Natural Gas Infrastructure Research: This new subprogram will focus on early-stage research on advanced materials and sensor technology to address the reliability, public safety, and operational efficiency of the Nation's aging natural gas infrastructure. The federal government has a role in addressing research gaps that are in the public interest. Natural gas pipeline failures pose a significant safety risk to U.S. consumers. This subprogram will work to strengthen natural gas pipeline reliability and ensure infrastructure security.	**+2,000**
Total, Natural Gas Technologies	**-37,500**

Natural Gas Technologies

Description

Gas Hydrates

The Gas Hydrates subprogram will continue to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates. In order to take advantage of the immense, future potential energy supply from hydrates, the subprogram is leading efforts to characterize hydrate resources through early-stage research in several ways: numerical simulations, fundamental property characterization, and pore-scale visualization of hydrate-bearing sediments. This unique R&D will provide the foundation for industry investment in development and transformation of these resources to energy assets. Industry funding for research on developing gas hydrate energy resources and understanding associated environmental issues, even in collaboration with the federal government, remains limited due to the current abundant supply of natural gas resources, increasing industry concern about operational liabilities associated with deep-water scientific drilling using industry ships, and constraints within industry that prevent dedicating technical staff and other resources to long-range projects over near-term corporate profitability, particularly given the development of shale gas and associated gas price declines.[4]

Subprogram activities funded in FY 2018 through competitively selected DOE National Lab R&D and existing projects will focus on characterization of laboratory-synthesized hydrate bearing sediments, which will provide critical input parameters for reservoir simulation of gas production. Numerical simulation efforts are designed to isolate and understand fundamental aspects of gas hydrate system behavior. This work will provide new insight into interactions between hydrate structure and matrix, and surrounding fluids and material. The subprogram intends to develop a comprehensive dataset for hydrate characterization and enhance understanding of hydrate behavior in natural settings.

In FY 2018, the subprogram will also continue analyzing the results from field investigation work conducted during FY 2017 through existing projects under the FY 2016 funding opportunity announcement in the Gulf of Mexico to confirm the nature and regional context of gas hydrate deposits, and the physical properties and characteristics of gas hydrate-bearing sediments. This work will build on preliminary results gained from previously acquired seismic analysis, by analyzing and interpreting pressurized and unpressurized core samples and performing pressure perturbation experiments in the laboratory.

Natural Gas Infrastructure Research

The new Natural Gas Technologies subprogram is committed to generating new knowledge that industry can use to develop advanced, cost-effective technologies to improve operational reliability and reduce loss from natural gas transmission, distribution, and storage facilities. Priority areas for the subprogram include early-stage research in advanced materials for pipeline integrity and initiation of research on new passive sensor platforms. Development of magnetoelastic materials will allow for novel applications which are not feasible using other adaptive materials, while R&D in electrochemical materials will lead to the ability to quantify corrosion rates.

In FY 2018, the subprogram will accelerate advances in materials science that, with additional scale up by industry, can enhance pipe integrity, reduce leaks, and improve the efficiency of midstream infrastructure operations. FER&D will specifically focus on early development of novel materials that can be utilized in liners and coatings. The subprogram will also support early-stage research through competitively selected DOE National Lab R&D on novel sensor technologies that can provide predictive analytics on pipeline corrosion rates via detection and monitoring of temperature, pressure, natural gas composition, vibration and strain. The proposed research entails topics and categories not addressed through efforts in other agencies, such as PHMSA (DOT) and that industry will

[4] Quadrennial Technology Review 2015

not fund because the Federal and State gas pipeline operators and local utility distribution systems, which achieve a return on their investment through rate cases, are currently prohibited from including an R&D fee in customer rates and billing. Additionally, there is continuing reluctance within industry to dedicate technical assets and funds to projects with limited immediate discernible impact on profitability.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Natural Gas Technologies $43,000,000	**$5,500,000**	**-$37,500,000**
Environmentally Prudent Development $11,200,000	**$0**	**-$11,200,000**
• Focus on continued implementation of the collaborative research strategy in areas such as water quality, water availability, air quality, induced seismicity, and mitigating the impacts of development. • Assess and develop technology options for treatment and use of co-produced water from oil and gas wells.	• No funding requested within the Natural Gas Technologies budget request.	• Current environmentally prudent development research will be completed under FY 2017 funding. Early-stage research focused on the development of the Nation's vast unconventional resources will be conducted under the Unconventional Fossil Energy Technologies budget line. These topics include shale geology and fracture dynamics, as well as fluid flow and chemical interactions in unconventional reservoirs
Emissions Mitigation and Quantification $12,000,000	**$0**	**-$12,000,000**
• Solicit and select projects that develop advanced, cost-effective technologies to detect and mitigate methane emissions from natural gas transmission, distribution, and storage facilities. • Communicate results on methane emissions mitigation to stakeholders. • Research projects focused on better quantifying methane emissions from the natural gas value chain.	• No funding requested within the Natural Gas Technologies budget request.	• While the oil and gas sector is the single largest industrial source of methane emissions, there is now a robust private sector presence in detection and prevention of methane leaks, and accordingly there is no longer a significant federal role for research in this area.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Gas Hydrates $19,800,000	**$3,500,000**	**-$16,300,000**
• Through the research project funded through the FY 2014 FOA, conduct field investigations in the Gulf of Mexico to confirm the nature and regional context of gas hydrate deposits, and the physical properties and characteristics of gas hydrate-bearing sediments. Collect and analyze pressurized and unpressurized core samples and perform pressure perturbation experiments. Some work may be done in collaboration with Mexico, which will benefit their resource assessment and characterization plans. • All projects fully funded through the FY 2012 and FY 2013 FOAs will be completed in FY 2016. • Provide resource characterization support in Alaska by assessing the presence and nature of methane hydrates on the North Slope.	• Conduct early-stage research such as numerical simulations, fundamental property characterization, and pore-scale visualization of hydrate bearing sediments. • Continue analyzing materials collected during FY 2017 in field investigations in the Gulf of Mexico to confirm the nature and regional context of gas hydrate deposits.	• Decrease reflects the completion of the current phase of the Gulf of Mexico field research and the conclusion of DOE support for field experiments in Alaska.
Natural Gas Infrastructure Research $0	**$2,000,000**	**+$2,000,000**
• New program in FY 2018.	• Conduct early-stage research focused on improving the physical properties of materials that will be used in pipelines, storage facilities, and related equipment. • Priority research areas include advanced composite materials, non-reactive coatings with embedded sensors, and pipeline inspection and repair.	• Increase reflects a new subprogram focused on early-stage research in materials and sensor technology for transmission, storage, and distribution infrastructure.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request
20,321	20,282	15,000

Overview

The overall mission of the Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program is to provide information and generate knowledge that can be advanced by industry to enable sustainable and responsible development of abundant domestic unconventional fossil energy resources. The prudent development of these natural resources supports the Nation's continued energy resilience and security.

Historically, most of the Nation's oil and natural gas has come from geologic formations that are termed "conventional": they have reservoir characteristics such as permeability and porosity, which typically make production and volumetric calculations relatively straightforward to predict. With the advent of production from shales over the past decade, the United States has increasingly turned to these "unconventional" reservoirs for domestic production. These "unconventional" reservoirs require complicated engineering measures, such as hydraulic fracturing, to improve reservoir access and enable production of oil and gas at commercially viable rates. The United States' abundant unconventional oil and natural gas resources represent a fast-growing component of its energy portfolio.

Despite the dramatic success by industry in producing hydrocarbons from shales, there remain key technical and scientific questions that require early-stage R&D, and which are best addressed through targeted federal investment. This work encompasses specific topics and challenges that, while of ultimate interest to industry, are early-stage and hence not able to yet attract industry investment. These include novel mechanisms for breaking rock to dramatically increase recovery factors, beyond the current industry standard of 7-10% of unconventional formations (conventional reservoirs have typical recovery factors of 25-40% of the original oil in place). It also includes better understanding of flow mechanisms and mechanics, and enhancing the ability to dynamically engineer the subsurface.

Highlights of the FY 2018 Budget Request

The Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program will pursue the following major activities in FY 2018:

- Fund existing Field Laboratories in the Marcellus, Permian, and Utica, and one additional in an emerging play that advance early-stage research to improve understanding of shale geology and fracture dynamics. These projects conduct field testing that complements research, modeling, and experimentation related to unconventional oil and natural gas development. Activities of these projects include borehole tests on the efficacy of production methods, surface and borehole geophysical and geochemical sampling of rocks and fluids, and determination and monitoring of water and gas chemistry at active oil and natural gas production sites.
- Conduct early-stage research and analysis through competitively selected DOE National Laboratory R&D on fluid flow and chemical interactions in unconventional reservoirs, and evaluation of causative factors of induced seismicity. This work is unique and separate from work being done by USGS (DOI) in addressing hazard assessments for induced seismicity, and instead addresses the opportunity to dynamically manage and manipulate the subsurface. The Program will continue to collaborate with USGS on this topic.

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies	20,321	20,282	15,000	-5,321

SBIR/STTR:

- FY 2016 Transferred: SBIR $573: STTR: $86
- FY 2017 Projected: SBIR $610: STTR: $86
- FY 2018 Request: SBIR $451: STTR: $64

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016 Request
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies:	
The decrease in funding is due to the completion of drilling activities at two Field Laboratory sites; continuing work on those two projects involves analysis and modeling of the data collected during earlier phases.	**-5,321**
Total, Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies	**-5,321**

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

Description

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

The Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies Program will conduct early-stage research focused on increasing understanding of shale geology and fracture dynamics through research and technology development at technology readiness levels ranging from proof of concept up to testing and prototype validation. The early-stage research and development activites will be conducted at existing and additional Field Laboratories in emerging plays, gathering field data to inform modeling and analysis. Additional work will include fundamental research on fluid flow and chemical interactions in unconventional reservoirs. The Program will conduct analysis on the relationship between hydraulic fracturing and induced seismicity in order to understand and manipulate the subsurface. This includes the collection and evaluation of big data sets sourced from industry for causative factors of induced seismicity. In FY 2018, these activities will be conducted through existing projects from previous competitive funding solicitations, a new competitive solicitation focused on establishing additional Field Laboratories, and competitively selected DOE National Laboratory R&D.

Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies		
$20,321,000	**$15,000,000**	**-$5,321,000**
• Hydraulic fracturing research at two field laboratories focused on reducing and minimizing environmental impacts and improving efficiency of hydraulic fracturing. • Conducted produced water research into geochemical and isotopic composition that provided insight into fluid migration and reaction during hydraulic fracturing treatments.	• Early-stage research on shale geology and fracture dynamics through existing and new Field Laboratories in emerging plays. • Conduct early-stage research in fluid flow and chemical interactions in unconventional reservoirs and evaluation of causative factors of induced seismicity.	• The decrease in funding is due to the completion of drilling activities at two Field Laboratory sites.

Special Recruitment Programs

Overview

The Office of Fossil Energy (FE) utilizes educational programs, such as the Mickey Leland Energy Fellowship (MLEF), Minority Educational Institution Student Partnership Program (MEISPP), and the DOE Scholars Program to support an increase in the number of females and under-represented minorities entering the scientific and engineering career fields within the U.S. workforce. The MLEF Program, developed by FE, is a ten-week summer educational program that offers undergraduate, graduate, and post-graduate students majoring in science, technology, engineering, and mathematic (STEM) disciplines the opportunity to learn about the programs, policies, and research and development initiatives within the Office of Fossil Energy and the challenges in providing clean, affordable energy for future generations. The MEISPP and DOE Scholars Programs also provide students the opportunity to gain work experience and learn about the FE and DOE missions.

Highlights of the FY 2018 Budget Request

In FY 2018, a diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering, and mathematic majors will be recruited and selected to participate in the MLEF program. Students may also be selected into the MEISPP and DOE Scholars Program, as funding permits. All participants in the MLEF will complete a hands-on research project under the mentorship of a Fossil Energy scientist, researcher, or program official. MEISPP and DOE Scholars will participate on challenging assignments supporting the FE mission.

Special Recruitment Programs
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Special Recruitment Programs	700	700	200	-500
Total, Special Recruitment Programs	**700**	**700**	**200**	**-500**

Special Recruitment Programs
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Special Recruitment Programs: Funding is reduced by 71 percent; the program will continue at a reduced level.	**-500**
Total, Special Recruitment Programs	

Special Recruitment Programs

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	FY 2018 vs FY 2016
Special Recruitment Programs $700,000	**$200,000**	**-$500,000**
• A diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program, the MEISPP, or DOE Scholars program. Provides students opportunity to gain hands-on research and work experience and learn more about the DOE and FE missions.	• A diverse group of undergraduate, graduate, and post-graduate students in science, technology, engineering and mathematic majors will be recruited and selected to participate in the MLEF program, the MEISPP, or DOE Scholars program. Provides students opportunity to gain hands-on research and work experience and learn more about the DOE and FE missions.	• The decrease in funding is due to an envisioned reduction in program size due to reprioritizations across the FER&D organization.

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Program Direction

Overview

Program Direction provides for the Headquarters workforce responsible for the oversight and administration of the Fossil Energy Research and Development (FER&D) program. It also provides for technical staff at the National Energy Technology Laboratory (NETL) who perform Procurement, Finance and Legal functions, as well as Federal workforce and contractor support for Communications and Human Resources. It does not include NETL scientific and managerial staff, nor does it include NETL scientific contract staff. Each of these elements also fund the DOE-wide Human Resources Shared Service Center in Oakridge. Finally, the FY 2018 Program Direction request includes funding for initial workforce reshaping activities.

Also included in Program Direction is funding for the operations of the Import/Export Authorization Office. Import/Export Authorization is managed by the Division of Natural Gas Regulatory Activities within the Office of Oil & Natural Gas. The program has responsibility for regulating natural gas and liquefied natural gas (LNG) imports and exports under the Natural Gas Act of 1938, section 3, using both Federal staff and contractor support.

Highlights of the FY 2018 Budget Request

Along with NETL Research & Development and NETL Infrastructure & Operations, Program Direction is part of the proposed Fossil Energy R&D budget line restructuring. Funding for NETL within the Program Direction line continues to include functions such as procurement, finance, and legal that are necessary for the performance of NETL activities. Program Direction no longer includes support for fixed occupancy funding—such as building and laboratory repairs, grounds maintenance, utilities and information technology infrastructure—which is now included in the new NETL Infrastructure & Operations budget line.

The proposed FY 2018 budget includes significant workforce reshaping within the overall Fossil Energy R&D program to right-size the workforce with the new program scope, with attendant impact on Program Direction. Workforce reshaping planning activities will commence in FY 2017 with studies and analysis, with implementation to start in FY 2018. While the FY 2018 request significantly reduces the level of R&D that will be performed by FER&D, the long lead time necessary to effect Federal workforce reshaping results in minimal reductions to salaries and benefits during FY 2018. During 2018, FER&D expects to design, seek approval for, and implement several workforce reshaping initiatives. These initiatives include a Voluntary Employee Retirement Authority (VERA) plan and a Voluntary Separation Incentive Payment (VSIP) plan, voluntary relocation, retraining and cross training, and to the extent necessary, establishment of an outplacement services taskforce. The workforce reshaping initiatives will also seek to optimize the scope of work being performed by FER&D's contractor workforce. Workforce restructuring costs included in the Program Direction request total $6.2 million and are detailed by activity below. More significant funding decreases will be seen during FY 2019 and level by FY 2020. Similarly, while headcount reductions are anticipated during 2018, full-time equivalent (FTE) numbers will reduce more slowly given the time frame to implement the workforce reshaping activities.

FY 2018 Workforce Restructuring Costs		
Activity:	**Amount:**	**Explanation:**
HQ salaries and benefits	$700,000	Covers VERA/VSIPs for HQ staff
NETL salaries and benefits	$1,800,000	Covers VERA/VSIPs for technical staff at NETL
Other related expenses	$3,700,000	Covers Federal employee relocation and re-training and contractual obligations related to contractor workforce contraction

Working Capital Fund (WCF) estimates for FY 2018 have increased due to projected inflation increases in existing WCF programs including corporate business systems, building occupancy, interagency transfers, and telecommunications. FER&D's share of this estimated increase is included in the Program Direction Budget Request. Also included is an increase to account for increased cost of background investigations. Import/Export authorization costs are increasing due to increased costs for personnel, technology and analytical support.

Program Direction
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	16,259	---	16,358	+99
Travel	900	---	470	-430
Support Services	66	---	650	+584
Other Related Expenses	12,071	---	12,700	+629
Total, Washington Headquarters	**29,296**	**---**	**30,178**	**+882**
National Energy Technology Laboratory				
Salaries and Benefits	14,713	---	16,913	+2,200
Travel	361	---	331	-30
Support Services	4,482	---	2,637	-1,845
Other Related Expenses	2,053	---	5,919	+3,866
Total, National Energy Technology Laboratory	**21,609**	**---**	**25,800**	**+4,191**
Import/Export Authorization				
Salaries and Benefits	1,367	---	1,617	+250
Travel	20	---	20	0
Support Services	0	---	250	+250
Other Related Expenses	626	---	613	-13
Total, Import/Export Authorization	**2,013**	**---**	**2,500**	**+487**
Total Program Direction				
Salaries and Benefits	32,339	---	34,888	+2,549
Travel	1,281	---	821	-460
Support Services	4,548	---	3,537	-1,011

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Other Related Expenses	14,750	---	19,232	+4,482
Total, Program Direction	**52,918**	**52,817**	**58,478**	**+5,560**
Federal FTEs – HQ	**116**	**116**	**112**	**-4**
Federal FTE – NETL[2]	**139**	**139**	**134**	**-5**
Support Services				
Technical Support				
Headquarters	66	---	650	+584
NETL	0	---	0	0
Import/Export Authorization	0	---	250	+250
Total, Technical Support	66	---	900	+834
Management Support				
Headquarters	0	---	0	0
NETL	4,482	---	2,637	-1,845
Import/Export Authorization	0	---	0	0
Total Management Support	4,482	---	2,637	-1,845
Total, Support Services	**4,548**	**---**	**3,537**	**-1,011**
Other Related Expenses				
Headquarters	12,071	---	12,700	+629
NETL	2,053	---	5,919	+3,866
Import / Export Authorization	626	---	613	-13
Total, Other Related Expenses	**14,750**	**---**	**19,232**	**+4,482**

[2] Additional NETL FTEs are funded within the NETL Research and Development and NETL Research and Operations budget line.

Program Direction

Activities and Explanation of Changes

FY 2016 Enacted (Restructured Funding)	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Program Direction $52,918,000	**$58,478,000**	**+$5,560,000**
Salaries and Benefits $32,339,000	**$34,888,000**	**+$2,549,000**
• The funding supports HQ Federal staff who provide monitoring (oversight and audit) activities for the FER&D portfolio.	• The funding supports HQ Federal staff who provide monitoring (oversight and audit) activities for the FER&D portfolio. Federal workforce reshaping costs for Headquarters staff are also included.	• HQ increase reflects 2018 workforce reshaping costs ($700,000 for VERA/VSIP), more than offsetting projected initial cost reductions from workforce reshaping.
• The funding supports the technical Federal staff at the National Energy Technology Laboratory. The staff covered in this area provide for management of the Lab, communications, legal, acquisition and finance activities.	• The funding supports the technical Federal staff at the National Energy Technology Laboratory. The staff covered in this area provide for management of the Lab, communications, legal, acquisition and finance activities. Federal workforce reshaping costs also included.	• NETL increase reflects 2018 workforce reshaping costs ($1.8M for VERA/VSIP), more than offsetting projected initial cost reductions from workforce reshaping.
Travel $1,281,000	**$821,000**	**-$460,000**
• Travel includes funding for management meetings, training, etc. Instituted travel reduction to comply with the OMB directive for reduced travel from FY 2010 levels.	• Travel includes funding for management meetings, training, etc. Instituted travel reduction to comply with the OMB directive for reduced travel from FY 2010 levels.	• 36% reduction driven by HQ travel reductions, consistent with reduced extramural research activities.
Support Services $4,548,000	**$3,537,000**	**-$1,011,000**
• Support Services at Headquarters includes technical support, IT support, and administrative support.	• Support Services at Headquarters includes; technical support, IT support, site operations support, administrative support.	• HQ increase reflects full cost of required support services and additional technical support at the Import/Export Authorization office.
• Support services at NETL include finance and acquisition technicians.	• Support services at NETL include finance and acquisition technicians.	• 41% reduction NETL, driven by efficiency efforts.
Other Related Expenses $14,750,000	**$19,232,000**	**+$4,482,000**
• The activities supported by this line item include E-Government initiatives, Working Capital fund, computer systems and support, contractual services for HQ and environmental, security, safety, and health requirements at HQ.	• The activities supported by this line item include E-Government initiatives, Working Capital fund, computer systems and support, contractual services for HQ and environmental, security, safety, and health requirements at HQ.	• The funding change is primarily due to a $600,000 increase in the amount of funds required to contribute to the Working Capital Fund.

• The activities supported by this line item include staff replenishment and development related activities, as well as general materials and supplies.	• The activities supported by this line item will include initial contractor workforce reshaping costs and Federal employee relocation and retraining costs. Also included are general materials and supplies.	• Increase reflects $3,700,000 funding for initial workforce reshaping and site consolidation activities (Federal employee relocation and contractual obligations related to contractor workforce contraction).

NETL Research and Development

Overview

The National Energy Technology Laboratory (NETL) is an integral part of the U.S. Department of Energy (DOE) national laboratory system. There are 17 laboratories in the DOE laboratory system, and NETL is unique in that it is the only government owned, government operated laboratory. NETL supports the DOE mission to advance the energy security of the United States, as well as Administration interests in domestic energy production, clean coal technologies, and reviving America's coal industry. NETL has expertise in coal, natural gas, and oil technologies; contract and project management; analysis of fossil energy systems; and international fossil energy issues.

The NETL Research and Development Program supports NETL science and technology activities. The Program comprises two subprograms: (1) Research and Development; and (2) Feasibility of Recovering Rare Earth Elements (REE).

The Research and Development subprogram funds all NETL science and technology development functions, including in-house research, technical program management, and strategic scientific planning and partnerships. Specifically, Research and Development funding supports salaries and benefits, travel, personal protective equipment and other employee costs for the NETL staff of scientists, engineers, and technical project managers who conduct both in-house and extramural research activities for Fossil Energy Research and Development (FER&D) programs. This subprogram also funds contractor costs related to collaboration with universities, other national labs, state and local governments, and industry, as well as strategic energy analysis and research data management areas.

The Feasibility of Recovering Rare Earth Elements subprogram was established by Congress in 2014 to perform an assessment and analysis of the feasibility of economically recovering rare earth elements from coal and coal byproduct streams such as fly ash, coal refuse, and aqueous effluent. This subprogram thereby supports creating a domestic supply chain of critical and strategic materials, as well as exploring the opportunity to create additional value from coal extraction and use.

Highlights of the FY 2018 Budget Request

The NETL Research and Development Program is new for FY 2018. This proposed restructuring of NETL budget lines is proposed to more accurately describe NETL's funding requirements, increase consistency with other National Laboratories, and increase transparency in how funds are utilized. This will promote enhanced visibility into cost drivers and more efficient resource allocation decisions. This budget line funds all NETL science and technology development functions, including in-house research, technical program management, and strategic scientific planning and partnerships.

This Program includes funds that were part of the former NETL Coal Research and Development program, a subset of the funding from the NETL portion of Program Direction, and funding requested under the former Supercomputer program line. The shifts between the new budget structure and the previous budget structure are shown in the crosswalk that is included in the Budget Structure Crosswalks section of the FER&D narrative.

The 2018 Budget Request reflects the increased focus in FER&D on innovative, early-stage research performed at NETL, as well as reduced extramural FER&D collaborations for later-stage R&D. The reduction to extramural research accordingly yields reductions to technical support management functions.

In addition, the 2018 request includes $5.5 million for one-year of a three-year lease related to the refresh of NETL's High Performance Computer, Joule. Funding for Joule is included in this budget line rather than in the NETL Infrastructure and Operations line because Joule is strategic research equipment necessary for conducting R&D at NETL. The full lease cost is estimated at $17 million, thus, the proposed three-year lease structure yields a 2018 request of $5.5 million. Joule is a unique and collaborative tool tailored for science and engineering calculations in support of FER&D research. It advances FER&D and NETL missions by supporting complex model simulations for advanced fossil energy technology development, such as combustion modeling, carbon capture physics, and the geological dynamics of CO_2 injection and storage. These

types of simulations help overcome technical development barriers more rapidly, reliably, and cost-effectively, thereby accelerating the rate of innovation. Joule's design balances computational requirements, efficiency, usability, and collaboration techniques to deliver a premier system to NETL and its research partners. Partners on research teams using Joule include universities and industry participants with whom NETL has Cooperative Research and Development Agreements. This crucial research asset is used by more than 50% of the research teams at NETL and has a current utilization rate above 90%. These computational capabilities are increasingly relevant for NETL's re-scoped mission focusing on early-stage R&D.

Joule was commissioned in FY 2012. Given the rapid advances in computing technology, high-performance computers typically have an expected life cycle of approximately three years after which standard warranties run out, replacement parts are not readily available, and maintenance costs rapidly escalate. The requested funding is designed to cover the cost of replacing all of the out-of-warranty high-speed processors by leasing new processors. Thanks to advances in technology, the computational power of the next generation equipment will be much greater. It is anticipated that the refresh will upgrade the processing speed from 0.5 petaflops to 5 petaflops, a 10-fold increase. The requested funding allows NETL to obtain and maintain a world-class supercomputer capable of using the most advanced software to enable key energy research while also maintaining the equipment under warranty. Finally, the proposed investment is consistent with expectations for computing performance and utilization at the other 16 DOE National Laboratories.

Funding is requested by FER&D for REE for the first time in FY 2018. This activity, funded by Congress in FY 2014 through 2017, explores the feasibility of REE extraction from coal and coal byproducts. The overall objective of the program is to develop information on the techno-economic feasibility of domestic coal and coal by-product feedstock-based REE separation technologies. Preliminary results have been promising, including a workshop with academia, national labs, other state and federal agencies, and stakeholders to discuss the development of technologies to separate and recover REEs from coal and coal by-products, and developing the generation of environmentally benign REE separation processing capabilities. In January 2017 DOE submitted a report to Congress on "Rare Earth Elements from Coal and Coal Byproducts." In FY 2018, this work will advance transformational separation R&D, support continued geological and characterization activities, and fund associated in-house R&D.

While NETL is initiating a workforce reshaping and site consolidation plan, these FY 2018 restructuring costs are reflected in the request as part of the Program Direction and NETL Infrastructure and Operations budget lines. All costs associated with workforce reshaping, site consolidation, and other necessary studies are also requested in those budget lines.

NETL Research and Development
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
NETL Research and Development				
Research and Development	58,713	---	68,100	+9,387
Rare Earth Elements	15,000	---	10,000	-5,000
Total, NETL Research and Development	**73,713**	**73,573**	**78,100**	**+4,387**
Federal FTEs	**310**	**310**	299	**-11**

Federal FTEs shown above include technical project managers and procurement and finance personnel providing support to DOE's Office of Energy Efficiency and Renewable Energy (EERE) and Office of Electricity Delivery and Energy Reliability (OE). These NETL personnel are funded by those non-FER&D offices to the extent that their time is spent supporting those offices.

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

NETL Research and Development
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
NETL Research and Development: A requested increase of 4,387 from the FY 2016 Enacted is due to NETL's plans to refresh its high-performance computer, fully fund its Laboratory costs, and the expectation that EERE and OE will reduce funding for NETL FTEs, partially offset by lower funding for research on the Feasibility of Recovering Rare Earth Elements and less funding for collaboration in more mature technologies.	**+4,387**
Total, NETL Research and Development	**+4,387**

NETL Research and Development
Activities and Explanation of Changes

FY 2016 Enacted (Restructured Funding)	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NETL Research and Development $73,713,000	**$78,100,000**	**+4,387,000**
Research and Development $58,713,000	**$68,100,000**	**+$9,387,000**
• Research and Development funding at NETL provides for internal and external research and development activities, including Federal salaries/benefits, travel and employee costs for scientists, engineers, and technical project managers associated with the fossil programs. • Funding also provides for contractor costs targeted toward collaboration, strategic energy analysis and research data management areas. • Funding also enables maintenance agreements on existing laboratory equipment and licenses on specialty research software.	• Research and Development funding at NETL provides for internal and external research and development activities, including Federal salaries/benefits, travel and employee costs for scientists, engineers, and technical project managers associated with the fossil programs. • Funding also provides for contractor costs targeted toward collaboration, strategic energy analysis and research data management areas. • Funding also enables strategic laboratory equipment upgrades, maintenance agreements on existing laboratory equipment and licenses on specialty research software.	• Increase reflects funding for strategic research equipment upgrades – including refresh of NETL's High Performance Computer to better-position NETL for the new FER&D focus primarily on early-stage R&D. Laboratory research equipment upgrades include scientific computer software renewals, licensing agreement extensions, and implementation of a planned refresh cycle for highly specialized research equipment. • Increase also reflects expectation that EERE and OE will fund fewer NETL FTEs to support their programs in FY 2018.

FY 2016 Enacted (Restructured Funding)	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Rare Earth Elements $15,000,000	**$10,000,000**	**-$5,000,000**
• Supports geological and characterization activities needed for finding rare earth assays associated with coal and coal byproducts, which will ultimately support commercial U.S. domestic production of rare earths and other strategic materials from coal and coal byproducts. • Continued pilot scale technology development resultant from the FY 2015 Funding Opportunity Announcement.	• Supports transformational early-stage R&D in the areas of mineralogy, pressure leaching, continuous ion chromatography, and hydrometallurgy to improve the economics of REE production from coal byproducts. • Supports continued knowledge development of geological and characterization activities such as knowledge of host rock properties and REE	• Decrease in funding reflects down selects for transformational separation awards.

• Funds in-house research activities to explore the feasibility of viable production economics.	mineralization in high REE content zones, along with the distributive properties of these parameters (i.e. with respect to particle size and specific gravity). • Funds in-house research activities including continued sampling, analysis, and characterization of REE in coal and coal mining waste and economic feasibility analyses.

NETL Infrastructure and Operations

Overview

The NETL Infrastructure and Operations Program supports the upkeep of NETL's lab footprint in three geographic locations: Morgantown, WV; Pittsburgh, PA; and Albany, OR. Table 1 below provides relevant information on the relative sizes of the sites.

The NETL Infrastructure and Operations Program comprises the following subprograms:

(1) **Site Operations and Maintenance** provides for NETL's facility operations, information technology, and Science and Technology (S&T) career management functions. It includes salaries and benefits, travel, and other employee costs for the NETL Laboratory Operations staff who manage the following activities: (1) site and facility operations and maintenance, including physical security; (2) information technology activities; and (3) development, implementation, integration and monitoring of a comprehensive career management program that includes the current and prospective NETL workforce. Given future workforce reshaping efforts, this subprogram will become increasingly vital to NETL's long-term success. This subprogram does not include salaries and benefits for project management, technical or scientific staff.

The subprogram also includes contractor and related equipment costs for modification and repair of existing laboratories and site-wide buildings and general purpose infrastructure, and operation and maintenance of buildings and grounds, including utilities and related equipment. It also includes funding to ensure reliable operation of IT hardware and applications, Internet and Intranet, telecommunications systems, and cybersecurity in performing the Fossil Energy research and development (FER&D) mission of NETL.

Also, in 2018, this subprogram includes facilities and laboratory asset-related funds for the proposed footprint consolidation described below.

(2) **Plant and Capital Equipment** includes construction of new, and renovation of existing, laboratory facilities and general-purpose buildings and site-wide infrastructure. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High Performance Sustainable Building goals.

(3) **Environmental Restoration** supports NETL's Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) obligations across all NETL sites and two off-site locations in Wyoming.

Table 1: Comparison of Physical Footprint, Workforce, and Value of Assets by Campus and in Total, National Energy Technology Laboratory as of April 30, 2017

	Morgantown	Pittsburgh	Albany	Total NETL
Buildings	45	29	38	112
Sq. Ft. of building space	454,654	455,821	248,122	1,158,597
Acres	136.0	62.6	43.9	242.5
NETL Federal Workforce (FTEs)	239	243	40	522
NETL Contractor Workforce (FTEs)	373	310	69	752
Assets Replacement Value	$247.2M	$212.6M	$111.6M	$571.4M

Table 2 below displays the total Fossil Energy Research & Development (FER&D) Federal workforce and reconciles it to the FY 2018 Budget Appendix.

Table 2: Reconciliation of FER&D Federal Employees (FTEs)

Program FTEs are funded in:					Headcount	
	FY 2016	FY 2017	FY 2018		Actual 4/30/17	Projected 9/30/18
NETL Research & Development	310	310	299		313	282
NETL Program Direction	139	139	134		140	126
NETL Infrastructure & Operations	73	73	70		73	66

TOTAL NETL	**522**	**522**	**503**		**526**	**474**
FE HQ Program Direction	116	116	112		116	104
TOTAL FER&D	**638**	**638**	**615**		**642**	**578**
FY 2018 Budget Appendix	569	638	615		N/A	N/A
Difference	69	-	-		N/A	N/A

The majority of the difference in Federal FTEs in 2016 is that the FY 2018 Budget Appendix erroneously omitted the Federal FTEs in the NETL Infrastructure & Operations budget line. The balance is due to the difference between the actual FTE usage compared to budget authority FTE level.

Highlights of the FY 2018 Budget Request

The NETL Infrastructure and Operations Program is new for FY 2018. This proposed restructuring of NETL budget lines is necessary to better describe NETL's funding requirements, increase consistency with other National Laboratories, and increase transparency in how funds are utilized, promoting enhanced visibility into cost drivers and more efficient resource allocation decisions. This budget line funds the Facility and Site Operations, Information Technology, and S&T Career Management functions at NETL.

This budget line includes the former Plant & Capital Equipment program and the former Environmental Restoration line, except for $1 million that has been moved to Program Direction for Environmental Oversight activities at HQ. It also includes site operations and information technology funds, formerly in the Program Direction budget line. The shifts between the new budget structure and the previous budget structure are shown in the crosswalk that is included in the Budget Structure Crosswalks section of the FER&D narrative.

As part of the Department's effort to operate more efficiently, this Request includes a phased approach to consolidation of NETL's Albany research operations into NETL's Eastern sites and commissioning of a Mission Alignment study beginning in Q3 FY 2017 that includes: (1) Evaluation of alternatives for locating NETL's Alloy Metallurgy Capabilities; (2) Study of Environmental Impacts Responsibility & Remediation at the Albany site; and (3) Analysis of Alternatives for Configuration of NETL's Eastern Sites.

In executing the plan for NETL's footprint during 2018, NETL expects to design, seek approval for, and implement workforce reshaping initiatives for the 40 Federal employees at the Albany site. These initiatives include a Voluntary Early Retirement Act (VERA) and Voluntary Separation Incentive Plan (VSIP); voluntary relocation; retraining and cross training as appropriate, and to the extent necessary, establishment of an outplacement services taskforce. The workforce reshaping initiatives will also factor in NETL's contractor workforce in Albany, currently 69 FTEs. The 2018 request also includes costs to initiate targeted VERA and VSIP plans for NETL's Eastern sites. Costs related to workforce reshaping are included in the Program Direction funding line.

During FY 2018, NETL will initiate real property disposal activities in Albany. These activities include engaging with the General Services Administration (GSA), as the Site Project Manager; initiating remediation actions as dictated by the Study of Environmental Impacts Responsibility & Remediation; and relocating NETL's Materials Fabrication and Geological Sciences equipment to an Eastern NETL site, as informed by the planned 2017 Analysis of Alternatives for Configuration of NETL's Eastern Sites. NETL will continue to aggressively pursue operational efficiencies; however, until the Albany site is exited, site operations and maintenance activities must be maintained at substantially similar levels to present day.

Given the long lead time required to implement workforce reshaping activities and cross-country physical consolidation of NETL's Materials capabilities currently resident at the Albany site, minimal program decreases are projected during FY 2018. More substantial funding decreases begin during FY 2019 and are fully achieved by FY 2020. Similarly, while headcount reductions are anticipated during 2018, Full Time Equivalent (FTE) numbers will drop more slowly given the time frame to implement these plans. Table 2 above illustrates the projected headcount (end of year employees) and the FTEs (weighted average during the year).

Certain site wide upgrades at NETL's Eastern sites are postponed pending the results of the planned 2017 Analysis of Alternatives for Configuration of NETL's Eastern Sites.

FY 2018 Departmental Crosscuts ($K)

	Cybersecurity		Total	
	2016 Enacted	2018 Request	2016 Enacted	2018 Request
NETL Infrastructure and Operations	1,750	3,183	1,750	3,183

Within the FY 2018 Budget Request, the NETL Infrastructure and Operations line supports one Departmental Crosscut: Cybersecurity. For FER&D, this includes operation and enhancement of the FER&D cybersecurity policy and program as it relates to the enterprise computing environment at field locations. Key activities include cybersecurity policy implementation, governance and oversight activities, incident detection and response through continuous monitoring and diagnostics, and meeting Departmental requirements for the Identity Control and Access Management initiative. Within the FY 2018 budget request for NETL Infrastructure, $3.183 million will be used to support these crosscutting cyber activities. Cybersecurity is funded under the Site Operations and Maintenance subprogram. The $1.433 million increase from 2016 is attributed to the estimated cost of addressing identified cyber security weaknesses listed in NETL's Plan of Action and Milestones document. Specific areas of focus include expanding vulnerability scanning capabilities, improving hardware and software asset management capabilities, improving account management capabilities, with a focus on privileged accounts, expanding and improving multifactor authentication, and replacing critical end-of-life network equipment.

NETL Infrastructure and Operations
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
NETL Infrastructure and Operations				
Site Operations and Maintenance	46,271	---	47,000	+729
Plant & Capital Equipment	15,782	---	13,800	-1,982
Environmental Restoration	2,295	---	2,300	+5
Total, NETL Infrastructure and Operations	**64,348**	**64,225**	**63,100**	**-1,248**
Federal FTEs	**73**	**73**	**70**	**-3**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

NETL Infrastructure and Operations
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
NETL Infrastructure and Operations: A decrease of $1,248,000 from the FY 2016 Enacted funding level reflects reduced Plant and Capital Equipment funding at NETL's Albany site and other cost reduction measures offsetting increased cybersecurity costs and general cost inflation.	**-1,248**
Total, NETL Infrastructure and Operations	**-1,248**

NETL Infrastructure and Operations

Activities and Explanation of Changes

FY 2016 Enacted (Restructured Funding)	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
NETL Infrastructure and Operations $64,348,000	**$63,100,000**	**-$1,248,000**
Site Operations and Maintenance $46,271,000	**$47,000,000**	**+$729,000**
• Funding is to support the upkeep of the laboratory and site-wide buildings and infrastructure at NETL's 3 sites. Costs include security, building maintenance, grounds upkeep, environmental health and safety, utilities and related equipment. The subprogram also ensures reliable operation of IT hardware and applications, Internet and Intranet, telecommunications systems, and cybersecurity in performing the FER&D mission of NETL.	• Funding is to support the upkeep of the laboratory and site-wide buildings and infrastructure at NETL's 3 sites. Costs include security, building maintenance, grounds upkeep, environmental health and safety, utilities and related equipment. The subprogram also ensures reliable operation of IT hardware and applications, Internet and Intranet, telecommunications systems, and cybersecurity in performing the FER&D mission of NETL. In FY 2018, this subprogram also includes costs related to the initiation of planned site consolidation activities.	• Increase reflects the estimated cost of addressing identified cyber security weaknesses listed in NETL's Plan of Action and Milestones document in compliance with Federal Information Technology Acquisition Reform Act (FITARA) requirements. • An increase of $4.5 million for site consolidation-related costs (relocation of Materials Fabrication and Geological Sciences equipment, Lab refurbishment, and estimated site remediation costs) are more than offset by planned cost reductions and efficiencies related to the contractor workforce ($5.7M). NETL's workforce mix for performing site operation and maintenance activities is nearly 80% contractor. Planned funding decreases are in the Facility Operations areas across all sites, including engineering, warehousing, and fleet operations. Additional site maintenance cost reductions are Albany-specific.
Plant & Capital Equipment $15,782,000	**$13,800,000**	**-$1,982,000**
• Plant & Capital Equipment includes construction of new, and renovation of existing, laboratory facilities and general-purpose buildings and site-wide infrastructure. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High Performance Sustainable Building goals.	• Plant & Capital Equipment includes construction of new, and renovation of existing, laboratory facilities and general-purpose buildings and site-wide infrastructure. Priorities for funding are established to ensure compliance with life safety standards, ensure critical laboratory research facilities and infrastructure, and comply with High Performance Sustainable Building goals.	• Funding reduction reflects minimal capital projects planned at NETL's Albany site, due to the planned consolidation.

FY 2016 Enacted (Restructured Funding)	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Environmental Restoration $2,295,000	**$2,300,000**	**+$5,000**
• Continue active operation and maintenance of the air sparge remediation system at Rock Springs Sites 4, 6,7, 9 and 12 as well as well as a 10-year surface revegetation at the Hoe Creek Site. Continue RCRA-related on-site regulatory, corrective, preventative, and maintenance activities – such as asbestos and lead abatement, waste minimization, and pollution prevention – along with the NETL Albany ground water investigation and compliance activities.	• Continue active operation and maintenance of the air sparge remediation system at Rock Springs Sites 4, 6,7, 9, and 12 as well as well as a 10-year surface revegetation at the Hoe Creek Site. Continue RCRA-related on-site regulatory, corrective, preventative, and maintenance activities – such as asbestos and lead abatement, waste minimization, and pollution prevention – along with the NETL Albany ground water investigation and compliance activities.	• Minimal increase for materials and supplies.

Plant and Capital Equipment
Capital Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2017 Annualized CR[2]	FY 2018 Request	FY 2018 vs FY 2016
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE))						
Plant Projects (GPP and IGPP) (<$10M)	n/a	n/a	15,782	15,752	13,800	-1,982
Total, Capital Operating Expenses	**n/a**	**n/a**	**15,782**	**15,752**	**13,800**	**-1,982**
Plant Projects (GPP and IGPP) (Total Estimated Cost (TEC) <$10M)						
Total Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$5M)	n/a	n/a	15,782	15,752	13,800	-1,982
Total, Plant Projects (GPP/IGPP) (Total Estimated Cost (TEC) <$10M)	**n/a**	**n/a**	**15,782**	**15,752**	**13,800**	**-1,982**
Total, Capital Summary	**n/a**	**n/a**	**15,782**	**15,752**	**13,800**	**-1,982**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

Fossil Energy Research and Development
Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction)
($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
National Energy Technology Laboratory	18,507	13,945	14,363	14,363
Total, Direct-Funded Maintenance and Repair	**18,507**	**13,945**	**14,363**	**14,363**

Report on FY 2016 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. Conf. Rep. No. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2016 to the amount planned for FY 2016, including Congressionally directed changes.

Total Costs for Maintenance and Repair
($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost
National Energy Technology Laboratory	18,507	13,945
Total, Direct-Funded Maintenance and Repair	**18,507**	**13,945**

In review of the planned vs actual costs for FY 2016, National Energy Technology Laboratory utilized the additional $4,562K toward multiple small projects for maintenance and repair to limit or reduce growth in deferred maintenance levels.

Fossil Energy Research and Development
Research and Development
($K)[1]

	FY 2016 Enacted	FY 2017 Annualized CR[2]	FY 2018 Request[3]	FY 2018 vs FY 2016
Basic	6,087	6,046	15,279	+9,192
Applied	225,223	223,686	290,299	+65,076
Development	377,400	374,826	0	-377,400
Subtotal, R&D	**608,710**	**604,558**	**305,578**	**-303,132**
Equipment	15,782	15,752	19,300	+3,518
Construction	0	0	0	0
Total, R&D	**624,492**	**620,310**	**324,878**	**-299,614**

[1] R&D reporting includes a proportional share of Program Direction (minus import/export), NETL Research and Development (minus supercomputer), and NETL Infrastructure and Operations (minus CERCLA, RCRA and plant and capital equipment). Plant and Capital Equipment and funding for the Supercomputer are counted as Equipment. This funding was not included in the R&D reporting in the FY 2016 and prior year budget justifications. It was included in our FY 2017 budget submission and is included in this submission as well. This change is being made to better align with international standards on reporting funding for R&D. Since these activities are necessary in order for R&D to be performed, they are now included in the conduct of R&D.

[2] FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year.

[3] FY 2018 R&D funding differs from the R&D totals in the Budget Appendix. Totals in the Budget Appendix are based on $280 million in new Budget Authority. The FY 2018 estimates shown here include $55.178 million in use of prior year balances, for a total program level of $335.178 million. Fossil Energy is focusing on early-stage research and development which is reflected in the zero funding amount for Development R&D.

Fossil Energy Research and Development
Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR)
($K)

	FY 2016 Current/ Transferred	FY 2017 CR Annualized Projected Transfer[1]	FY 2018 Request/ Projected Transfer	FY 2018 vs FY 2016
CCS and Power Systems				
SBIR	10,483	11,159	3,295	-7,188
STTR	1,571	1,569	463	-1,108
Natural Gas Technologies				
SBIR	1,213	1,292	166	-1,047
STTR	182	182	23	-159
Unconventional Fossil Energy Technologies from Petroleum – Oil Technologies				
SBIR	573	610	451	-122
STTR	86	86	64	-22
Total, SBIR/STTR	**14,108**	**14,898**	**4,462**	**-9,646**

[1] The SBIR amount goes up in the 2017 CR Annualized calculation because the percentage increased to 3.2% from the FY 2016 percentage of 3%. The STTR percentage stayed the same from FY 2016 to FY 2017 so that amount decreases.

Fossil Energy Research and Development
Safeguards and Security
($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Protective Forces	3,666	--	2,723	-943
Physical Security Systems	257	--	325	+68
Information Security	54	--	56	+2
Cyber Security	1,750	--	3,183	+1,433
Personnel Security	173	--	168	-5
Material Control and Accountability	680	--	721	+41
Program Management	220	--	233	+13
Security Investigations	0	--	0	0
Transportation Security	0	--	0	0
Research and Development	1,848	--	1,881	+33
Construction	0	--	0	0
Total, Safeguards and Security	**8,648**	**8,632**	**9,290**	**+642**

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Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Fossil Energy Research and Development	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Ames Laboratory			
CCS and Power Systems			
Advanced Energy Systems	500	499	0
Cross Cutting Reasearch	1,255	1,253	200
Total, CCS and Power Systems	**1,755**	**1,752**	**200**
Total, Ames Laboratory	**1,755**	**1,752**	**200**
Lawrence Berkeley National Laboratory			
CCS and Power Systems			
Carbon Storage	1,206	1,204	100
Cross Cutting Reasearch	3,094	3,088	0
Total, CCS and Power Systems	**4,300**	**4,292**	**100**
Natural Gas Technologies			
Natural Gas Technologies	1,270	1,268	75
Total, Lawrence Berkeley National Laboratory	**5,570**	**5,560**	**175**
Lawrence Livermore National Laboratory			
CCS and Power Systems			
Carbon Capture	2,113	2,109	0
Cross Cutting Reasearch	1,350	1,347	0
Total, CCS and Power Systems	**3,463**	**3,456**	**0**
Total, Lawrence Livermore National Laboratory	**3,463**	**3,456**	**0**
Los Alamos National Laboratory			
CCS and Power Systems			
Carbon Storage	1,149	1,147	80
Cross Cutting Reasearch	750	749	0
Total, CCS and Power Systems	**1,899**	**1,896**	**80**
Total, Los Alamos National Laboratory	**1,899**	**1,896**	**80**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Fossil Energy Research and Development	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
National Energy Technology Lab			
CCS and Power Systems			
Carbon Capture	92,184	92,010	14,261
Carbon Storage	102,153	101,960	14,735
Advanced Energy Systems	101,900	101,706	13,550
Cross Cutting Reasearch	33,961	33,896	32,491
STEP (Supercritical CO2)	15,000	14,971	0
NETL Coal R&D	53,000	52,899	0
Total, CCS and Power Systems	**398,198**	**397,442**	**75,037**
Natural Gas Technologies			
Natural Gas Technologies	38,665	38,591	5,425
Program Direction			
National Energy Technology Center Program Direction	83,893	83,733	25,800
Fossil Energy Environmental Restoration			
Fossil Energy Environmental Restoration	7,920	7,905	0
Plant & Capital Equipment			
Plant & Capital Equipment	15,782	15,752	0
Unconventional FE Technologies from Petroleum – Oil			
Unconventional FE Technologies from Petroleum – Oil	19,585	19,547	15,000
NETL Research and Operations			
NETL Research and Operations	0	0	78,100
NETL Infrastructure			
NETL Infrastructure	0	0	63,100
Total, National Energy Technology Lab	**564,043**	**562,970**	**262,462**
Oak Ridge National Laboratory			
CCS and Power Systems			
Advanced Energy Systems	1,000	998	0
Cross Cutting Reasearch	1,805	1,802	0
Total, CCS and Power Systems	**2,805**	**2,800**	**0**
Natural Gas Technologies			
Natural Gas Technologies	40	40	0
Total, Oak Ridge National Laboratory	**2,845**	**2,840**	**0**
Pacific Northwest National Laboratory			
CCS and Power Systems			
Carbon Capture	963	961	500
Cross Cutting Reasearch	975	973	175
Total, CCS and Power Systems	**1,938**	**1,934**	**675**
Natural Gas Technologies			
Natural Gas Technologies	50	50	0
Total, Pacific Northwest National Laboratory	**1,988**	**1,984**	**675**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Fossil Energy Research and Development	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Sandia National Laboratories			
CCS and Power Systems			
Carbon Storage	370	369	85
Cross Cutting Reasearch	1,060	1,058	500
Total, CCS and Power Systems	**1,430**	**1,427**	**585**
Total, Sandia National Laboratories	**1,430**	**1,427**	**585**
Washington Headquarters			
CCS and Power Systems			
Carbon Capture	5,740	5,729	1,239
Carbon Storage	1,122	1,120	0
Advanced Energy Systems	1,600	1,597	32,450
Cross Cutting Reasearch	5,750	5,739	4,434
Total, CCS and Power Systems	**14,212**	**14,185**	**38,123**
Natural Gas Technologies			
Natural Gas Technologies	2,975	2,969	0
Program Direction			
Headquarters Program Direction	30,309	30,251	32,678
Fossil Energy Environmental Restoration			
Fossil Energy Environmental Restoration	75	75	0
Special Recruitment Programs			
Special Recruitment Programs	700	699	200
Unconventional FE Technologies from Petroleum – Oil			
Unconventional FE Technologies from Petroleum – Oil	736	735	0
Total, Washington Headquarters	**49,007**	**48,914**	**71,001**
Total, Fossil Energy Research and Development	**632,000**	**630,799**	**335,178**

Naval Petroleum and Oil Shale Reserves

Naval Petroleum and Oil Shale Reserves

Naval Petroleum and Oil Shale Reserves
Proposed Appropriation Language

For Department of Energy expenses necessary to carry out naval petroleum and oil shale reserve activities, $4,900,000 to remain available until expended: Provided, That notwithstanding any other provision of law, unobligated funds remaining from prior years shall be available for all naval petroleum and oil shale reserve activities.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

New FY 2018 budget authority of $4.9 million and $15.3 million in prior-year unobligated balances will fund continued environmental assessment and remediation activity at the Naval Petroleum Reserve No. 1 (NPR-1) site and post-sale remediation and closure activities at the Naval Petroleum Reserve No. 3 (NPR-3) site.

Public Law Authorizations

- P.L. 94-258, U.S. Naval Petroleum reserves Production Act of 1977
- P.L. 95-91, U.S. Department of Energy Organization Act of 1977
- P.L. 104-106, The National Defense Authorization Act For Fiscal Year 1996
- P.L. 105-261, The Strom Thurmond National Defense Act for Fiscal Year 1999
- P.L. 109-58, Energy Policy Act of 2005

Naval Petroleum and Oil Shale Reserves
($K)

FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request
17,500	17,467	4,900[1]

* The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

The Naval Petroleum and Oil Shale Reserves (NPOSR) program manages five legal agreements that were executed as part of the 1998 sale of Naval Petroleum Reserve 1 (NPR-1) in Elk Hills, California. The legal agreements direct post-sale work, including environmental restoration and remediation, contract closeout, and records disposition. Legal agreements also include payment for post-employment medical and dental benefits to former Management & Operating (M&O) contractor employees. The NPR-1 program continues to work towards closing out the remaining environmental findings at the site, as required by the 2008 agreement between the Department of Energy (DOE) and the California Department of Toxic Substances Control (DTSC).

DOE also operated Naval Petroleum Reserve 3 (NPR-3) and the Rocky Mountain Oilfield Testing Center (RMOTC), co-located near Casper, Wyoming. The implementation plan for selling the facility and closing out the office has been completed. DOE retains responsibility for Industrial Landfill number 2 (IND-2) located at NPR-3 until a closure permit is issued by the Wyoming Department of Environmental Quality (WDEQ). DOE will oversee completion of remediation activities in FY 2018. Following remediation, ground water sampling will begin in compliance with WDEQ requirements. The period of sampling will be specified by WDEQ following remediation but is expected to continue for four to seven years. No new FY 2018 Budget Authority is being requested for NPR-3 as prior-year balances are sufficient to fund ongoing remediation and monitoring activities through NPR-3 closeout.

Highlights and Major Changes in the FY 2018 Budget Request

NPR-1 will continue to work with California Resources Corporation (CRC; formerly Occidental), Chevron, and the California DTSC on the environmental remediation and cultural resource activities in accordance with the 2008 DTSC Corrective Action Consent Agreement to obtain a status of No Further Action (NFA) required for 131 Areas of Concern (AOC). Also included is the payment to former M&O contractor employees for post-employment medical and dental benefits.

NPR-3 will continue remediation activities for the landfill closure with oversight by the Washington Headquarters office.

[1] This is the new FY 2018 budget authority requested and therefore does not include the use of $15,300,000 in prior-year unobligated balances.

Naval Petroleum and Oil Shale Reserves
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Naval Petroleum and Oil Shale Reserves				
Production Operations	13,330	---	18,200	+4,870
Management	4,170	---	2,000	-2,170
Subtotal, Naval Petroleum and Oil Shale Reserves	**17,500**	**17,467**	**20,200**	**+2,700**
Use of Prior Year Balances			-15,300	-15,300
Total, Naval Petroleum and Oil Shale Reserves	**17,500**	**17,467**	**4,900**	**-12,600**
Federal FTEs	**8**	**4**[2]	**4**	**-4**

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[2] Reduction in FTEs from FY 2016 to FY 2017 is due to the sale of NPR-3 and closure of the Casper, Wyoming office.

Naval Petroleum and Oil Shale Reserves
Production Operations

Overview

The NPR-1 program continues to close out the remaining environmental restoration and remediation activities for 131 AOCs, as required by the 2008 agreement between DOE and California's DTSC. DOE will continue the monitoring and oversight of environmental remediation of the Elk Hills site and the work on records disposition.

The NPR-3 program will continue post-sale remediation activities for the closure of the landfill using prior-year balances. No new FY 2018 Budget Authority is requested for NPR-3.

Highlights of the FY 2018 Budget Request

The program will continue the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1. As of the end of FY 2016, all AOCs have undergone an initial investigation and the program has made recommendations to California's DTSC for either NFA status, additional investigation, or remedial action.

The FY 2018 request includes funding for implementation of and reporting on sampling and investigation activities and remedial action work plans. In FY 2018, remedial action work plans will be developed for three trenches, three gas plants, fifty well pads, and seven sumps. The FY 2018 request also includes funding to implement remedial action work plans for six sumps that sampling and analysis have shown exceed safe human health levels. Contaminated soils from two trenches, one gas plant and five sumps will be dug and either hauled or capped as part of the clean closure process. The contaminated soil will be disposed of in accordance with state and federal regulations.

Of the 131 AOCs for which DOE is responsible for environmental cleanup, as of April 12, 2017, 51 AOCs have received NFA certification from California's DTSC, 2 AOCs are being prepared by the Department for NFA certification based on data assessments, 36 AOCs are under DTSC review, 27 AOCs that have undergone an initial filed work investigation now require additional testing, and 15 AOCs are awaiting field investigation or remediation activities.

Production Operations
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
NPR-1 Closeout – Planned Activity Level	12,330	---	16,600	+4,270
NPR-3 Disposition – Planned Activity Level	1,000	---	1,600	+600
Total, Production Operations	**13,330**	**---**	**18,200**	**+4,870**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

Production Operations
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
NPR-1 Closeout – Planned Activity Level: $13,700,000 in prior-year funds will supplement new FY 2018 budget authority of $2,900,000 to finance continued environmental assessment and remediation activity, in accordance with NPR-1 post-sale legal agreements.	**+4,270**
NPR-3 Disposition – Planned Activity Level: No FY 2018 Budget Authority is requested. $1,600,000 in prior-year funds will support NPR-3 ongoing post-sale remediation monitoring activities through NPR-3 closeout in four to seven years.	**+600**
Total, Production Operations	**+4,870**

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018	Explanation of Changes FY 2018 vs FY 2016
Production and Operations $13,330,000	**Planned Activity Level: $18,200,000**	**+$4,870,000**
NPR-1 Closeout $12,330,000	**Planned Activity Level: $16,600,000**	**+$4,270,000**
NPR-1 continued the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1 Elk Hills. Work plans were developed for additional characterization, surface samples, and borings for sumps that exceed safe human health levels to determine full vertical and lateral extent of the arsenic contamination. Remedial action work plans were developed for four sumps that exceed safe human health levels for consolidation and clean closure. Also in FY 2016, sixteen supplemental investigative sampling work plans, seven implementation reports, and two remedial action work plans were completed. Remediation was completed at four AOCs. Received nine NFAs from California's DTSC.	Program will continue the ongoing activities to attain release from the remaining environmental findings related to the sale of NPR-1. In FY 2018, remedial action work plans will be developed for three trenches, three gas plants, fifty well pads, and seven sumps. The FY 2018 request includes implementation of remedial action work plans for six sumps that sampling and analysis have shown exceed safe human health levels. Contaminated soils from two trenches, one gas plant and five sumps will be dug and either hauled or capped as part of the clean closure process. The contaminated soil will be disposed of in accordance with state and federal regulations.	Program intends to use $13,700,000 in prior-year funds to supplement new FY 2018 budget authority of $2,900,000 which provides for some acceleration of environmental remediation activities.
NPR-3 Disposition $1,000,000	**Planned Activity Level: $1,600,000**	**+$600,000**
Completion of Phase III of the NPR-3 Disposition.	Disposition completed; post-sale remediation monitoring activities for the landfill are ongoing.	$1,600,000 in prior-year funds will support ongoing NPR-3 post-sale remediation monitoring activities through NPR-3 closeout in four to seven years.

Naval Petroleum and Oil Shale Reserves
Management

Overview

Management provides the Federal staffing resources and associated costs required to provide overall direction and execution of the NPOSR. There are a variety of inherently governmental functions, such as program management, contract administration, and budget formulation and execution that require a dedicated Federal workforce. NPOSR uses contractor support services and other related expenses to support the field environmental assessment, remediation and management of the program.

Highlights of the FY 2018 Budget Request

The NPR-1 funding supports Federal staff that provide oversight and monitor environmental clean-up and records disposition activities. The sales agreement also includes payments to former M&O contractor employees for post-medical and dental benefits.

NPR-3/RMOTC final office closeout was completed December 30, 2015; however, administrative oversight of the landfill closure will continue to be conducted by the Department of Energy Headquarters office. No new FY 2018 Budget Authority is requested for NPR-3.

Management
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Washington Headquarters				
Salaries and Benefits	525	---	525	0
Travel	50	---	50	0
Support Services	450	---	425	-25
Other Related Expenses	1,045	---	1,000	-45
Total, Washington Headquarters	**2,070**	**---**	**2,000**	**-70**
NPR – Wyoming				
Salaries and Benefits	860	---	0	-860
Travel	35	---	0	-35
Support Services	905	---	0	-905
Other Related Expenses	300	---	0	-300
Total, NPR – Wyoming	**2,100**	**---**	**0**	**-2,100**
Total Management				
Salaries and Benefits	1,385	---	525	-860
Travel	85	---	50	-35
Support Services	1,355	---	425	-930
Other Related Expenses	1,345	---	1,000	-345
Total, Management	**4,170**	**---**	**2,000**	**-2,170**
Federal FTEs	**8**	**---**	**4**	**-4**
Support Services				
Technical Support				
Environmental, Safety, Security & Health	270	---	0	-270
Technical Services	450	---	400	-50
Total, Technical Support	**720**	**---**	**400**	**-320**
Management Support				
Business Administration	360	---	0	-360

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
IT Support	275	---	25	-250
Total Management Support	**635**	**---**	**25**	**-610**
Total, Support Services	**1,355**	**---**	**425**	**-930**
Other Related Expenses				
Rent to Others	115	---	0	-115
Communications, Utilities & Misc.	90	---	0	-90
Other Services	1,120	---	1,000	-120
Operation and Maintenance of Equipment	5	---	0	-5
Supplies and Materials	15	---	0	-15
Total, Other Related Expenses	**1,345**	**---**	**1,000**	**-345**

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Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Management $4,170,000	**$2,000,000**	**-$2,170,000**
Salaries and Benefits $1,385,000	**$525,000**	**-$860,000**
Continued monitoring (cultural resources mitigation, environmental clean-up, oversight and audit) activities at NPR 1 and NPR 3.	Continue monitoring (cultural resources mitigation, environmental clean-up, oversight and audit) activities at NPR-1. No new FY 2018 Budget Authority is requested for NPR-3.	Reduction of salaries reflects closure of NPR-3 office.
Travel $85,000	**$50,000**	**-$35,000**
Federal travel remained at prior reduced levels and was available to accomplish disposition process and environmental cleanup.	Federal travel will be required for environmental cleanup at NPR-1. No new FY 2018 Budget Authority is requested for NPR-3.	Reduction of travel activities reflects closure of NPR-3.
Support Services $1,355,000	**$425,000**	**-$930,000**
Support services provided for ESS&H, IT, Finance, and Technical Services supported disposition of the site at NPR-3 and environmental clean-up of NPR-1.	Support Services for environmental clean-up of NPR-1. No new FY 2018 Budget Authority is requested for NPR-3.	Reduction of services reflects closure of NPR-3.
Other Related Expenses $1,345,000	**$1,000,000**	**-$345,000**
Funding provided for communication services, materials and supplies, services; lease of Casper office and NPR Headquarters other expenses. Office lease expired December 2015.	As in prior years, funding provides for post-employment medical and dental benefits for former M&O contractor employees at NPR 1. No new FY 2018 Budget Authority is requested for NPR-3.	Reduction of expenses reflects closure of NPR-3.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Naval Petroleum and Oil Shale Reserves	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Naval Petroleum Reserve No 1			
Naval Petroleum and Oil Shale Reserves			
Productions Operations	12,330	12,307	16,600
Management	1,000	998	1,000
Total, Naval Petroleum and Oil Shale Reserves	**13,330**	**13,305**	**17,600**
Total, Naval Petroleum Reserve No 1	**13,330**	**13,305**	**17,600**
Naval Petroleum Reserve No 3			
Naval Petroleum and Oil Shale Reserves			
Productions Operations	1,000	998	1,600
Management	2,100	2,096	0
Total, Naval Petroleum and Oil Shale Reserves	**3,100**	**3,094**	**1,600**
Total, Naval Petroleum Reserve No 3	**3,100**	**3,094**	**1,600**
Washington Headquarters			
Naval Petroleum and Oil Shale Reserves			
Management	1,070	1,068	1,000
Total, Washington Headquarters	**1,070**	**1,068**	**1,000**
Total, Naval Petroleum and Oil Shale Reserves	**17,500**	**17,467**	**20,200**

Strategic Petroleum Reserve

Strategic Petroleum Reserve

Strategic Petroleum Reserve
Proposed Appropriation Language

For Department of Energy expenses necessary for Strategic Petroleum Reserve facility development and operations and program management activities pursuant to the Energy Policy and Conservation Act (42 U.S.C. 6201 et seq.), $180,000,000, to remain available until expended.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

Decrease reflects reduction of the Cavern Integrity Program, Major Maintenance Projects, preventive/corrective maintenance activities, Physical Security Program, replacement of information technology hardware and software necessary to support storage integrity and drawdown readiness at SPR's underground storage caverns.

Public Law Authorizations

- Public Law 109-58, "Energy Policy Act of 2005"

Strategic Petroleum Reserve

($K)

FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request
212,000	211,597	180,000

* The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

The Strategic Petroleum Reserve (SPR) protects the U.S. economy from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, P.L. 94-163, as amended, Section 151). The SPR benefits the United States by providing an insurance policy against potential interruptions in U.S. petroleum supplies, whether originating from domestic or international supply disruptions, natural disasters, sabotage, or acts of terrorism.

FY 2018 funds support the program's operational readiness and drawdown capabilities. The SPR will continue conducting multiple non-emergency crude oil sales as directed by sections 403 and 404 of the Bipartisan Budget Act of 2015 (P.L. 114-74) and Section 5010 of the 21st Century Cures Act (P.L. 114-255). In accordance with the Bipartisan Budget Act of 2015, Section 403 directs the sale of 5 million barrels in FY 2018, while Section 404 authorizes DOE, subject to appropriation, to sell SPR oil up to the authorized revenue ceiling to fund the SPR Modernization Program, to include up to $350 million in FY 2018 year. Under Section 5010 of the 21st Century Cures Act, the Secretary of Energy is directed to draw down and sell 9 million barrels of crude oil in FY 2018.

The FY 2018 Budget proposes an SPR half-liquidation sale to sell approximately 270 million barrels of SPR crude oil by 2027—roughly half of the remaining SPR inventory after all sales currently authorized by law are completed. The post-sale projected SPR inventory would be approximately 250-260 million barrels. As sales progress, SPR operational storage sites would be reduced from four to two. The SPR Program will commence a comprehensive analysis to determine the selection of sites to be decommissioned and associated operational impacts. Statutory changes will be needed to enable this SPR half-liquidation sale (e.g., to lower the emergency floor, drawdown requirements, etc.), and these directed sales would be scheduled such that they maximize revenue and minimize potential price/supply effects.

Highlights and Major Changes in the FY 2017 Budget Request

This FY 2018 request will support the SPR's operational readiness and drawdown capability of 4.16 million barrels per day. The SPR program will pursue the following major activities in FY 2018:

- Continue the degasification of crude oil inventory at the West Hackberry site to ensure its availability, and conduct cavern wellbore diagnostic and remediation activities.
- Support the program's ability to meet performance goals and milestones/targets. Under the Performance Goal of Sustained (90 day) Drawdown rate- Enable ready distribution of SPR oil by achieving maximum sustained (90 day) drawdown rate of 4.4 million barrels per day, the target drawdown rate has been revised to 4.16 million barrels per day. This was done due to the non-availability of two above ground storage tanks at the SPR Bryan Mound site, as well as the projected availability of caverns for use in drawdown operations, as derived from the Five Year Integrated Workover Schedule, and assumes complete availability of non-impacted remaining caverns. The drawdown rate will decrease as unscheduled cavern outages occur.
- Major changes from FY 2016 include a decrease in the number of cavern wellbore remediations from 5 to 2; a decreased funding level in the Major Maintenance Program due to reclassification of activities to the SPR Modernization Program's Life Extension Phase II project; and the continuation of multi-year oil sales that were initiated in FY 2017.

Cybersecurity: DOE is engaged in three categories of cyber-related activities: protecting the DOE enterprise from a range of cyber threats that can adversely impact mission capabilities; bolstering the U.S. Government's capabilities to address cyber threats; and, improving cybersecurity in the electric power subsector and the oil and natural gas subsector. The cybersecurity crosscut supports central coordination of the strategic and operational aspects of cybersecurity and facilitates cooperative efforts such as the Joint Cybersecurity Coordination Center for incident response and the implementation of Department-wide Identity Credential and Access Management.

	Cybersecurity	Total
Facilities Development and Operations	2,111	2,111

Strategic Petroleum Reserve
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Strategic Petroleum Reserve				
Facilities Development and Operations	186,870	---	155,042	-31,828
Management	25,130	---	24,958	-172
Total, Strategic Petroleum Reserve	**212,000**	**211,597**	**180,000**	**-32,000**
Federal FTEs	**126**	**126**	**126**	**0**

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Strategic Petroleum Reserve

Overview

The Strategic Petroleum Reserve (SPR) protects the U.S. economy from disruptions in critical petroleum supplies and meets the U.S. obligations under the International Energy Program (Energy Policy and Conservation Act, P.L. 94-163, as amended, Section 151). The SPR benefits the United States by providing an insurance policy against potential interruptions in U.S. petroleum supplies whether originating from domestic and international supply disruptions, natural disasters, sabotage, and acts of terrorism.

The SPR has 688.7 million barrels of crude oil inventory (as April 30, 2017) stored in underground cavern storage, provides the U.S. with multiple geostrategic benefits, and anchors the world's collective energy security system. A release of petroleum from the SPR can mitigate the potential economic damage of an actual disruption in international or domestic petroleum supplies and the accompanying price increases. The SPR avails the United States of international emergency assistance through its participation in the International Energy Agency (IEA) energy supply security initiatives. IEA members are required to maintain 90 days' worth of net petroleum import protection in government-owned and/or commercial stocks, and have a commitment to participate with other stockholding nations in a coordinated release of stocks in the event of a major supply disruption. As an example, the 695 million barrels of SPR inventory (as of December 31, 2016) provided 143 days of net petroleum import protection, while the U.S. percentage share of an IEA collective action release was 43.3% (as of December 31, 2016).

To accomplish its mission and address the challenges outlined above, the SPR program is organized into two subprograms: Facilities Development and Operations, and Management. The Facilities Development and Operations subprogram funds all requirements associated with developing and maintaining facilities for the storage of petroleum, operations activities associated with placing petroleum into storage, and operational readiness initiatives associated with drawing down and distributing the inventory within 13 days' notice in the event of an emergency. The Management subprogram funds personnel and administrative expenses related to maintaining the Project Management Office (New Orleans, LA) and the Program Office (Washington, DC), as well as contract services required to support management and technical analysis of program initiatives and issues.

Highlights of the FY 2018 Budget Request

SPR's underground storage caverns require maintenance to assure their storage capability and integrity. Likewise, the continued degasification of SPR stocks is required for the crude oil to be available for emergency use and to prevent the off-gassing of Volatile Organic Compounds (VOCs) and hydrogen sulfide above permitted levels during oil movements through commercial distribution points. Ongoing oil sale activities increase equipment usage and run times and will require consistent preventive and corrective maintenance to prevent or address equipment failures.

Major Maintenance

In FY 2017, Major Maintenance projects that met the SPR Modernization Program's scope for the Life Extension Phase II Project were transferred to that account, leaving a core sustainable program of construction projects that support operational readiness, while taking into account multi-year oil sales.

Cavern Integrity

The Casing Inspection and Cavern Remediation Program was developed in 2010 to remediate the anomalies in wellbore casings. This is necessary to maintain the required level of operational and withdrawal capability. Cavern remediation and diagnostic workovers anticipate and remediate cavern wellbore failures that cause caverns to be removed from service, and in preventing potential environmental releases.

Major changes in FY2018 include the use of only one rig and leased crew to perform cavern remediation and well workover activity, (reduced from two rigs and crews in FY 2016). Changes from the FY 2016 level for these activities will be a reduction in wellbore remediations from five to two, and a reduction in diagnostic workovers from nine to six. It is anticipated this will result in a 30–35% reduction in the amount of crude oil in the SPR's overall crude oil inventory that would be available to respond to an emergency supply disruption. Major Maintenance and Maintenance of facilities and equipment will require ongoing monitoring with increased usage due to multi-year oil sales.

Strategic Petroleum Reserve
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Strategic Petroleum Reserve				
Facilities Development and Operations	186,870	---	155,042	-31,828
Management	25,130	---	24,958	-172
Total, Strategic Petroleum Reserve	**212,000**	**211,597**	**180,000**	**-32,000**

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Strategic Petroleum Reserve
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Facilities Development and Operations: The request supports a decrease to the Cavern Integrity Program (-$7,032); and additional reductions to the Major Maintenance Projects (-$12,128); preventive/corrective maintenance related to corrosion and lifecycle maintenance tasks (-$2,594); reduction to supplies and training for Physical Security Program for all sites (-$1,476); and decreases of IT support systems projects and contractor support (-$8,598).	**-31,828**
Management: No significant change.	**-172**
Total, Strategic Petroleum Reserve	**-32,000**

Strategic Petroleum Reserve
Facilities Development and Operations

Description

The Facilities Development and Operations subprogram funds activities to maintain the SPR's operational readiness capability for successful drawdowns and operate the sites in a safe, secure, and environmentally acceptable manner. U.S. reliance on petroleum, combined with significant global reserves in regions of the world subject to political unrest, have made the United States economy vulnerable to supply disruptions. The SPR's stockpile of petroleum products diminishes this vulnerability to the effects of disruptions in supplies.

The SPR's underground storage caverns require maintenance to assure their storage capability and integrity. Surface and sub-surface infrastructure and systems that must be maintained to meet operational readiness requirements have been identified, and are funded in this subprogram.

Facilities Development and Operations

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Facilities Development and Operations		
$186,870	**$155,042**	**-31,828**
Casing Inspections and Remediations 5 planned remediation workovers and 9 workovers using 2 rigs.	*Casing Inspections and Remediations* Funding level supports 1 cavern workover rig and leased crew to execute 2 cavern wellbore remediations and 6 cavern wellbore diagnostic workovers.	*Casing Inspections and Remediations (-$7,032)* Reduction from 2 to 1 leased rig and crew for cavern integrity operations, with a corresponding reduction of 3 planned cavern wellbore remediations and 3 planned wellbore diagnostic workovers.
Major Maintenance Continues the major maintenance program and supports buy-down of delayed projects.	*Major Maintenance* Continue approach to repair, replace, or upgrade equipment including Security, Environmental, Safety & Health (ESH), Drawdown and Non-Drawdown critical systems.	*Major Maintenance (-$12,128)* Reduced level of funding from FY 2016 for the Major Maintenance Program would sustain scheduled projects. In FY17, Major Maintenance projects that met the modernization scope of the Life Extension Phase II Program were transferred, leaving a core sustainable program of construction projects that support operational readiness, given multi-year oil sales.
Maintenance Provides maintenance of the SPR equipment and facilities to support drawdown readiness in a safe and environmentally compliant manner.	*Maintenance* Provides maintenance of the SPR equipment, preventive/corrective equipment maintenance, and facilities to support drawdown readiness in a safe and environmentally compliant manner.	*Maintenance (-$2,594)* Reduction to preventive/corrective maintenance of drawdown critical equipment, and a reduction to spare inventory supplies (pumps, valves, actuators and motors) for drawdown critical

		equipment.
Security Protect and defend personnel, property and resources against assault, sabotage, vandalism, theft, trespass and compromise of sensitive as well as classified information.	*Security* Protect and defend personnel, property and resources against assault, sabotage, vandalism, theft, trespass and compromise of sensitive as well as classified information.	*Security (-$1,476)* Funding level supports a reduced Physical Security Program with marginally capable effectiveness in providing a deterrence and response posture to adversarial threats (as defined and required by the latest threat assessments).
Data Systems & Support Data Systems to support the mission of drawdown readiness, processing, sale and receipt of goods (oil), communications, reporting, providing protection from malware and computer viruses, and all other activity associated with the use of data and information systems.	*Data Systems & Support* Data Systems to support the mission of drawdown readiness, processing, sale and receipt of goods (oil), communications, reporting, providing protection from malware and computer viruses, and all other activity associated with the use of data and information systems.	*Data Systems & Support (-$8,598)* Funding level is reduced due to tasks previously performed in FY 2016 and no longer required to be performed in FY 2018 to include: Multi-Factor Authentication (PIV/MFA) project, and reduced technical support activities.

Strategic Petroleum Reserve
Capital Summary[1] ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Capital Operating Expenses Summary (including MIE)				
Capital Equipment > $500K (including MIE)	19,964	---	6,707	-13,257
Plant Projects (GPP >$10M)	0	---	0	+0
Total, Capital Operating Expenses	**19,964**	**---**	**6,707**	**-13,257**
Capital Equipment > $500K (including MIE)				
Total Non-MIE Capital Equipment (>$500K)	6,494	---	3,707	-2,787
Replace Critical Loop Conductors/Cables (BH-1319)	2,557	---	0	-2,557
Replace sec 36' Pipeline-Hildebrant Bayou (BH-756)	2,190	---	0	-2,190
Replace WHT-1 Flush Water & WHT-10 Seal Flush	2,055	---	0	-2,055
Rework 42 Inch Crude Oil Pipeline Mainline Valves	3,188	---	0	-3,188
Close Anhydrate Pond 9-Chloride Removal(BH-	1,431	---	0	-1,431
Replace RWIP Discharge Piping and Recycle Line (WH-	704	---	0	-704
Replace 24' Brine disposal Pipeline GFE (WH-826A)	1,345	---	0	-1,345
Replace Foam Deluge Piping (BC-MM-1591))	0	---	1,504	+1,504
Site Building Upgrades (Phase 3) (E2P2) (BM-MM-674)	0	---	1,496	+1,496
Total, Capital Equipment (including MIE)	**19,964**	**---**	**6,707**	**-13,257**
Plant Projects (GPP - Total Estimated Cost >$10M)				
Total, Plant Projects (GPP – Total Estimated Cost	**0**	**---**	**0**	**0**

Total, Capital Summary	**19,964**	**---**	**6,707**	**-13,257**

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[1] This list of projects is illustrative and can be adjusted based on operational requirements, priorities, and/or funding.

Strategic Petroleum Reserve
Management

Overview

Management provides funding for the salaries and related requirements of the Headquarters federal workforce responsible for providing programmatic policy, planning and oversight, to include strategic project planning, budget formulation and financial management, operations, engineering, safety, security, and technical analysis of programmatic activity of the SPR. The additional Federal workforce of the SPR Project Management Office directs program execution and establishes technical performance standards as well as scope, cost, and schedule milestones for the Management and Operations contractor.

Highlights of the FY 2018 Budget Request

The Federal staff remains at 126 FTEs with additional technical support contractors. Travel is for operational field support and oversight, including site and vendor visits. Other related expenses include field building leases, telecommunications, and annual hurricane preparedness activities**.**

Management
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	5,476	---	5,476	+0
Travel	100	---	130	+30
Support Services	1,660	---	2,247	+587
Other Related Expenses	500	---	1,147	+647
Total, Washington Headquarters	**7,736**	**---**	**9,000**	**+1,264**
Strategic Petroleum Reserve Project Management Office				
Salaries and Benefits	14,114	---	14,114	+0
Travel	469	---	372	-97
Support Services	471	---	458	-13
Other Related Expenses	2,340	---	1,014	-1,326
Total, SPR Project Management Office	**17,394**	**---**	**15,958**	**-1,436**
Total Management				
Salaries and Benefits	19,590	---	19,590	+0
Travel	569	---	502	-67
Support Services	2,131	---	2,705	+574
Other Related Expenses	2,840	---	2,161	-679
Total, Management	**25,130**	**---**	**24,958**	**-172**
Federal FTEs	**126**	**---**	**126**	**0**

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Technical Support				
Economic & Environmental Analysis	560	---	560	+0
Total, Technical Support	560	---	560	+0
Management Support				
Training and OPM Recruitment	209		147	-62
Technical Support	1,362		1,998	+636
Total Management Support	1,571		2,145	+574
Total, Support Services	**2,131**		**2,705**	**+574**
Other Related Expenses				
Rent to Others	559		635	+76
Communications, Utilities, Misc.	118		72	-46
Other Services	1,748		1,404	-344
Supplies and Materials	40		50	+10
Equipment	375		0	-375
Total, Other Related Expenses	**2,840**		**2,161**	**-679**

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FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Management $25,130,000	**$24,958,000**	**-$172,000**
Salaries and Benefits $19,590,000	**$19,590,000**	**+$0**
Continue Management and oversight activities.	The funding supports salaries and benefits for 126 FTEs and associated costs required to provide overall direction and execution of the SPR. The SPR mission is carried out by a workforce composed largely of M&O contractors, although there are a variety of functions that are inherently governmental (i.e., program management, contract administration, budget formulation, and interagency/international coordination) that require a dedicated Federal workforce.	No change.
Travel $569,000	**$502,000**	**-$67,000**
Continue constrained travel.	Provides travel to assure capability to achieve Level 1 Performance criteria for drawdown and distribution of the Reserve.	No significant change.
Support Services $2,131,000	**$2,705,000**	**+$574,000**
Activities support project-planning efforts to maintain technical, mission essential support capabilities.	Activities support project-planning efforts to maintain technical, mission essential support capabilities.	Increase provides for project-planning efforts for technical analyses which support programmatic operational readiness and capability requirements.
Other Related Expenses $2,840,000	**$2,161,000**	**-$679,000**
Provides teleconferencing capabilities between sites; field site building leases; and contingency for DOE field employee evacuation expenses in the event of a hurricane.	Provides teleconferencing capabilities between sites; field site building leases; and contingency for DOE field employee evacuation expenses in the event of a hurricane.	Decrease for revised estimate of hurricane preparedness requirements with offsetting increases to Headquarters rent and IT system support.

Strategic Petroleum Reserves
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Drawdown Readiness - Ensure drawdown readiness by achieving equal to or greater than 95% of monthly maintenance and accessibility goals.**		
Target	95 % of monthly maintenance achieved	95 % of monthly maintenance and accessibility goals achieved	95 % of monthly maintenance achieved
Result	Met - 98.1	TBD	TBD
Endpoint Target	Achieve 95% of monthly maintenance and accessibility goals in all years.		
Performance Goal (Measure)	**SPR Operating Cost - Ensure cost efficiency of SPR operations by achieving low operating cost per barrel of capacity**		
Target	≤ 0.3 $ operating cost per barrel	≤ 0.3 $ operating cost per barrel	≤ 0.23 $ operating cost per barrel
Result	Met - 0.25	TBD	TBD
Endpoint Target	Achieve ≤ $ 0.30 operating cost per barrel.		
Performance Goal (Measure)	**Sustained (90 day) Drawdown Rate - Enable ready distribution of SPR oil by achieving maximum sustained (90 day) drawdown rate of 4.4 million barrels per day.**		
Target	4.22 MMB/Day drawdown readiness rate	4.2 MMB/Day drawdown readiness rate	4.16 MMB/Day drawdown readiness rate
Result	Not Met - 4.1	TBD	TBD
Endpoint Target	Maintain a 90 day drawdown rate of 4.4 million barrels per day		

Strategic Petroleum Reserve
Facilities Maintenance and Repair

The SPR Program's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. The Facilities Maintenance and Repair activities funded by this budget and displayed below are intended to halt asset condition degradation.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
Strategic Petroleum Reserve	50,596	46,018	74,127	30,602
Total, Direct-Funded Maintenance and Repair	**50,596**	**46,018**	**74,127**	**30,602**

Report on FY 2016 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2016 to the amount planned for FY 2016, including congressionally directed changes.

Total Costs for Maintenance and Repair ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost
Strategic Petroleum Reserve	50,596	46,018
Total, Direct-Funded Maintenance and Repair	**50,596**	**46,018**

Strategic Petroleum Reserve
Safeguards and Security ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Protective Forces	18,859	23,191	17,755	-1,104
Physical Security Systems	957	1,016	1,070	113
Information Security	205	242	234	29
Cyber Security	1,299	2,047	2,111	812
Personnel Security	587	602	662	75
Material Control and Accountability	0	0	0	0
Research and Development	5	6	0	-5
Program Management	1,494	1,074	1,413	-81
Security Investigations	0	0	0	0
Transportation Security	0	0	0	0
Construction	1,376	150	0	-1376
Total, Safeguards and Security	**24,782**	**28,328**	**23,245**	**-1,537**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

18-E-001, Strategic Petroleum Reserve (SPR) Modernization
Various locations

Project is for Design and Construction

Significant Changes and Summary

Significant Changes

This is the initial Construction Project Data Sheet (CPDS) for the two projects comprising the SPR Modernization Program. An appropriation was requested as an FY17 budget amendment and funding for the Life Extension project was provided in the FY 2017 Continuing Resolution (Public Law 114-254). This CPDS includes a new start for the Marine Terminal Distribution Capability Enhancements project for the budget year.

At this time, the program's scope remains as originally conceived. However, the FY 2018 Budget contains proposals that could alter the scope. If enacted, DOE will update this CPDS accordingly with the subsequent budget.

Summary

There are two projects that comprise the SPR Modernization Program: Life Extension Phase II (LE2) and Marine Terminal Distribution Capability Enhancements (MTE). The LE2 project will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure continued ability to meet mission requirements for the next 25 years. LE2 activities will occur at the Bryan Mound, Big Hill, West Hackberry, and Bayou Choctaw storage sites as well as the St. James Marine Terminal site. The MTE project will address the SPR's effective distribution capability gap through the construction of dedicated marine terminals and associated pipelines and equipment in both the Seaway and Texoma Distribution Systems.

The Energy Security and Infrastructure Modernization (ESIM) Fund was established as the funding source for the SPR Modernization Program. The fund contains offsetting collections from the sale of SPR crude oil up to the authorized annual revenue ceiling. These sales are limited to the period of fiscal years 2017 through 2020.

The most recently approved Critical Decision (CD) for LE2 is CD-1, which was approved December 22, 2016, with a cost range of $750 million to $1.4 billion and a CD-4 range of September 2022 to September 2024. The most recently approved CD for MTE is CD-0, which was approved on August 12, 2016, with a preliminary cost range of $0.5 billion to $1.5 billion and a CD-4 range of FY 2024 to 2025.

A Level 2A Federal Project Director has been assigned to LE2, and has approved this CPDS. A Federal Project Director has not yet been assigned to the MTE project.

Critical Milestone History

Life Extension 2

	CD-0	Complete NEPA EIS Analysis	Conceptual Design Complete	CD-1	CD-2	CD-3A	Final Project Design Complete	CD-3	CD-4
FY2018*	10/30/2015	Not applicable	09/01/2016	12/22/2016	3rd Qtr 2019	3rd Qtr 2017 3rd Qtr 2018	3rd Qtr 2019	3rd Qtr 2019	4th Qtr 2024

Marine Terminal Distribution Capability Enhancements

	CD-0	Complete NEPA EIS Analysis	Conceptual Design Complete	CD-1	CD-2	CD-3A	Final Project Design Complete	CD-3	CD-4
FY2018*	8/12/2016	1st Qtr FY2019	4th Qtr FY2020	2nd Qtr FY2019	2nd Qtr FY2021	2nd Qtr FY2021	2nd Qtr FY2022	3rd Qtr FY2022	1st Qtr FY2025

CD-0 – Approved Mission Need for a construction project with a conceptual scope and cost range
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Alternative Selection and Cost Range
CD-2 – Approve Performance Baseline
Final Design Complete – Estimated/Actual date the project design will be/was complete(d)
CD-3 – Approve Start of Construction
D&D Complete –Completion of D&D work
CD-4 – Approve Start of Operations or Project Closeout
PB – Indicates the Performance Baseline

*****Neither of the LE2 or MTE projects have been baselined at this time (projects are baselined at CD-2 approval). The project schedules are for planning purposes only at this time, and are consistent with the more lengthy end of the schedule range.

Project Cost History

	TEC Design ($000)	TEC, Construction ($000)	TEC Total ($000)	OPC Except D&D ($000)	OPC D&D ($000)	OPC Total ($000)	High End TPC ($000)
LE2	100,628	1,299,372	1,400,000	6,711	0	6,711	1,406,711
MTE	150,900	937,949	1,088,849	411,151	0	411,151	1,500,000
Total	**251,528**	**2,237,321**	**2,488,849**	**417,862**	**0**	**417,862**	**2,906,711**

The project costs are for planning purposes only at this time, and are consistent with the high end of the cost ranges. No construction funds, except for approved long lead equipment procurement, will be used until the project performance baseline has been validated and CD-3 has been approved.

Project Scope and Justification

Scope

The SPR LE2 Project involves work at the Bryan Mound, Big Hill, West Hackberry, and Bayou Choctaw Storage Sites and the St. James Terminal site. Completion of the SPR LE2 project will extend the life of SPR equipment and infrastructure capabilities for an additional 25 years and ensure the SPR will be able to meet mission requirements. The major components of LE2 work activities at each site are:

- Bryan Mound and Big Hill: Process Piping, Pipelines, Process & Rotating Equipment

- West Hackberry: Brine System, Civil and Security Systems, Process Piping, and Process Equipment
- Bayou Choctaw: Brine Disposal System, Degas Plant, Roadways and Lighting, Security and Electrical Systems
- St. James Terminal: Fire Protection System, Security and Lighting, Control System, Dock Loading Facilities, Vapor Control Units

The MTE project will enhance the SPR's effective distribution capability through the addition of dedicated marine terminals and associated pipelines and equipment in both the Seaway and Texoma Distribution Systems.

Justifications

LE2: In August 2016, the Department of Energy published a Long-Term Strategic Review (LTSR) of SPR capabilities and infrastructure. The LTSR compared current operational capability to Level 1 Technical and Performance Criteria and identified gaps within the storage site infrastructure and distribution system necessary to provide the design delivery rate of 4.4 million barrels per day, now and for the next 25 years. The results indicated that a significant investment in infrastructure and process equipment is critical to ensure the SPR can maintain readiness, meets mission requirements, and operate in an environmentally responsible manner. The SPR LE2 Project addresses these requirements.

Current surface assets and systems are more than halfway through their original design life of 25 years, and early analysis suggests the required Life Extension Program (LEP) could take up to six years to complete. Revitalization of many, but not all, of those assets and systems last occurred from 1995 to 2000 under the first LEP. As these assets continue to age, modernization will be required – either through additional maintenance and/or repair, or outright replacement.

MTE: One of the SPR's core missions is to carry out U.S. obligations under the IEP, the 1974 treaty that established the International Energy Agency (IEA). As a member of IEA, one of two primary obligations of the U.S. is to contribute to an IEA collective action based on its share of IEA oil consumption. Currently, the SPR must be prepared to contribute 43.3 percent of the barrels released in an IEA coordinated drawdown of oil stocks. In a 2015 DOE-sponsored analysis of global oil import disruption scenarios, it was found that the U.S. is currently unable to meet its IEP obligation to an IEA collective action under multiple disruption scenarios. In order to support the goals and objectives contained in the Strategic Plan, meet mission requirements and International Energy Program (IEP) obligations of the U.S., the project will address a strategic energy requirement to meet the SPR's distribution capability gap. Additionally, the 2015 Quadrennial Energy Review (QER) addressed SPR distribution capability. The QER identified that "DOE should make investments to ... increase the incremental distribution capacity of the SPR by adding dedicated marine loading dock capacity at the Gulf Coast terminus of the SPR distribution systems.

The projects are being conducted in accordance with the project management requirements of DOE Order 413.3B, Program and Project Management for the Acquisition of Capital Assets.

Financial Schedule

The costs are only estimates and consistent with the high end of the cost ranges. Once CD-2 is approved for each project, a baseline for both costs and schedule will be set. The intent is to execute SPR modernization within the authorized revenue ceiling proposed in the FY 2018 budget request.

SUMMARY
(dollars in thousands)

	Appropriations	Obligations	Costs
Design			
FY 2017	N/A	64,848	5,706
FY 2018	N/A	33,517	37,022
FY 2019 - FY 2024	N/A	153,163	208,800
Total, Design	N/A	251,528	251,528
Construction			
FY 2017	N/A	38,810	17,210
FY 2018	N/A	523,782	125,038
FY 2019 - FY 2024	N/A	1,674,729	2,095,073
Total, Construction	N/A	2,237,321	2,237,321
TEC			
FY 2017	N/A	103,658	22,916
FY 2018	N/A	557,299	162,060
FY 2019 - FY 2024	N/A	1,827,892	2,303,873
Total, TEC	N/A	2,488,849	2,488,849
Other Project Cost (OPC)			
FY 2015*	N/A	88*	88*
FY 2016*	N/A	4,190*	4,190*
FY 2017	N/A	1,033	1,033
FY 2018	N/A	9,491	16,416
FY 2019 - FY 2024	N/A	403,060	396,135
Total, OPC	N/A	417,862	417,862
Total Project Cost			
FY 2015	0	88	88
FY 2016	0	4,190	4,190
FY 2017	375,400	104,691	23,949
FY 2018	350,000	566,790	178,476
FY 2019 - FY 2024	274,600	2,230,952	2,700,008
Total, TPC	1,000,000	2,906,711	2,906,711

***** Funding from SPR Facilities account

LIFE EXTENSION 2
(dollars in thousands)

	Appropriations	Obligations	Costs
Design			
FY 2017	N/A	64,848	5,706
FY 2018	N/A	33,517	37,022
FY 2019 - FY 2024	N/A	2,263	57,900
Total, Design	N/A	100,628	100,628

Construction			
FY 2017	N/A	38,810	17,210
FY 2018	N/A	523,782	125,038
FY 2019 - FY 2024	N/A	736,780	1,157,124
Total, Construction	N/A	1,299,372	1,299,372
TEC			
FY 2017	N/A	103,658	22,916
FY 2018	N/A	557,299	162,060
FY 2019 - FY 2024	N/A	739,043	1,215,024
Total, TEC	N/A	1,400,000	1,400,000
Other Project Cost (OPC)			
FY 2015*	N/A	88*	88*
FY 2016*	N/A	4,190*	4,190*
FY 2017	N/A	2,433	1,033
FY 2018	N/A	0	1,400
FY 2019 - FY 2024	N/A	0	0
Total, OPC	N/A	6,711	6,711
Total Project Cost			
FY 2015	N/A	88	88
FY 2016	N/A	4,190	4,190
FY 2017	N/A	106,091	23,949
FY 2018	N/A	557,299	163,460
FY 2019 - FY 2024	N/A	739,043	1,215,024
Total, TPC	N/A	1,406,711	1,406,711

* Funding from SPR Facilities account

MARINE TERMINAL ENHANCEMENTS

(dollars in thousands)

	Appropriations	Obligations	Costs
Design			
FY 2017	N/A	0	0
FY 2018	N/A	0	0
FY 2019 - FY 2024	N/A	150,900	150,900
Total, Design	N/A	150,900	150,900
Construction			
FY 2017	N/A	0	0
FY 2018	N/A	0	0
FY 2019 - FY 2024	N/A	937,949	937,949
Total, Construction	N/A	937,949	937,949
TEC			
FY 2017	N/A	0	0
FY 2018	N/A	0	0
FY 2019 - FY 2024	N/A	1,088,849	1,088,849
Total, TEC	N/A	1,088,849	1,088,849
Other Project Cost (OPC)			
FY 2015*	N/A	0	0
FY 2016*	N/A	0	0
FY 2017	N/A	0	0

FY 2018	N/A	8,091	15,016
FY 2019 - FY 2024	N/A	403,060	396,135
Total, OPC	N/A	411,151	411,151
Total Project Cost			
FY 2015	N/A	0	0
FY 2016	N/A	0	0
FY 2017	N/A	0	0
FY 2018	N/A	8,091	15,016
FY 2019 - FY 2024	N/A	1,491,909	1,484,984
Total, TPC	N/A	1,500,000	1,500,000

* Funding from SPR Facilities account

6. Details of Project Cost Estimate

The costs are only estimates and consistent with the high end of the cost ranges. Once CD-2 is approved for each project, a baseline for both costs and schedule will be set. The intent is to execute SPR modernization within the authorized revenue ceiling proposed in the FY 2018 budget request.

SUMMARY	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design (PED)			
Design	$ 243,816	N/A	N/A
Contingency	$ 45,437	N/A	N/A
Total PED	$ 289,253	N/A	N/A
Land Acquisition	$ 62,505		
Contingency	$ 15,627		
Total Land Acquisition	$ 78,132		
Construction			
Site Facilities Construction	$ 335,992	N/A	N/A
Tank Storage Facilities	$ 393,681		
Marine Terminal	$ 303,731		
Pipeline	$ 240,535		
Off-Site Facilities	$ 171,605	N/A	N/A
Drilling/Wellhead/Casings	$ 58,344	N/A	N/A
Pipeline Construction	$ 135,685	N/A	N/A
Construction Management	$ 108,752	N/A	N/A
Project Support	$ 174,573		
Contingency	$ 548,910	N/A	N/A
Total, Construction	$ 2,471,808	N/A	N/A
Total, TEC	$ 2,839,193	N/A	N/A
Contingency, TEC	$ 609,974	N/A	N/A
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Design	$ 2,781	N/A	N/A
Other OPC Costs	$ 3,930	N/A	N/A

Start-up	$	-	N/A	N/A
EIS		5,724		
Environmental Permits		4,419		
Project Management		38,503		
Contingency		12,161	N/A	N/A
Total OPC except D&D	$	67,518	N/A	N/A
D&D		0	N/A	N/A
Total, OPC	$	67,518	N/A	N/A
Contingency, OPC		12,161	N/A	N/A
Total, TPC	$	2,906,711	N/A	N/A
Total, Contingency	$	622,135	N/A	N/A

Life Extension 2	**Current Total Estimate**		**Previous Total Estimate**	**Original Validated Baseline**
Total Estimated Cost (TEC)				
Design (PED)				
Design	$	92,916	N/A	N/A
Contingency	$	7,712	N/A	N/A
Total PED	$	100,628	N/A	N/A
Construction				
Site Facilities Construction	$	335,992	N/A	N/A
Off-Site Facilities	$	171,605	N/A	N/A
Drilling/Wellhead/Casings	$	58,344	N/A	N/A
Pipeline Construction	$	135,685	N/A	N/A
Construction Management	$	108,752	N/A	N/A
Project Support	$	174,573		
Contingency	$	314,421	N/A	N/A
Total, Construction	$	1,299,372	N/A	N/A
Total, TEC	$	1,400,000	N/A	N/A
Contingency, TEC	$	322,133	N/A	N/A
Other Project Cost (OPC)				
OPC except D&D				
Conceptual Design	$	2,781	N/A	N/A
Other OPC Costs	$	3,930	N/A	N/A
Start-up		0	N/A	N/A
Contingency		0	N/A	N/A
Total OPC except D&D	$	6,711	N/A	N/A
D&D		0	N/A	N/A
Total, OPC	$	6,711	N/A	N/A
Contingency, OPC		0	N/A	N/A
Total, TPC	$	1,406,711	N/A	N/A
Total, Contingency	$	322,133	N/A	N/A

Marine Terminal Enhancements	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design (PED)			
Design	$ 150,900	N/A	N/A
Contingency	$ 37,725	N/A	N/A
Total PED	$ 188,625	N/A	N/A
Land Acquisition	$ 62,505	N/A	N/A
Contingency	$ 15,627	N/A	N/A
Total Land Acquisition	$ 78,132	N/A	N/A
Construction			
Tank Storage Facilities	$ 393,681	N/A	N/A
Marine Terminal	$ 303,731	N/A	N/A
Pipeline	$ 240,535	N/A	N/A
Contingency	$ 234,489	N/A	N/A
Total Construction	$ 1,172,436	N/A	N/A
Other Project Cost (OPC)			
EIS	$ 5,724	N/A	N/A
Environmental Permits	$ 4,419	N/A	N/A
Project Management	$ 38,503	N/A	N/A
Contingency	$ 12,161		
Total OPC	$ 60,807	N/A	N/A
Total Project Cost	$ 1,500,000	N/A	N/A
Total Contingency	$ 300,000	N/A	N/A

Schedule of Appropriations Requests

Section 404 of the Bipartisan Budget Act authorizes drawdown and sale of SPR crude oil over four fiscal years (FY2017 - FY2020) to finance SPR modernization. Sections 5 and 6 of this CPDS reflect the high end of the cost ranges. Once CD-2 is approved for each project, a baseline for both costs and schedule will be set. The intent is to execute SPR modernization within the authorized revenue ceiling proposed in the FY 2018 budget request shown below.

($000)

Request		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	Total
FY 2018	TEC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	OPC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	TPC*	$ 375,400	$ 350,000	$ 174,600	$ 100,000	$ -	$ -	$ -	$ -	$ 1,000,000

Related Operations and Maintenance Funding Requirements

Not applicable for PED.

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	Establish at CD-2 of LE2
Expected Useful Life (number of years)	25
Expected Future Start of D&D of this capital asset (fiscal quarter)	N/A

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	Previous Total Estimate	Current Total Estimate	Previous Total Estimate
Operations		N/A		N/A
Maintenance & Repair		N/A		N/A
Total *		**N/A**		**N/A**

* Funding requirements are included in the Facilities Appropriation 089X0218.

D&D Information

This Project does not require D & D funding.

Area	Square Feet
Area of new construction	
Area of existing facility(s) being replaced	
Area of additional D&D space to meet the "one-for-one" requirement	

Acquisition Approach

LE2: The existing Strategic Petroleum Reserve Management and Operating Contractor, Fluor Federal Petroleum Operations, will procure the Architect-Engineer contractor as well as all Government Furnished Property and firm fixed priced construction contracts.

MTE: The acquisition approach will use new contracts.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Strategic Petroleum Reserve	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
National Energy Technology Lab			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	446	445	456
Total, National Energy Technology Lab	**446**	**445**	**456**
Oak Ridge National Laboratory			
SPR Econometric Modelling Support			
Management	490	489	560
Total, Oak Ridge National Laboratory	**490**	**489**	**560**
Sandia National Laboratories			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	3,412	3,406	2,670
Total, Sandia National Laboratories	**3,412**	**3,406**	**2,670**
Strategic Petroleum Reserve - Bayou Choctaw			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	10,617	10,597	13,017
Total, Strategic Petroleum Reserve - Bayou Choctaw	**10,617**	**10,597**	**13,017**
Strategic Petroleum Reserve - Big Hill			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	27,446	27,394	19,956
Total, Strategic Petroleum Reserve - Big Hill	**27,446**	**27,394**	**19,956**
Strategic Petroleum Reserve - Bryan Mound			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	19,363	19,326	16,923
Total, Strategic Petroleum Reserve - Bryan Mound	**19,363**	**19,326**	**16,923**
Strategic Petroleum Reserve - West Hackberry			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	30,200	30,143	20,679
Total, Strategic Petroleum Reserve - West Hackberry	**30,200**	**30,143**	**20,679**
Strategic Petroleum Reserve Project Office			
SPR Geotechnical Analytical Support			
SPR - Facilities Development	95,386	95,204	81,341
SPR Econometric Modelling Support			
Management	17,394	17,361	15,958
Total, Strategic Petroleum Reserve Project Office	**112,780**	**112,565**	**97,299**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Strategic Petroleum Reserve	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
SPR Econometric Modelling Support			
Management	7,246	7,232	8,440
Total, Washington Headquarters	**7,246**	**7,232**	**8,440**
Total, Strategic Petroleum Reserve	**212,000**	**211,597**	**180,000**

SPR Petroleum Account
Proposed Appropriation Language

For the acquisition, transportation, and injection of petroleum products, and for other necessary expenses pursuant to the Energy Policy and Conservation Act of 1975, as amended (42 U.S.C. 6201 et seq.), sections 403 and 404 of the Bipartisan Budget Act of 2015 (42 U.S.C. 6241, 6239 note), and Section 5010 of the 21st Century Cures Act (Public Law 114-255); $8,400,000 to remain available until expended.

Explanation of Changes

Increase reflects drawdown costs associated with multi-year oil sales directed by the Bipartisan Budget Act of 2015 and the 21st Century Cures Act, as well as the proposed wind-down of the Northeast Gasoline Supply Reserve.

Public Law Authorizations

- Public Law 94-163, as amended.
- Public Law 114-74
- Public law 114-255

Strategic Petroleum Reserve – Petroleum Account
($K)

FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request
0	0[1]	8,400[1]

* The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

The Strategic Petroleum Reserve (SPR) – Petroleum Account funds the Northeast Gasoline Supply Reserve (NGSR) as well as petroleum inventory acquisitions, associated transportation costs, U.S. Customs duties, terminal throughput charges and other related miscellaneous costs. During all drawdowns and sales, the SPR Petroleum Account funds the incremental costs of withdrawing oil from the storage caverns and transporting it to the sales point where purchasers take title.

The NGSR was administratively established in 2014 as part of the Strategic Petroleum Reserve (SPR). The NGSR consists of 1 million barrels of gasoline blendstock, acquired and owned by the U.S. government, and stored in leased commercial storage terminals located at South Portland, Maine; Revere, Massachusetts; Carteret, New Jersey; and Raritan Bay, New Jersey. The 2012 events of Superstorm Sandy raised the question of whether a regional-type reserve of refined petroleum products could ease regional shortages resulting from sudden and unexpected supply interruptions. However, as a component of the SPR, the NGSR must follow the statutory release authorities of the SPR, which require national impact thresholds, making it operationally ineffective as a regional-type product reserve. As a consequence, the NGSR has not been utilized and does not have the operational functionality that was envisioned post-Sandy.

Highlights and Major Changes in the FY 2018 Budget Request

Sections 403 and 404 of the Bipartisan Budget Act of 2015 (P.L. 114-74) and Section 5010 of the 21st Century Cures Act (P.L. 114-255) direct non-emergency multi-year oil sales. This request covers drawdown costs associated with these oil sales. No request is made for the NGSR other than potential drawdown costs associated with its liquidation; leased commercial storage is currently financed through December 2018.

[1] Does not include the use of prior-year funds.

SPR Petroleum Account
Funding by Congressional Control
($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Strategic Petroleum Reserve – Petroleum Account				
Petroleum Acquisition, Transportation and Drawdown	0	---	11,400	11,400
Northeast Gasoline Supply Reserve	0	---	0	0
Use of Prior Year Balances	0	---	-3,000	-3,000
Total, SPR Petroleum Account	**0**	****0**	**8,400**	**8,400**
Federal FTEs	**0**	**0**	**0**	**0**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

** $8 million in unobligated balances will fund the drawdown operations for FY 2017 non-emergency oil sales directed by Section 404 of the Bipartisan Budget Act of 2015 and Section 5010 of the 21st Century Cures Act.

Strategic Petroleum Reserve – Petroleum Account

Overview

The SPR Petroleum Account funds two subprograms: SPR Petroleum Acquisition/Transportation/Drawdown and the Northeast Gasoline Supply Reserve (NGSR). The Petroleum Acquisition subprogram funds all crude oil acquisition, transportation, drawdown and distribution of the inventory in the SPR within 13 days' notice in the event of an emergency. The NGSR subprogram funds all aspects of the refined petroleum product reserve of gasoline blendstock, acquired and owned by the U.S. government and stored at leased commercial storage terminals in the Northeast to help mitigate the impacts of sudden and unexpected supply interruptions.

SPR Oil Acquisition/Transportation/Drawdown

In 2014, the program conducted a Test Sale of the SPR to evaluate the drawdown and sales procedure capabilities of the Reserve in the TEXOMA distribution system. A portion of the 2014 SPR Test Sale receipts were used to acquire 4.2 million barrels of crude oil per Section 161(g) of the Energy Policy and Conservation Act of 1975, increasing the crude oil inventory to 695.1 million barrels. Currently, the Department is undergoing a series of non-emergency, multi-year oil sales pursuant to the Bipartisan Budget Act (BBA) of 2015 (Public Law 114–74), the 21st Century Cures Act (Public Law 114-255), and the Fixing America's Surface Transportation (FAST) Act (Public Law 114-94). Drawdown and sales are scheduled as follows:

- From FY 2018 through FY 2025 (eight consecutive years) – sell 58 million barrels of crude oil, with 5 million barrels to be sold in FY 2018. Proceeds will be deposited into the General Fund of the Treasury (BBA, Section 403).
- From FY 2017 through FY 2020 (four consecutive years) – sell the required volumes of SPR inventory to raise up to the authorized revenue ceiling to be deposited into the Energy Security and Infrastructure Modernization Fund (BBA, Section 404). In FY 2017, 6.3 million barrels were sold, with revenues totaling approximately $320 million.
- From FY 2017 through FY 2019 (three consecutive years) – sell 10 million barrels of crude oil in FY 2017, 9 million barrels in FY 2018, and 6 million barrels in FY 2019, for a total of 25 million barrels. Proceeds will be deposited in the General Fund of the Treasury (21st Century Cures Act, Section 5010).
- From FY 2023 through FY 2025 (three consecutive years) – sell 16 million barrels of crude oil in FY 2023, 25 million barrels in FY 2024, and 25 million barrels in FY 2025, for a total of 66 million barrels. Proceeds will be deposited in the General Fund of the Treasury (Fixing America's Surface Transportation Act, Section 32204).
- From FY 2018 through FY 2027 (ten consecutive years), SPR half-liquidation sale to sell approximately 270 million barrels of crude oil—roughly half of the SPR inventory remaining after all sales currently authorized by law are completed:
    - Sell a sufficient number of barrels of crude oil needed to raise at least $1,000,000,000 in total sales revenue not later than fiscal year 2019. Proceeds will be deposited in the General Fund of the Treasury during the fiscal year in which the sales occur.
    - Sell 255 million barrels of crude oil, with 10 million barrels to be sold in FY 2020, 25 million barrels in FY 2021, 25 million barrels in FY 2022, 25 million barrels in FY 2023, 25 million barrels in FY 2024, 25 million barrels in FY 2025, 60 million barrels in 2026, and 60 million barrels in 2027. Proceeds will be deposited in the General Fund of the Treasury during the fiscal year in which the sales occur.

Drawdown costs associated with the FY 2017 oil sales were solely financed with $8 million of prior year Test Sale balances. This FY 2018 request incorporates the use of $3 million in offsets from prior year Test Sale balances. Drawdown costs associated with the SPR half-liquidation sale will be financed with existing resources currently reserved for an emergency drawdown, or with other funding resources as authorized by law.

Northeast Gasoline Supply Reserve

Following the completion of the 2014 Test Sale, DOE established a gasoline blendstock reserve in locations near New York Harbor and in New England. This reserve of gasoline blendstock– acquired and owned by the U.S. government – was created with the goal of mitigating the impact of sudden and unexpected regional supply interruptions. NGSR utilized $235 million of the Test Sale receipts for the acquisition of 1 million barrels of gasoline blendstock, 4.5 years of commercial storage, and initial oversight, quality control, and administrative activities.

As a component of the SPR, the NGSR must follow the same statutory release authorities designed for the SPR, which incorporate national impact thresholds even though the NGSR is a regional-type product reserve and contribute to the NGSR

being operationally ineffective. For this and other fiscal reasons, the Department proposes the disestablishment and liquidation of the NGSR. Because the NGSR's leased commercial storage contracts expire in early FY 2019, DOE proposes to divest the one million barrels of government-owned gasoline blendstock in FY 2018. These sales are proposed to offset $69 million of discretionary spending with any additional proceeds net of costs going to Treasury's general fund for deficit reduction.

SPr Petroleum Account
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
SPR Petroleum Account				
Petroleum Acquisition, Transportation and Drawdown		---	11,400	+11,400
Northeast Gasoline Supply Reserve	0	---	0	0
Use of Prior Year Balances	0	**0	-3,000	-3,000
Total, SPR Petroleum Account	**0**	**0**	**8,400**	**+8,400**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

** $8 million in unobligated balances will fund the drawdown operations for FY 2017 non-emergency oil sales directed by Bipartisan Budget Act, Section 404 and 21st Century Cures Act, Section 5010.

Strategic Petroleum Reserve – Petroleum Account
Explanation of Major Changes ($K)

Activities and Explanation of Changes

Strategic Petroleum Reserve – Petroleum Account		Explanation of Changes FY 2018 vs FY 2016
FY 2016 Enacted	**FY 2018 Request**	
SPR Petroleum Account		
Petroleum Acquisition, Transportation and Drawdown $0	**$8,400**	**+$8,400**
Non-Emergency Drawdown No Activity.	Drawdown costs for non-emergency, multi-year oil sales directed by Sections 403 and 404 of the Bipartisan Budget Act of 2015 (P.L. 114-74) and Section 5010 of the 21st Century Cures Act (P.L. 114-255). Prior year balances ($3 million) will offset new budget authority.	There were no oil sales in FY 2016. Increase reflects addition of drawdown costs associated with congressionally mandated non-emergency, multi-year oil sales (commenced in FY 2017).
NGSR $0	**$0**	**+$0**
Activities are funded with prior-year balances.	Continue commercial storage leases (4.5 years) and oversight and administration activities financed with 2014 Test Sale proceeds. Commercial storage contracts expire on December 31, 2018 (FY 2019).	No change.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Strategic Petroleum Reserve - Petroleum Account	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Strategic Petroleum Reserve Project Office			
SPR - Petroleum Account			
Oil Acquisition and Transportation	0	0	11,400
Total, Strategic Petroleum Reserve Project Office	**0**	**0**	**11,400**
Total, Strategic Petroleum Reserve - Petroleum Account	**0**	**0**	**11,400**

Energy Security and Infrastructure Modernization Fund
Proposed Appropriation Language

As authorized by section 404 of the Bipartisan Budget Act of 2015 (Public Law 114–74; 42 U.S.C. 6239 note), the Secretary of Energy shall drawdown and sell not to exceed $350,000,000 of crude oil from the Strategic Petroleum Reserve in fiscal year 2018: Provided, That the proceeds from such drawdown and sale shall be deposited in this account during fiscal year 2018: Provided further, That such amounts shall remain available until expended for necessary expenses to carry out modernization activities for the Strategic Petroleum Reserve.

Explanation of Changes

Reflects the financing structure of multi-year (FY 2017 – FY 2020) oil sales that will support SPR Modernization Program activities.

Public Law Authorizations

- Public Law 114-74, "Bipartisan Budget Act of 2015"

Energy Security and Infrastructure Modernization Fund
($K)

FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request
0	375,400[1]	350,000[1]

* The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

Section 404 of the Bipartisan Budget Act of 2015 authorizes the drawdown and sale of crude oil from the Strategic Petroleum Reserve (SPR) up to the amount of the authorized revenue ceiling for the period of fiscal years 2017 through 2020 to finance an SPR Modernization Program. The Energy Security and Infrastructure Modernization (ESIM) Fund was established in 2016 for the purpose of providing for the construction, maintenance, repair, and replacement of SPR facilities.

In establishing the ESIM Fund, Congress made the following findings: 1. The SPR is one of the nation's most valuable energy security assets; 2. The age and condition of the SPR have diminished its value as a federal energy security asset; 3. Global oil markets and the location and amount of U.S. oil production and refining capacity have dramatically changed in the 40 years since the establishment of the SPR; and 4. Maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions.

Section 404 also directs the Secretary to establish an SPR Modernization Program to protect the United States economy from the impacts of emergency supply disruptions. This program may include: 1. Operational improvements to extend the useful life of surface and subsurface infrastructure; 2. Maintenance of cavern storage integrity; and 3. Addition of infrastructure and facilities to optimize the drawdown and incremental distribution capability of the SPR. The Department has identified two specific projects—Life Extension Phase II and Marine Terminal Distribution Capability Enhancements—that comprise the SPR Modernization Program.

The Life Extension Phase II project will modernize aging SPR infrastructure through systems upgrades and equipment replacement to ensure the SPR is able to meet mission requirements and maintain operational readiness for the next several decades.

The Marine Terminal Distribution Capability Enhancements project will increase the SPR's effective distribution capability (the ability to add incremental barrels of crude oil to the market without displacing domestically produced oil and Canadian imports) during an oil supply disruption through the construction of new marine terminals, pipelines, and associated facilities.

Highlights and Major Changes in the FY 2018 Budget Request

This FY 2018 funding level continues the financing structure for multi-year (FY 2017 – FY 2020) oil sales that support an effective SPR Modernization Program.

[1] Budget Request and FY 2017 Annualized CR are offset by Crude Oil Sales revenue Offsetting Collections

Energy Security and Infrastructure Modernization Fund
Funding by Congressional Control
($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Energy Security and Infrastructure Modernization Fund				
Oil Sale Revenue Targets	0	375,400	350,000	350,000
Crude Oil Sales Revenue Offsetting Collections	0	-375,400	-350,000	-350,000
Total, Energy Security and Infrastructure Modernization Fund	**0**	**0**	**0**	**0**
Federal FTEs	**0**	**19**	**19**	**19**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

Energy Security and Infrastructure Modernization Fund

Overview

Section 404 of the Bipartisan Budget Act of 2015 authorizes the drawdown and sale of crude oil from the Strategic Petroleum Reserve (SPR) up to the amount of the authorized revenue ceiling over four fiscal years (FY 2017 – FY 2020) to finance the modernization of the SPR. The Energy Security and Infrastructure Modernization Fund was established in FY 2016 to provide for the construction, maintenance, repair, and replacement of SPR facilities for the purpose of funding an SPR Modernization Program.

The Fund is organized into two subprograms: (1) Life Extension Phase II and (2) Marine Terminal Distribution Capability Enhancements. The Life Extension Phase II subprogram will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure that the Reserve is able to meet its mission requirements and maintain operational readiness for the next several decades. The Marine Terminal Distribution Capability Enhancements subprogram will increase the effective distribution capacity of the SPR through the construction of new marine terminals, pipelines, and associated facilities. The Major Milestones (approved and estimated) for the two SPR Modernization Program projects that have yet to be baselined are as follows:

Life Extension Phase II Critical Decisions (CD):

- CD-0 Approve Mission Need – FY 2016 (Approved October 2015)
- CD-1 Approve Alternative Selection and Cost Range (Approved December 2016)
- CD-3A Approve Long Lead Time Equipment Procurement Items (Bryan Mound, Big Hill, West Hackberry) – FY 2017
- CD-3A Approve Long Lead Time Equipment Procurement Items (Bayou Choctaw, Saint James) – FY 2018
- CD-2 Approve Performance Baseline– FY 2019
- CD-3 Approve Start of Construction– FY 2019
- CD-4 Approve Project Completion – FY 2022

Marine Terminal Distribution Capability Enhancements Critical Decisions (CD):

- CD-0 Approve Mission Need – FY 2016 (Approved August 2016)
- CD-1 Approve Alternative Selection and Cost Range (FY 2019)
- CD-3A Approve Long Lead Time Equipment Procurement Items – FY 2021
- CD-2 Approve Performance Baseline – FY 2021
- CD-3 Approve Start of Construction– FY 2022
- CD-4 Approve Project Completion – FY 2024

Although Section 404 (d) (2) (B) (ii) of the Act notes that maintenance of the cavern storage integrity may be included as part of the SPR Modernization Program, the current scope of work for the Life Extension Phase II Project does not include maintenance of cavern storage integrity. Expenditures for operations and maintenance activities not directly related to the SPR Modernization Program continue to be financed through the SPR Facilities Account, including the Cavern Storage Integrity subprogram, which would be funded at a level $11.5 million below the FY 2018 requirements level in the SPR Facilities Account request.

Because final estimated costs for the two SPR Modernization Program projects will not be determined until the technical baselines are set for both projects upon approval of CD-2 (currently planned for FY 2019 for the Life Extension Phase II Project and FY 2021 for the Marine Terminal Distribution Capability Enhancements Project), it would be premature to utilize ESIM funds to finance cavern storage integrity maintenance activities not included in the project scope of work for SPR Modernization Program Projects.

Life Extension**:** The Life Extension Phase II project will extend SPR key equipment and infrastructure capabilities for an additional 25 years. The project involves work at the Bryan Mound, Big Hill, West Hackberry, Bayou Choctaw storage sites as well as the St. James Marine Terminal site. The major components of work activities at each site are:

- Bryan Mound and Big Hill: Process Piping, Pipelines, Process & Rotating Equipment

- West Hackberry: Brine System, Civil and Security Systems, Process Piping, and Process Equipment
- Bayou Choctaw: Brine Disposal System, Degas Plant, Roadways and Lighting, Security and Electrical Systems
- St. James Terminal: Fire Protection System, Security and Lighting, Control System, Dock Loading Facilities, Vapor Control Units

Marine Terminal Enhancements: The SPR's Marine Terminal Enhancement (MTE) project will address the strategic energy requirement to meet the SPR's distribution capability gap. Major components of work activities include distribution infrastructure modernization of crude oil pipelines, crude oil tank farm storage and dedicated marine loading and unloading facilities at the Seaway Distribution System and the Texoma Distribution System.

Energy Security and Infrastructure Modernization Fund
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Energy Security and Infrastructure Modernization Fund				
Oil Sale Revenue Targets	0	---	350,000	+350,000
Crude Oil Sales Revenue Offsetting Revenue Collections	0	---	-350,000	-350,000
Total, Energy Security and Infrastructure Modernization Fund	**0**	**375,400**	**0**	**0**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

Energy Security and Infrastruture Modernization Fund
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Oil Sale Revenue Targets: The increase reflects ESIM oil sale targets necessary toward funding the SPR Modernization Program's	
Total, Energy Security and Infrastructure Modernization Fund	**+350,000**

Energy Security and Infrastructure Modernization Fund
Life Extension Phase II

Description

The Life Extension Phase II subprogram funds activities to modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure the ability to maintain operational and drawdown readiness capability. The scope of work includes system upgrades and associated equipment replacement for the following systems:

- Crude oil transfer systems
- Raw water systems
- Power distribution and electrical systems
- Physical security systems
- Firefighting systems
- Crude oil processing (degasification) plant
- Auxiliary systems and facilities

FY 2018 activities continue procurement of government furnished equipment with long lead times as well as project design, geotechnical and geo-mechanical analyses, surveys, permitting, Title II and III engineering services, real estate and right-of-way issues, wetland mitigation, and permitting. The project technical baseline, to include final scope of work, cost, and schedule, will be set at CD-2 approval. Revisions to the project's scope of work may occur between now and CD-2 approval.

FY 2018 – FY 2021 Key Milestones

- Life Extension CD-2 Approve Performance Baseline – FY 2019.
- Life Extension CD-3 Approve Start of Construction Project Execution – FY 2019.

Energy Security and Infrastructure Modernization Fund
Marine Terminal Distribution Capability Enhancements

Description

The Marine Terminal Distribution Capability Enhancements subprogram funds activities to increase the effective distribution capability of the SPR (the ability to add incremental barrels of crude oil to the market without displacing domestically produced oil or Canadian imports) during an oil supply disruption through the construction of new marine terminals, pipelines, and associated facilities within the SPR's distribution system.

Since 2010, there has been a dramatic increase in domestic oil production, as well as in the imports of Canadian crude oil. These increases have fundamentally changed North American crude oil flow patterns, resulting in reversals in major U.S. crude oil pipelines that now move oil southward to major refining centers along the U.S. Gulf Coast. Midstream infrastructure congestion caused by these flow reversals, along with high utilization rates of crude oil pipelines and marine terminals along the U.S. Gulf Coast have compromised the SPR's effective distribution capability under numerous global oil supply disruption scenarios. While the SPR remains connected to physical assets which could bring oil to the market, in many circumstances forcing SPR crude oil into the distribution system would result in an offsetting reduction in domestic and Canadian import commercial crude oil flow.

Enhancing the SPR's effective distribution capability through the construction of new marine terminals, pipelines, and associated facilities would address the SPR's effective distribution capability shortfall, including the inability under multiple scenarios to meet U.S. international energy program obligations in the event of an International Energy Agency (IEA) collective action for responding to global oil supply disruptions.

FY 2018 activities include performing an environmental analysis and development of an Environmental Impact Statement required under the National Environmental Policy Act (NEPA).

FY 2018 – FY 2021 Key Milestones

- Marine Terminal Distribution Capability Enhancements CD-1, Approve Alternative Selection and Cost Range – FY 2019.
- Marine Terminal Distribution Capability Enhancements CD-2, Approve Performance Baseline – FY 2021.

Energy Security and Infrastructure Modernization Fund
Activities and Explanation of Changes

FY 2016 Enacted SPR Modernization	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
$0	**$375,400**	**+$350,000**
No oil sales	Collection of oil sale receipts will be allocated towards the project's Total Estimated Cost in support of design; construction; construction management; and project management.	Increase reflects oil sale proceeds required to meet the revenue target within the four-year window of oil sales (FY 2017 – FY 2020).

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Security & Infrastructure Modernization Fund (ESIM)	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Strategic Petroleum Reserve Project Office			
Energy Security & Infrastructure Modernization Fund (ESIM)			
Energy Security & Infrastructure Modernization Fund (ESIM)	0	375,400	350,000
Total, Strategic Petroleum Reserve Project Office	**0**	**375,400**	**350,000**
Total, Energy Security & Infrastructure Modernization Fund (ESIM)	**0**	**375,400**	**350,000**

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve

Northeast Home Heating Oil Reserve
Proposed Appropriation Language

For Department of Energy expenses necessary for Northeast Home Heating Oil Reserve storage, operation, and management activities pursuant to the Energy Policy and Conservation Act (42 U.S.C. 6201 et seq.), $6,500,000 to remain available until expended.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

New budget authority of $6.5 million and $3.5 million in prior-year balances will be used to maintain leased commercial storage contracts.

Public Law Authorizations

- P.L. 109-58, Energy Policy Act of 2005

Northeast Home Heating Oil Reserve

($K)

FY 2016 Enacted[1]	FY 2017 Annualized CR*[1]	FY 2018Request[1]
7,600	7,586	6,500

* The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

The Northeast Home Heating Oil Reserve (NEHHOR) provides a short-term supplement to the Northeast commercial system's supply of heating oil, in the event of a supply interruption. In FY 2012, NEHHOR converted from 2 million barrels of high sulfur heating oil to 1 million barrels of Ultra Low Sulfur Diesel (ULSD) to meet new Northeast states' emission standards. The FY 2018 program will continue operation of the existing 1 million barrel Reserve. New leased commerical storage contracts went into effect on April 1, 2016, with the final option year extending through March 31, 2020.

Highlights and Major Changes in the FY 2018 Budget Request

FY 2018 activities will focus on oversight, management and quality analysis of the Reserve as well as ongoing information technology support for the Reserve's sales system.

[1] Does not include the use of prior-year funds.

Northeast Home Heating Oil Reserve
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Northeast Home Heating Oil Reserve				
Northeast Home Heating Oil Reserve	7,600	---	10,000	+500
Subotal, Northeast Home Heating Oil Reserve	**7,600**	**---**	**10,000**	**+500**
Use of Prior Year Balances	**0	**---	-3,500	-1,600
Total, Northeast Home Heating Oil Reserve	**7,600**	**7,586**	**6,500**	**-1,100**
Federal FTEs	**0**	**0**	**0**	**0**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown

** Prior year balances were used in FY 2016 ($2.3 million) and FY 2017 ($2.9 million) to cover full cost of leased commercial storage contracts.

Northeast Home Heating Oil Reserve

Overview

Of all the households in the United States that use heating oil as fuel to heat their homes, the majority reside in the Northeast region of the country, making this area especially vulnerable to fuel oil disruptions. In 2000, the NEHHOR was created to provide protection from severe heating oil supply disruptions throughout the Northeast. The NEHHOR provides a short-term supplement to the Northeast system's commercial supply of heating oil in the event of a supply interruption. The NEHHOR is designed to augment, but not replace, commercial supplies during an emergency. It provides a buffer to assist the heating oil industry in mitigating short-term supply interruptions. The NEHHOR is a valuable component of U.S. energy readiness efforts, separate from the Strategic Petroleum Reserve.

Highlights of the FY 2018 Budget Request

The NEHHOR request will fund leased commerical storage contratcs, oversight, management, information technology sales system support, and quality analysis by an independent quality assurance and inspection service. Unobligated balances will supplement new FY 2018 Budget Authority to maintain leased commercial storage contracts and to fund associated oversight costs.

Northeast Home Heating Oil Reserve
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Northeast Home Heating Oil Reserve				
Commercial Leases	7,600	---	9,200	-300
Information Technology Support	0	---	700	+700
Quality Control and Analysis	0	---	100	+100
Subtotal, Northeast Home Heating Oil Reserve	**7,600**	**7,586**	**10,000**	**+500**
Use of Prior Year Balances	****0**	****---**	-3,500	-1,600
Total, Northeast Home Heating Oil Reserve	**7,600**	**7,586**	**6,500**	**-1,100**

1 The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown"

** Prior year balances were used in FY 2016 ($2.3 million) and FY 2017 ($2.9 million) to cover full cost of leased commercial storage contracts.

Northeast Home Heating Oil Reserve
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Northeast Home Heating Oil Reserve: The decrease in funding will be offset by the use of $3,500,000 in prior-year balances to cover full costs of leased commerical storage contracts. In FY 2016, prior-year balances were used to fund both Information Technology Sales Support and Quality Control and Analysis.	**-1,100**
Total, Northeast Home Heating Oil Reserve	**-1,100**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Northeast Home Heating Oil Reserve Account	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Undesignated Lab/Plant/Installation			
Northeast Home Heating Oil Reserve			
Northeast Home Heating Oil Reserve	7,600	7,586	9,076
Total, Undesignated Lab/Plant/Installation	**7,600**	**7,586**	**9,076**
Washington Headquarters			
Northeast Home Heating Oil Reserve			
Northeast Home Heating Oil Reserve	0	0	924
Total, Washington Headquarters	**0**	**0**	**924**
Total, Northeast Home Heating Oil Reserve Account	**7,600**	**7,586**	**10,000**

Nuclear Energy

Nuclear Energy

Nuclear Energy

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Nuclear Energy

Proposed Appropriation Language

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for nuclear energy activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion, $703,000,000, to remain available until expended: Provided, That of such amount, $66,500,000 shall be available until September 30, 2019, for program direction.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Nuclear Energy
($K)

FY 2016 Enacted[1]	FY 2017 Enacted Annualized CR[2]	FY 2018 Request
986,161	984,286	703,000

Overview

The primary mission of the Nuclear Energy (NE) program is to advance nuclear power as a resource capable of contributing toward the Nation's energy supply, environmental, and national security needs. Nuclear power has reliably and economically contributed about 20% of electrical generation in the United States over the past two decades.

To ensure that nuclear energy remains a viable energy option for the Nation, NE supports research and development activities designed to resolve the technical, cost, safety, waste management, proliferation resistance, and security challenges of nuclear energy. NE leads the Federal research effort to develop nuclear energy technologies, including generation, safety, waste storage and management, and security technologies to help meet energy security, and proliferation resistance. Efforts to ensure NE research capabilities are available to US universities, industry and small businesses are focused through the Nuclear Science User Facilities, the public-private research initiative Gateway for Accelerated Innovation in Nuclear (GAIN), vouchers to assist small businesses seeking access to the knowledge and capabilities at the national laboratories, and the Office of Technology Transition.

Within the FY 2018 Budget request, NE funds the following major programs: Reactor Concepts Research, Development and Demonstration; Fuel Cycle Research and Development; Nuclear Energy Enabling Technologies; Radiological Facilities Management; Idaho Facilities Management; Idaho Sitewide Safeguards and Security; International Nuclear Energy Cooperation; and Program Direction.

Highlights and Major Changes in the FY 2018 Budget Request

Nuclear Energy Research and Development will be focused on early stage R&D with potential benefits to the broad civilian nuclear power industry. Later stage R&D on more mature technologies with benefits to specific private entities is being de-emphasized as it is better achieved by the private sector. Programs that have achieved their primary program goals are being terminated. Specifically:

- Increased R&D emphasis is placed on the least mature but highest potential pay-off accident tolerant fuel options. (-$2.1M);
- Increased support for Nuclear Energy Enabling Technologies cooperative research with universities and industry on promising emerging technologies, particularly in regards to innovative research that directly supports and enables the development of new, next generation reactor designs and fuel cycle technologies, through Crosscutting Technology Development (+$20.0M), Nuclear Energy Advanced Modeling and Simulation (+$7.0M), and Nuclear Science User Facilities ($-6.9M);
- No funding for STEP R&D is requested (-$5.0M) consistent with the Department's decision to shift scale up of the technology to the private sector for some applications.
- Light Water Reactor Sustainability efforts are focused on early stage R&D with industry covering a larger share of reactor-specific development activities (-$20.0M);
- Research into Advanced Reactor Technologies is focused on critical early stage R&D with high potential payoff and supporting the Nuclear Regulatory Commission and industry with implementing an advanced reactor licensing framework (-$37.7M);
- A new subprogram within Reactor Concepts is established, The Versatile Fast Test Reactor R&D, to conduct research and development necessary as a prerequisite to decisions to proceed to build a test reactor to support new innovative advanced reactor concepts response to NRC licensing requirements for qualification testing of fuel and materials under extreme conditions (+$10.0M);
- Funding for the 9th and 10th years of the Modeling and Simulation Hub will be discontinued reflecting the efforts success in modeling commercial reactors and moving those codes into commercial use (-$24.3M).

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] The FY 2017 amount shown reflects the P.L. 114-254 continuing resolution level annualized to a full year.

- The Department met its SMR LTS program objectives and commitments in FY 2017 and is not requesting additional budget for the SMR LTS program (-$62.5M). The request invests in early-stage research and development on next generation reactor technologies, including $20 million supporting advanced small modular reactors.

Funds Idaho Facilities Management and Safeguards and Security to support continued operation of the national laboratories and to ensure a robust cybersecurity program.

In FY 2018 the activities in the Integrated Waste Management System (-$22.5M) and Used Nuclear Fuel Disposition R&D (-$62.5M) are discontinued. Limited interim storage and transportation planning scope is being moved under the new Yucca Mountain Nuclear Waste Repository & Interim Storage account. Program Direction funding for the associated federal staff and support (at NE Headquarters, Office of General Counsel, and the Nevada Field Office) are also transferred to the new account (-$13.5M).

Nuclear Energy
Funding by Congressional Control ($K)

	FY 2016 Enacted[1]	FY 2017 Annualized CR[2]	FY 2018 Request
Integrated University Program	**5,000**	**4,990**	**0**
STEP R&D	**5,000**	**4,990**	**0**
SMR Licensing Technical Support	**62,500**	**62,381**	**0**
Reactor Concepts Research, Development and Demonstration	**141,718**	**141,449**	**94,000**
Fuel Cycle Research and Development	**203,800**	**203,413**	**88,500**
Nuclear Energy Enabling Technologies	**111,600**	**111,388**	**105,360**
Radiological Facilities Management	**24,800**	**24,753**	**9,000**
Idaho Facilities Management			
Operations & Maintenance	220,582	220,163	198,140
16-E-200, Sample Preparation Laboratory	2,000	1,996	6,000
Total, Idaho Facilities Management	**222,582**	**222,159**	**204,140**
Idaho Sitewide Safeguards and Security	**126,161**	**125,921**	**133,000**
International Nuclear Energy Cooperation	**3,000**	**2,994**	**2,500**
Program Direction	**80,000**	**79,848**	**66,500**
Department of State Transfer	**0**	**0**	**0**
Subtotal, Nuclear Energy	**986,161**	**984,286**	**703,000**
Rescission of Prior Year Balances	0	0	0
Total, Nuclear Energy	**986,161**	**984,286**	**703,000**
Federal FTEs	351	342	291

SBIR/STTR:

- FY 2016 Transferred: SBIR $13,129; STTR $1,969
- FY 2017 Projected: SBIR $13,977; STTR $1,966
- FY 2018 Request: SBIR $9,212; STTR $1,295

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] The FY 2017 amount shown reflects the P.L. 114-254 continuing resolution level annualized to a full year.

Integrated University Program

Overview

No funding is being requested in FY 2018 for the Integrated University Program (IUP).

All Department awards are fully funded in the year funding is received. As a result, multi-year student research fellowships do not require support by out-year funds after the appropriation year.

Integrated University Program
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Integrated University Program				
Integrated University Program	**5,000**	**4,990**	**0**	**-5,000**
Total, Integrated University Program	**5,000**	**4,990**	**0**	**-5,000**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Integrated University Program
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Integrated University Program: No funding is being requested to continue this program in FY 2018.	**-5,000**
Total, Integrated University Program	**-5,000**

Integrated University Program

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Integrated University Program		
$5,000,000	**$0**	**-$5,000,000**
• $5.0 million appropriation supported 33 multi-year student fellowships and 57 single-year scholarships.	• No funding is requested to continue this program in FY 2018.	• No funding is requested to continue this program in FY 2018.

SMR Licensing Technical Support

Overview

The SMR Licensing Technical Support (LTS) program was initiated in FY 2012 to support first-of-a-kind costs associated with design certification and licensing activities for SMR technologies and site licensing activities for SMRs through cost-shared arrangements with industry partners. The goal of the program was focused on supporting industry first-movers as they pursued the design development, certification, and licensing of SMRs for deployment in the mid-2020s.

The Department met its SMR LTS program objectives and commitments to industry in FY 2017 and is not requesting a budget for the SMR LTS program in FY 2018. The Department will continue efforts in FY 2018 to advance technologies in support of SMRs and other advanced reactor designs under the Nuclear Energy Enabling Technologies program.

SMR Licensing Technical Support
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
SMR Licensing Technical Support				
SMR Licensing Technical Support	62,500	62,381	0	-62,500
R Licensing Technical Support	**62,500**	**62,381**	**0**	**-62,500**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

SMR Licensing Technical Support
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
SMR Licensing Technical Support: The decrease from $62,500,000 to $0 reflects the Department accomplishment of its SMR LTS program objectives and a focusing of the Departments mission.	**-62,500**
Total, SMR Licensing Technical Support	**-62,500**

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
SMR Licensing Technical Support $62,500,000	**$0**	**-$62,500,000**
Certification Documentation • NuScale Power accomplished the key activities involved in the design and engineering of its SMR technology to finalize certification documentation for the on-time submission to the Nuclear Regulatory Commission (NRC) in January 2017, including: • Submitted final fuel design information (Design Certification Application (DCA) chapter 4.2) to the NRC. • Completed the final draft of the DCA and supported a readiness review by the NRC staff in September 2016, a precursor to the completion of the application. • Completed and submitted to the NRC several key topical and technical reports supporting the nuclear safety case described in the DCA. • Completed all integral systems testing required for the DCA at the NuScale Integral Systems Test Facility in Corvallis, Oregon. • Site Permitting and Licensing • Tennessee Valley Authority (TVA) completed the Early Site Permit Application for the Clinch River Site and submitted to the NRC in May 2016. • TVA developed and submitted supplemental information on seismic, hydrology and geological topical areas in support of the NRC docketing review. • NuScale / Utah Associated Municipal Power Systems (UAMPS) accomplished a down-select of a preferred SMR site at the Idaho National Laboratory.	• No funding is being requested in FY 2018.	• The decrease reflects the Department accomplishing its SMR LTS program objectives by the end of FY 2017.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• NuScale / UAMPS performed financial, technical and legal analyses in support of a "decision to proceed" with the SMR Carbon Free Power Project at INL. Program Management • DOE conducted several studies and analyses important to improving SMR licensing and commercialization potential, including: • Completed siting study coordinated with Department of Defense entitled "Assessment of Small Modular Reactor Suitability for Use On or Near Air Force Space Command Installations" (Sandia National Laboratory, December 2015). • Completed study entitled "Using Technology for Small Modular Reactor Staff Optimization, Improved Effectiveness, and Cost Containment" (Electric Power Research Institute, March 2016). • Conducted an industry-focused workshop to identify nuclear industry commercialization drivers for SMRs in June 2016.		

SMR Licensing Technical Support
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**SMR - Licensing Technical Support Program - Enable the submission of license application documentation to the Nuclear Regulatory Commission (NRC) by SMR vendors and utility partners by supporting design, engineering, certification, and licensing efforts for selected SMR projects.**		
Target	= 1 complete program milestones	= 1 complete program milestones	N/A
Result	Met - 1	TBD	N/A
Endpoint Target	Provide financial risk reduction to industry first-movers for the completion of design development, certification and licensing in a timeframe that supports SMR deployment in the early to mid-2020s.		

Supercritical Transformational Electric Power Research and Development

Overview

The Supercritical Transformational Electric Power Research and Development (STEP R&D) initiative was a collaborative Department of Energy (DOE) project to develop and scale up advanced Supercritical Carbon Dioxide (sCO_2) Brayton cycle energy conversion technology to facilitate commercial development. This program engaged with industry, and the broader stakeholder community, to develop an effective public-private cost-shared sCO_2 Brayton cycle program, including research and development of sCO_2 technologies.

This transformative technology has the potential to significantly reduce costs of energy production by improving the efficiency of converting thermal energy to electrical energy using traditional steam-Rankine cycle systems, which are used for roughly 80% of the world's electricity generation. sCO_2 Brayton cycle technology utilizes smaller equipment and will be simpler to operate compared to Rankine cycle technology, resulting in lower capital and operating costs. These improvements could make advanced nuclear energy technologies more cost competitive.

As a result of the large incentive for industry development of this technology, DOE resources are being focused on earlier stage research in FY 2018. No funding is requested in FY 2018.

Early stage research on Brayton cycle energy conversion technology issues specific to nuclear energy applications is continued within the Reactor Concepts, Research, Development and Deployment (RD&D) program.

Highlights of the FY 2018 Budget Request

No funding is requested for the STEP R&D initiative, consistent with the Department's decision to shift scale up of the technology to the private sector.

Supercritical Transformational Electric Power Research and Development

Funding ($K)

	FY 2016 Enacted[1]	FY 2017 Annualized CR[2]	FY 2018 Request	FY 2018 vs FY 2016
Supercritical Transformational Electric Power Research and Development				
Supercritical Transformational Electric Power Research and Development	5,000	4,990	0	-5,000
Total, Supercritical Transformational Electric Power Research and Development	**5,000**	**4,990**	**0**	**-5,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR $150; STTR $23
- FY 2017 Projected: SBIR $160; STTR $22
- FY 2018 Request: SBIR $0; STTR $0

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.

[2] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Supercritical Transformational Electric Power Research and Development
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Supercritical Transformational Electric Power Research and Development: No funding is being requested in FY 2018.	**-5,000**
Total, Supercritical Transformational Electric Power Research and Development	**-5,000**

Supercritical Transformational Electric Power Research and Development

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Supercritical Transformational Electric Power Research and Development $5,000,000	**$0**	**-$5,000,000**
• Supported Fossil Energy's implementation of the Supercritical Transformational Electric Power (STEP) pilot scale project. • Evaluated options to reduce technical risks and reduce cost for the STEP project. • Conducted specific research and development and technology development activities. • Worked with the Supercritical Carbon Dioxide (sCO2) industry and national laboratories to update market analysis to reflect range of market opportunities for the sCO2 Brayton Cycle. • Awarded three Request for Proposals for sCO2 conceptual designs to support a test facility. • Awarded four FedBizOps proposals to support the development of sCO2 bearings and seals. • Continued support of Vacuum Process Engineering and provide technical guidance on cross-cutting engineering challenges related to printed circuit heat exchangers to ensure programmatic and industrial needs are met.	• No funding is being requested.	• The decrease from $5,000 to $0 reflects DOE's decision to terminate this initiative.

Reactor Concepts Research, Development and Demonstration

Overview

The Reactor Concepts Research, Development and Demonstration (RD&D) program develops new and advanced reactor designs and technologies to further the state of reactor technology. Program activities are designed to address technical, cost, safety, and security issues associated with the existing commercial light water reactor fleet and advanced reactor technologies, such as small modular reactors, fast reactors using liquid metal coolants and high temperature reactors using helium or liquid salt coolants.

In maximizing the benefits of nuclear power, work must be done to address the following challenges:

- Improving affordability of nuclear energy technologies;
- Management of nuclear waste;
- Minimizing proliferation risks of nuclear materials; and
- Further enhancing safety and incorporating lessons learned from Fukushima.

The Light Water Reactor Sustainability (LWRS) subprogram conducts research in support of Light Water Reactor (LWR) technologies so that LWR-based nuclear power can continue to be a major contributor to the nation's economy. The goal is to enable the extended operation of current nuclear power plants while improving their reliability and economic performance. The primary focus is to develop the scientific basis for understanding and predicting long-term environmental degradation behavior of key nuclear power plant components. Activities in the Reactor Safety Technologies area address opportunities to enhance the safety profile of the domestic reactor fleet.

The Advanced Reactor Technologies (ART) subprogram conducts early stage R&D on advanced reactor technologies, including small modular reactors, and supports work on generic topics that can apply to various advanced reactor concepts. This program focuses on efforts in the following areas: advanced reactor coolants, safety and technology for advanced reactors, advanced energy conversion, advanced instrumentation and controls, supporting the Nuclear Regulatory Commission (NRC) and industry with implementing an advanced reactor licensing framework and other initiatives for licensing of advanced reactors, liquid metal reactor component testing, fuel development and graphite material qualification, advanced materials development and codification, and continued international collaborations.

For the United States to regain a global leadership role in development of next generation of advanced reactors, a versatile fast spectrum test reactor may be required as a key experimental tool. A significant R&D program is a prerequisite to decisions on proceeding with building a test reactor.

Highlights of the FY 2018 Budget Request

Light Water Reactor Sustainability is re-prioritized to facilitate leading edge R&D of innovative technologies and capabilities to support operation of the existing fleet of reactors and with broad applicability to a continuum of advanced reactor designs. As a result, some lower priority materials degradation research and plant modernization activities will now be more dependent on industry to perform.

Advanced Reactor Technologies focuses on critical early-stage R&D activities that offer the highest potential payoff in terms of improved economics and performance and shifts some more mature activities towards investment by the private sector.

The Versatile Fast Test Reactor R&D subprogram is established. In FY 2017, a multi-laboratory team with University and Industry participation was assembled to begin work on developing the capability requirements and technical details for a Versatile Fast Test Reactor. In FY 2018, the capability requirements will be finalized and work will continue for specifying the technical attributes of a reactor.

Reactor Concepts Research, Development and Demonstration
Funding ($K)

	FY 2016 Enacted[1]	FY 2017 Annualized CR[2]	FY 2018 Request
Reactor Concepts Research, Development and Demonstration			
Light Water Reactor Sustainability	40,000	-	20,000
Advanced Reactor Technologies	101,718	-	64,000
Versatile Fast Test Reactor R&D	0	-	10,000
Total, Reactor Concepts Research, Development and Demonstration	**141,718**	**141,449**	**94,000**

SBIR/STTR:

- FY 2016 Transferred: SBIR $4,252; STTR $637
- FY 2017 Projected: SBIR $4,526; STTR $637
- FY 2018 Request: SBIR $3,008 ; STTR $423

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] The FY 2017 amounts shown reflect the P.L. 114-254 continuing resolution level annualized to a full year.

Reactor Concepts Research, Development and Demonstration
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Light Water Reactor Sustainability: The decrease from $40,000,000 to $20,000,000 reflects a focus on fundamental, science-based research on Light Water Reactor (LWR)-related technologies.	**-20,000**
Advanced Reactor Technologies: The decrease from $101,718,000 to $64,000,000 reflects completion of the advanced test/demonstration reactor planning study; a focus on early-stage applied energy R&D for advanced reactor systems; and does not include funding for two ongoing industry cost-shared awards made in early calendar year 2016.	**-37,718**
Versatile Fast Test Reactor R&D: The increase from $0 to $10,000,000 reflects the continuation of the basic assessment/user needs started in FY 2017 for a new test reactor. Based on input from a broad group of interested parties including industry and universities, domestic and international resources, the capability requirements will be finalized and work will continue for specifying the technical attributes of areactor.	**+10,000**
Total, Reactor Concepts Research, Development and Demonstration	**-47,718**

Reactor Concepts Research, Development and Demonstration
Light Water Reactor Sustainability

Description

The existing U.S. commercial nuclear fleet has an excellent safety and performance record and today accounts for about 20% of the U.S. electricity supply. The Light Water Reactor Sustainability (LWRS) program conducts research to develop the scientific basis for technologies and other solutions that can improve reliability and economics, sustain safety, and extend the life of the current fleet of commercial nuclear power plants. The LWRS program is also helping address challenges by researching new technologies that can help gain efficiencies, address flexible plant operations and improve safety, including potential cybersecurity related issues.

LWRS has partnered with industry and the Nuclear Regulatory Commission (NRC) to closely coordinate research needs and share costs. Industry will primarily address the near-term research needs and the LWRS program, along with industry, will make progress on the long-term research needs. This research will form the science-based technical basis for age-related material degradation management and inform major component refurbishment and replacement strategies related to instrumentation and control systems, and safety margin characterization. Given the nature of the work done by this program, cost-sharing is of particular importance to ensure industry pull for new technologies. The program will ensure appropriate cost-sharing arrangements for its activities according to Section 988 of the Energy Policy Act of 2005.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Light Water Reactor Sustainability $40,000,000	**$20,000,000**	**-$20,000,000**
• Materials Aging and Degradation – Completed a report detailing Irradiation Assisted Stress Corrosion Cracking (IASCC) mechanisms in core internals. Delivered a mechanistic understanding of crack initiation susceptibility in Ni-based alloy components. Delivered a predictive capability for swelling in Light Water Reactor core components. Completed the harvesting of Reactor Pressure Vessel (RPV) sections from the Zion Nuclear Power Plant. Completed the construction of an alkali-silica reaction test assembly. Delivered an updated knowledge gap assessment for irradiation effects in concrete. Delivered an updated gap assessment of remaining cable insulation degradation research needs. Completed ion-irradiation campaign on advanced radiation-resistant materials. Developed an initial model for predicting component fatigue lifetimes. • Safety Margin Characterization – Completed a multi-hazard seismic and flooding analysis using the Risk-Informed Safety Margins Characterization (RISMC) methodology. Completed a RISMC Toolkit software module (called Grizzly) using first-principles models and multi-physics simulation capabilities. Completed a plant analysis of a detailed Loss of Coolant Accident. Completed a RISMC Toolkit software module (called RAVEN) with advanced probabilistic risk simulation capabilities. • Instrumentation and Controls – Developed state-of-the-art computer-based procedures	• Materials Aging and Degradation – Research is focused on the scientific basis for understanding and predicting long-term environmental degradation behavior of materials in nuclear power plants. Deliver a validated model for Reactor Pressure Vessel (RPV) transition temperature shifts due to radiation damage. Complete assessment of cable degradation mitigation strategies. Complete the development of a tool to assess the impact of radiation on the structural performance of concrete components. Initiate a neutron irradiation campaign to test and validate candidate advanced replacement alloys. Deliver a validated model for core internals swelling. • Safety Margin Characterization – Complete the development of advanced flooding analysis tools suitable for ocean and river based flooding scenarios. Continue to conduct flooding and seismic fragility testing for mechanical components to validate models. • Instrumentation and Controls – Develop an integrated framework for on-line monitoring for concrete structures. Develop concepts for real-time plant operational diagnostics. Complete a model implementation plan for a modernized (combination analog and digital) control room. Work on automated work procedures will be ended in FY 2017. • Systems Analysis and Emerging Issues – Address emerging issues that could influence the continued viability of nuclear energy plants, including flexible plant operations, and cybersecurity. • Reactor Safety Technologies – Complete model development and scaled validation testing to determine long-term cooling capability for Terry Turbine pumps during beyond design basis events.	Reduction in funding reflects a focus on fundamental, science-based research on LWR related technologies. • Materials Aging and Degradation – Reduce or eliminate work associated with Environmentally Assisted Fatigue, core internal phase transformations, and concrete and civil structure Non-Destructive Examination (NDE) capabilities. Work on Environmentally Assisted Fatigue, phase transformation on core internals, high fluence IASCC, and concrete NDE will be ended in FY 2017. • Safety Margin Characterization – Research supporting the development of the RELAP-7 code will move to the Nuclear Energy Advanced Modeling and Simulation program. Work on industry applications will end in FY 2017. • Instrumentation and Controls – Work on automated work procedures will be ended in FY 2017 and work scope to develop a modernized control room will be reduced in FY 2018. • Reactor Safety Technologies – Work on Severe Accident Management Guideline improvements will end in FY 2017. Fukushima forensics activities will be covered under NE's International Activities.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
focusing on human factors and software design. Completed an end-state vision and strategy for a modernized, hybrid (mixed analog-digital) control room. Developed a framework for structural health monitoring of large structural systems. • Systems Analysis and Emerging Issues – Addressed emerging issues that could influence the continued viability of existing plants, such as the implementation of flexible operations within an integrated grid. • Reactor Safety Technologies – Developed a prioritized list of forensic activities for a Fukushima inspection plan. Used the system-level MELCOR and MAAP severe accident analysis software tools to aid in developing an interactive diagnostic tool to inform responders during a severe accident.		

Reactor Concepts Research, Development and Demonstration
Advanced Reactor Technologies

Description

The Advanced Reactor Technologies (ART) subprogram will support the development of innovative reactor technologies that may offer improved safety, functionality and economics, and build upon existing nuclear technology and operating experience. The ART subprogram supports efforts to reduce long-term technical barriers for advanced nuclear energy systems across reactor technology concepts, including next-generation small modular reactors. In addition, the subprogram supports the resolution of regulatory questions for advanced reactors through direct engagement with the Nuclear Regulatory Commission (NRC) and industry. The ART subprogram will continue support for international activities in the Generation IV International Forum and international collaborations on advanced reactor operations and safety. This subprogram will be focused on high value research for long-term concepts, research and development (R&D) needs of promising mid-range concepts, the development of innovative technologies that benefit multiple advanced reactor concepts, and stimulation of new ideas for transformational future concepts. The ART subprogram also supports R&D for increased proliferation resistance and security. In addition, the ART subprogram supports laboratory and university to conduct nuclear technology R&D, including the development of codes and standards, sensors and instrumentation, probabilistic risk assessments (PRA) methods, and other technologies that are unique and would be useful to support development of advanced reactor systems.

Advanced reactor technologies pursued through this program, including next generation small modular reactor technologies, reside at different maturity levels. R&D efforts are mainly focused on three advanced reactor concepts: fast reactors using liquid sodium coolant (SFRs), and two high temperature reactors: the more mature high temperature gas-cooled reactors (HTGRs), and the less mature reactors using liquid salt coolants and/or fuels. High temperature reactor R&D includes fuel qualification and graphite used in HTGRs and some salt cooled reactors. R&D is also being pursued that could provide wide benefits across many different advanced reactor systems (e.g., nuclear materials qualified for high temperature and fast reactor environments, energy conversion technologies including supercritical CO_2, and instrumentation and controls). In addition to the R&D activities, initiatives focused on addressing licensing questions specific to non-light water cooled reactors are being conducted in coordination with the NRC and the nuclear industry. ART will continue to solicit and evaluate new ideas in order to encourage innovation, support technology advances, and enhance the safety and performance of advanced reactor systems.

R&D activities within the ART subprogram will follow a stepwise process that includes feedback and a focus on efficiency and cost-effectiveness to ensure maximum usefulness and applicability of results.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Reactor Technologies $101,718,000	**$64,000,000**	**-$37,718,000**
• Industry Awards – Provided two industry cost-shared awards for further development of advanced reactor concepts. • Fast Reactor Technologies – Mechanism Engineering Test Laboratory (METL) gear test assembly components were fully assembled and optimized for initial shakedown tests. Completed fabrication and assembly of METL piping system, began heater and thermocouple installation. Completed fast reactor point concept to support Advanced Test/Demonstration. Continued optimization of fast reactor knowledge preservation databases and began efforts to validate legacy data for future fast reactor licensing use. • High Temperature Reactor Technologies – Continued post-irradiation examination (PIE) of the Advanced Gas Reactor (AGR)-3/4 fuel experiment for fission product transport data. Completed AGR-5/6/7 test fuel specimen fabrication and experiment preparations for final TRISO fuel tests in the Advanced Test Reactor (ATR). Continued PIE of Advanced Graphite Creep (AGC)-2 and -3 graphite experiments and continued irradiation of AGC-4 experiment in ATR. Completed reconfiguration of Argonne National Laboratory's Natural Circulation Shutdown Heat Removal Test Facility from air cooled to water cooled to test alternative configuration effectiveness. Performed severe accident analytical methods validation	• Fast Reactor Technologies – Continue operations of the Mechanism Engineering Test Laboratory (METL) and test the gear-on-gear test assembly in prototypic sodium environment. Continue and expand optimization of fast reactor knowledge preservation databases, including those for metal fuels and safety testing. Investigate the system and components necessary for development of advanced electromagnetic pump technology, such as high temperature insulation and advanced power feedthroughs and control systems. Continue limited international collaborations on metal fuel core studies, modeling and simulation of fast reactor transients and severe accident analysis, and validation of modeling and benchmark data. • High Temperature Reactor Technologies – Continue graphite qualification and development, including post-irradiation data analysis of graphite samples from AGC-3 and characterization of graphite specimens for AGC experiments, oxidation studies, and thermal creep. • Support a science-based research program to accelerate the molten salt technologies development and develop a fundamental understanding of molten salt physical chemistry and properties. Design advanced salt synthesis and purification methods. Conduct systematic study to understand fission product chemistry and salt irradiation behavior. Evaluate materials and molten salt compatibility under extreme environments. Develop advanced analytical methods and computational chemistry capabilities for molten salt application. • Advanced Reactor Generic Technologies - Continue code qualification of Alloy 709 steel – continue very long term creep tests, initiate thermal aging exposure, base metal procurement and weldment fabrication, generate intermediate term creep data for establishing time-	Reduction in funding from $101,718,000 to $74,000 reflects a focus on early-stage applied energy R&D for advanced reactor systems and technologies. • Industry Awards – no funding included for two ongoing industry cost shared awards to further the development of two performance based advanced reactor concepts. • High Temperature Reactor Technologies – no funding is included for TRISO fuel qualification activities, including completing safety heat-up tests and PIE for completed irradiation campaigns and continuing AGR-5/6/7 irradiation experiments. TRISO fuel qualification is sufficiently complete and at the point where industry can finalize testing to meet their specific fuel design (e.g. pebble or stick fuel). • Advanced Reactor Generic Technologies – Reduction in international R&D collaborations. • Advanced Reactor Regulatory Framework – Development of the Advanced Reactor Regulatory Framework was largely completed in FY 2016-2017. Initiation of a competitive and tailored advanced reactor regulatory review initiative in FY 2018 signals a government shift from framework support to initial implementation support.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
using the Oregon State High Temperature Test Facility. • Advanced Reactor Generic Technologies – Developed two American Society of Mechanical Engineers code cases for improved high temperature design methods. Code case for advanced high temperature alloy (617) approved for low-temperature use and approval for high-temperature use proceeding well. Continued development and in-sodium tests of linear array waveguide transducers, brush-type waveguide phased array, and very high temperature transducers for under sodium viewing. Continued international benchmarking activities to validate advanced reactor safety codes and methods. Continued development and operational performance testing on heat exchangers and modeling for high efficiency Brayton cycle energy conversion technology. Continued bilateral and multi-lateral (e.g., Generation IV International Forum) efforts on advanced reactor safety, thermohydraulics, facilities, and other collaborative research. • Advanced Reactor Regulatory Framework – Continued engagement with the Nuclear Regulatory Commission to develop guidance on advanced reactor design criteria. Implemented a regulatory technology development strategy to address outstanding regulatory issues related to advanced reactor technologies. • Advanced Reactor System Studies – Completed advanced test/demonstration reactor planning study and began steps to implement identified options. Continued	dependent allowable stresses, and develop inelastic analysis methods. Continue material design technology and code qualification activities to support development of long-life intermediate heat exchangers for sodium fast reactors (SFR). Demonstrate a representative remote maintenance activity to facilitate increased maintenance automation. Continue in-service-inspection research focusing on detection of non-surface connected crack detection during SFR outages. Continue the development and validation of a high temperature fission chamber suitable for direct in-core deployment for startup through power range monitoring. Continue R&D on turbomachinery and critical components to support nuclear applications of Brayton cycle energy conversion. Continue bilateral and multi-lateral (e.g., Generation IV International Forum) efforts on advanced reactor safety, thermohydraulics, facilities, and other collaborative research. • Advanced Reactor Regulatory Framework – The Department will continue to engage with NRC and industry to conduct R&D leading to a streamlined regulatory process for advanced reactor technologies,. R&D will focus on resolving uncertainties on key issues. • Special Purpose Applications – Continue limited activities to support development of advanced reactor concepts for compact, remote applications, including system analysis research and development of candidate fuel specimens for testing.	

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
economic analysis study including capital, operations, and fuel costs. • Space and Defense Power Systems - Conducted stewardship activities for legacy special nuclear materials and system assets resulting from National Security projects.		

Reactor Concepts Research, Development and Demonstration
Versatile Fast Test Reactor R&D

Description

The Versatile Fast Test Reactor R&D subprogram is focused on the research and development necessary as a prerequisite to decisions to proceed to build a test reactor. A preliminary test reactor research and development plan will be completed to inform such decisions. Key to a successful program is a clear and concise understanding of the user requirements and the type of experimental testing to be conducted to meet the needs of next generation nuclear energy research and development.

Due to the very high neutron flux provided by such a test reactor the irradiation time for testing of new materials could be reduced by an order of magnitude compared to that for a standard thermal test reactor such as the Advanced Test Reactor at Idaho National Laboratory.

Versatile Fast Test Reactor R&D

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Versatile Fast Test Reactor $0	**$10,000,000**	**-$10,000,000**
• No funding was requested.	• Versatile Fast Test Reactor R&D – Continue R&D on the Versatile Fast Test Reactor Design, a key experimental tool, to regain global leadership in Advanced Reactor R&D. • Implement an expanded R&D program, led by a dedicated multi-discipline team of experts from industry, national laboratories and universities, to define the essential attributes, features and capabilities needed in a versatile fast test reactor to accelerate the development of innovative nuclear concepts. Concepts, components and equipment will be heavily analyzed using modern high-performance modeling and simulation codes, along with hardware testing as appropriate.	• The increase reflects the Versatile Fast Test Reactor R&D subprogram.

Reactor Concepts Research, Development and Demonstration

Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**ART Activities - Complete 90% of annual program milestones to support the development of innovative reactor technologies that may offer improved safety, functionality and affordability, and build upon existing nuclear technology and operating experience.**		
Target	90 % of annual program milestones met	90 % annual milestones met	90 % annual milestones met
Result	Met - 94	TBD	TBD
Endpoint Target	Advanced Reactor Technologies (ART) performance endpoints range from the mid-term (2030s) to very long term. ART is focused on high value research for long term concepts, R&D needs of promising mid-range concepts, and development of innovative technologies that benefit multiple concepts and stimulation of new ideas for transformational future concepts.		
Performance Goal (Measure)	**Light Water Reactor Sustainability (LWRS) - Complete 90% of annual program milestones to support development of scientific knowledge to extend existing nuclear plant operating life beyond the current 60-year limit.**		
Target	90 % annual program milestones met	90 % annual program milestones met	90 % annual milestones met
Result	Met - 100	TBD	TBD
Endpoint Target	NE-developed tools and assessments will help establish the scientific bases for existing plants to receive license extensions from the NRC in the 2030 timeframe.		

Fuel Cycle Research and Development

Overview

The Fuel Cycle Research and Development (FCR&D) program conducts early-stage applied research and development (R&D) on advanced fuel cycle technologies that have the potential to enhance safety, improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. Advancements in fuel cycle technologies support the enhanced availability, economics, safety, and security of nuclear-generated electricity in the United States, further enhancing U.S. energy independence and economic competitiveness. The FCR&D program also provides technical support for the Department's uranium management policies to mitigate negative impacts on domestic producers from Departmental actions.

The FCR&D program participates in world-class R&D and employs internationally renowned technical experts. All FCR&D subprograms leverage their technical expertise by participating in international collaborations through bilateral and multilateral technical agreements. The program also participates in projects sponsored by the International Atomic Energy Agency and the Organization for Economic Cooperation and Development/Nuclear Energy Agency which provides further leverage in key technical areas.

Highlights of the FY 2018 Budget Request

The Advanced Fuels subprogram continues to make progress towards its goal of supporting industry development of one or more light water reactor fuel concepts with significantly enhanced accident tolerance through early-stage R&D. In FY 2018, the program will focus on high risk/high pay-off research such as advanced separation technologies with improved process control and accountability, as well as addressing the challenges associated with gaseous fission product release. The program will also begin to explore potential fuel development options and fissile resources to inform fast test reactor decisions.

In FY 2018 the activities in Integrated Waste Management System and Used Nuclear Fuel Disposition R&D are discontinued. Interim storage and transportation planning scope is being moved under the new Yucca Mountain and Interim Storage Programs.

Fuel Cycle Research and Development

Funding ($K)

	FY 2016 Enacted[1]	FY 2017 Annualized CR[2]	FY 2018 Request	FY 2018 vs FY 2016
Fuel Cycle Research and Development				
Material Recovery and Waste Form Development	32,950	-	14,000	-18,950
Advanced Fuels	62,100	-	60,000	-2,100
Systems Analysis and Integration	10,500	-	8,500	-2,000
Materials Protection, Accounting & Control Technology	8,050	-	6,000	-2,050
Used Nuclear Fuel Disposition R&D	62,500	-	0	-62,500
Integrated Waste Management System	22,500	-	0	-22,500
Fuel Resources	5,200	-	0	-5,200
Total, Fuel Cycle Research and Development	**203,800**	**203,413**	**88,500**	**-115,300**

SBIR/STTR:

- FY 2016 Enacted: SBIR $5,439; STTR $816
- FY 2017 Projected: SBIR $5,791; STTR $814
- FY 2018 Request: SBIR $2,832; STTR $398

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.

[2] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Fuel Cycle Research and Development
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Materials Recovery and Waste Form Development: The decrease from $32,950,000 to $14,000,000 reflects a focus on the CoDCon project, waste form development, off gas capture and domestic electrochemistry, deferring R&D on minor actinides recovery for the development of advanced and innovative aqueous recycling technologies. There is also a change in the R&D direction with an emphasis on molten salt coolant chemistry to support advanced reactor technologies based on the use of molten salts as fuel and/or coolants.	**-18,950**
Advanced Fuels: The decrease from $62,100,000 to $60,000,000 is a result of refocusing accident tolerant fuel activities on early-stage research and development that supports high-risk, high-reward concepts. Other R&D activities are deferred or significantly reduced.	**-2,100**
Systems Analysis and Integration: The decrease from $10,500,000 to $8,500,000 reflects a focus on analyzing a complete nuclear energy system from resource acquisition to waste disposal.	**-2,000**
Materials Protection, Accounting & Control Technology: The decrease from $8,050,000 to 6,000,000 reflects the narrowing of the scope of R&D for advanced instrumentation to focus on the most promising technologies. Support to electrochemical processing and safeguard by design continue to be priorities of this subprogram.	**-2,050**
Used Nuclear Fuel Disposition R&D: The decrease from $62,500,000 to $0 is a result of discontinuing this program activity with limited interim storage and transportation planning scope being moved under the new Yucca Mountain and Interim Storage Programs account.	**-62,500**
Integrated Waste Management System: The decrease from $22,500,000 to $0 is a result of discontinuing most of this program activities with interim storage and transportation planning scope being moved under the new Yucca Mountain and Interim Storage Programs account.	**-22,500**
Fuel Resources: The decrease from $5,200,000 to $0 reflects completion of this R&D effort and no funding is requested. The subprogram had successfully reached the initial goals of doubling the sorption capacities of uranium recovery from seawater, along with a significant reduction in the technical uncertainties.	**-5,200**
Total, Fuel Cycle Research and Development	**-115,300**

Fuel Cycle Research and Development
Material Recovery and Waste Form Development

Description

The Material Recovery and Waste Form Development (MRWFD) subprogram's mission is to conduct broad research and development (R&D) activities related to the improvement of the current back end of the nuclear fuel cycle, which have the potential to improve resource utilization and energy generation, reduce waste generation, enhance safety, and limit proliferation. The program employs a long-term, science-based approach to foster innovative, and transformational technology solutions to achieve this mission. Research on molten salt chemistry to support advanced reactor technologies based on the use of molten salts as fuel and/or coolants as well as research on advanced and innovative analytical technologies, characterization technologies and on-line monitoring tools to support the back end of the nuclear fuel cycle will strengthen the sustainability of advanced nuclear fuel cycles.

MRWFD applies the unique expertise and technical capabilities to a broad range of applications such as a fundamental understanding of various chemical challenges related to civil nuclear applications.

Regarding civilian nuclear applications, the ability to sustainably and economically recycle advanced reactor fuels is dependent on the ability to understand the long-term behavior of chemical species that are in either solid, aqueous or gaseous state for reuse and/or for disposal in a cost-effective manner that reduces proliferation and security risks. The ability to engineer, produce, and manage fuel cycle waste forms that are chemically and structurally stable over relevant periods of time from decades to hundreds of thousands of years (depending on the radioisotope) would be critical for any advanced fuel cycle.

Joint Fuel Cycle Studies (JFCS) is a key activity within MRWFD. In collaboration with the Republic of Korea, the JFCS is assessing the technical and economic feasibility and nonproliferation acceptability of electrochemical recycling and other options for managing used nuclear fuel. In FY 2018, the JFCS will be in its second phase, which is the determination of reliable integrated process operation with used LWR fuel.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Material Recovery and Waste Form Development		
$32,950,000	**$14,000,000**	**-18,950,000**
• Continued preparations for laboratory scale demonstration of single step process (homogenous) or two-step process (heterogeneous) separations, by addressing flowsheet design and testing, and further development of the most promising alternative processes. • Developed and demonstrated fission gas capture and immobilization technologies, focusing on iodine, krypton, and tritium and evaluated carbon-14 management requirements and technology options. • Investigated thermodynamics and kinetics of various case study processes. • Continued development of U/TRU recovery technologies on solid electro-refining cathode. Fabricated equipment for solid cathode demonstration at kg scale with actual fuel following Joint Fuel Cycle Studies (JFCS) Integrated Recycling Test (IRT) testing. • Performed lab-scale testing with simulants of candidate aqueous processes. • Continued to develop solvent degradation (radiolysis and hydrolysis) evaluations. • Provided software tools and analysis for the tracking of material at risk during operations of the IRT in the Hot Fuel Examination Facility (HFEF). • Provided for the design, fabrication, qualification, and installation of remote, kilogram-scale process equipment in the HFEF.	• Perform lab scale testing in glove box of the CoDCon Project, which is an investigation of advanced process control capabilities with improved accountability potential and advanced co-conversion technology. • Continue the research on fission products gas and noble gas capture and immobilization with advanced new sorbents and advanced waste forms technology. • Continue R&D on glass corrosion rate and develop new advanced glass ceramic waste-forms and ceramic waste-forms as a substitute to the traditional glass waste-form. • Continued development of advance solid cathode co-deposition technology with a focus on process relevant conditions. • Demonstrate methods to clean up salt in advanced electrochemistry processes. • Continue the testing and qualification of advanced equipment for the reduction of oxide to metal, along with process monitoring equipment. • Continue to install remote, kilogram-scale process equipment in the HFEF.	• MRWFD program will limit its portfolio to the CoDCon project, waste form development, off gas capture and domestic electrochemistry, deferring R&D on minor actinides recovery for the development of advanced and innovative aqueous recycling technologies.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Investigated critical technical topics (related to fuel fabrication) to enable the success of the IRT or to enable determination of the long-term technical and economic feasibility and non-proliferation acceptability of electrochemical recycling. • Established the technical basis for an international consensus glass corrosion rate for reference glass.		

Fuel Cycle Research and Development
Advanced Fuels

Description

Every commercial nuclear power reactor in the United States is a light water reactor with fuel that consists of ceramic uranium dioxide pellets encased in zirconium alloy cladding. The Advanced Fuels subprogram conducts early-stage research and development on other types of fuel that have the potential for significantly improved performance. This includes advanced, innovative fuel concepts for existing light water reactors, future light water reactors, and advanced non-light water reactors. Advanced Fuels also invests in the facilities, equipment, and technical expertise to advance the science-based approach to fuel development. That science-based approach should save many years and millions of dollars in the development of advanced fuel concepts.

Following the accident at Fukushima and responding to 2012 Congressional mandate, Advanced Fuels initiated a program to explore advanced light water reactor fuel with enhanced accident tolerance to benefit existing U.S. commercial nuclear power reactors. After five years of feasibility studies and assessments of potential fuel concepts, the program identified promising concepts that have the potential to significantly enhance accident tolerance and that can have lead fuel rods or lead fuel assemblies inserted into commercial reactors by 2022. The program is exceeding expectations regarding the 2022 milestone. It is expected that several fuel concepts will be inserted in U.S. commercial nuclear power reactors as early as 2018. As a result, in FY 2018 the program will refocus its efforts on the high-risk, high-reward concepts that require more research and development but offer significant benefits over any of the near-term technologies. The accident tolerant fuel program will also continue to provide the unique capabilities of the national laboratories that do not exist in industry to support both the near-term and long-term fuel concepts under development by industry. These capabilities include irradiation test facilities, post-irradiation test equipment, and associated technical expertise which is only available at the national laboratories.

There are enhanced accident tolerant fuel concepts that require more research and development beyond 2022 but have the potential for even greater performance for future light water reactors. In FY 2018 Advanced Fuels will continue to conduct the laboratory-scale research and development on these advanced fuel types and advanced cladding material.

There is a wide range of advanced non-light water reactor types that are in the early stages of development by industry. Many of these reactor types will require early-stage research and development on innovative fuels that are beyond the capabilities of the firms developing these reactor concepts. Advanced Fuels will provide the capabilities of the national laboratories to support the most promising reactor types and associated fuel concepts. One non-light water reactor fuel type that has been a focus of Advanced Fuels for many years is metallic fuel for sodium-cooled fast reactors.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Advanced Fuels $62,100,000	**$60,000,000**	**-$2,100,000**
• Initiated post irradiation examination (PIE) on first set of industry-led accident tolerant fuel (ATF)-1 fuel-clad samples. • Selected and prioritized ATF technologies for phase 2 development and qualification towards lead fuel rod or lead fuel assembly irradiation. • Continued planning for a Halden reactor irradiation test on ATF-related FeCrAl cladding material that started in late 2016. • Continued development of remote casting of metallic fuel samples. • Coordinated with France on return of PHENIX-irradiated advanced cladding materials (total dose up to 70 dpa). • Completed FUTURIX-FTA baseline PIE and issued report. • Issued update to the transmutation fuels handbook. • Fabricated fuels which incorporate integral fuel cladding chemical interaction barriers. • Continued development of processing techniques for next generation cladding materials. • Continued preparations for Am-target irradiation tests in Advanced Test Reactor (ATR) in collaboration with French Alternative Energies and Atomic Energy Commission (CEA). • Continued preparations for China Experimental Fast Reactor irradiation of advanced cladding materials through the U.S.-China bilateral agreement. • Continued development of BISON code applications for ternary metallic fuels.	• Continue PIE of ATF-1 fuel-clad samples. Progress from baseline PIE to more advanced PIE that provides more detailed performance data. • Continue to support development of high-risk, high-reward ATF concepts including uranium silicide fuels and silicon carbide cladding. • Begin ATF-2 water loop irradiation test in the Advanced Test Reactor. • Begin to fabricate a test rig for irradiation tests of ATF concepts. • Continue early-stage, laboratory-scale R&D on innovative light water reactor fuels including fully ceramic microencapsulated fuel and high uranium density fuels such as uranium nitrides and uranium silicides. • Conduct early-stage R&D for a new class of advanced high-dose cladding materials. • Conduct early-stage R&D for advanced fabrication methods of metallic fuels such as extrusion and continuous casting. • Initiate ATF-3 transient tests in INL's TREAT reactor to involve un-irradiated fuel samples in a static test capsule. • Continue to invest in fuel development capabilities at the national laboratories including sample transport casks and state-of-the-art thermal property measurement equipment. • Continue development of BISON code applications for metallic fuels. • Continue early-stage R&D on transmutation fuels.	• The decrease is a result of refocusing accident tolerant fuel activities on early-stage research and development that supports high-risk, high-reward concepts.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• In support of ATF FeCrAl development, analyzed separate effects test data for irradiation induced creep. • Continued development needed to demonstrate electron probe micro-analyzer capability on irradiated fuel in Irradiated Materials Characterization Laboratory. • Completed design of test train for irradiation of ATF concepts in ATR water loop 2A. Initiated fabrication of loop experiment hardware. • Completed conceptual design of TREAT water loop. Completed draft ATF transient test plan incorporating requirements of the three ATF vendor teams.		

Fuel Cycle Research and Development
Systems Analysis and Integration

Description

The Systems Analysis and Integration subprogram provides the critical capability needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between various subsystems and associated technologies. The objective is to develop and implement analysis processes and tools and perform integrated fuel cycle evaluations to provide information that can be used to objectively and transparently inform decision makers about overall research and development (R&D) directions and to integrate activities through R&D efforts on common fuel cycle goals.

In FY 2018, Systems Analysis and Integration will further expand the capability to analyze a complete nuclear energy system from resource acquisition to waste disposal and thus retain global leadership in this important area of nuclear technology. Another priority for FY 2018 is to support the development of promising fuel cycle options under development by industry.

The Systems Analysis and Integration subprogram also includes program assessment and coordination activities that ensure the R&D pathways being explored in the various subprograms are well integrated, executed effectively, and aligned with the overall mission of the Office of Nuclear Energy.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Systems Analysis and Integration $10,500,000	**$8,500,000**	**-$2,000,000**
• Continued analysis of transition and growth projections from the current fuel cycles to the smaller set of promising fuel cycles as identified by the Evaluation and Screening Study. • Performed study of options that may affect transition time using fissile materials from existing stockpiles or recovered from existing used fuel, use of legacy waste (and its fissile content), fast reactor conversion ratio, and use of enriched uranium to start the transition. • Identified what is needed to support credible fuel cycle cost estimates and evaluation of financial risk and perform cost analyses to support systems studies and identify where additional research and development (R&D) could provide significant impact. • Reviewed the claimed performance benefits, as compared to the current U.S. nuclear power fleet, for over 50 innovative fuel cycle and reactor concepts currently under development by industry, and compared the claims to the results from the Nuclear Fuel Cycle Evaluation and Screening study to inform DOE/Office of Nuclear Energy (NE) on the accuracy of the claims, any overstated benefits, and associated R&D needs. • Ensured the R&D pathways being explored by the various campaigns within the Fuel Cycle R&D subprograms were well integrated, executed effectively, and aligned with the overall mission of NE.	• Continue to enhance the critical capability to analyze a complete nuclear energy system from resource acquisition to waste disposal to retain Unites States' global leadership position for this capability and provide a basis for integration and prioritization of long-term R&D for advanced nuclear energy systems. • Inform Fuel Cycle R&D program development, planning and budget formulation by conducting studies on the impacts of nuclear power deployment for both continuing with the current U.S. fuel cycle and for transitions to alternative advanced nuclear energy systems; assessment and integration of R&D activities conducted by the program. • Support technology development roadmaps and progress evaluation of long-term R&D through a technology and system readiness assessment process. • Continue to evaluate performance potential and R&D needs of innovative reactor concepts under development by industry. • Continue to maintain publicly-available online Fuel Cycle Catalog. • Conduct program assessment and coordination activities to ensure the R&D pathways being explored in the various subprograms are well integrated, executed effectively, and aligned with the overall mission of the Office of Nuclear Energy.	• The activities for the cost analyses of advanced nuclear energy systems and technologies, as well as the enhancements to the publicly-available online Fuel Cycle Catalog will be suspended in FY 2018.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Working with R&D campaigns, analyzed specific technology options to narrow the R&D focus. • Expanded the information in the publicly-available online Fuel Cycle Catalog, developed and maintained by the campaign by adding several new fuel cycle options, reactors, and fuels.		

Fuel Cycle Research and Development
Materials Protection, Accounting & Control Technology

Description

The Materials Protection, Accounting and Control Technology (MPACT) subprogram develops the technologies and analysis tools to support the next generation of nuclear materials management and safeguards for planned and emerging U.S. nuclear fuel cycles. It also includes assessing vulnerabilities in current nuclear systems while managing and minimizing proliferation and terrorism risks. Addressing the energy security needs of the country will require innovative approaches to materials control and accounting to ensure that nuclear material is not misused, diverted, or stolen.

The Office of Nuclear Energy (NE) works closely with the National Nuclear Security Administration (NNSA), the Department of State, and the Nuclear Regulatory Commission (NRC) on issues related to nuclear nonproliferation. NNSA has broad responsibilities in international nonproliferation and security matters for the present and into the future. MPACT is focused on research and development (R&D) as it relates to potential future fuel cycle facilities here in the United States.

Challenges facing nuclear materials accountancy generally include:

- Limitations of accuracy and timeliness of detection (especially in high radiation fields).
- Aggregating and integrating process data from large information streams.
- Assessment of new reactor designs and fuel cycle concepts, which require new nuclear material management approaches (Small Modular Reactors, Gas-Cooled Reactors, Thorium, etc.).
- Traditional material control and accountability challenges, such as uncertainty in large throughput facilities.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Materials Protection, Accounting and Control Technology $8,050,000	**$6,000,000**	**-2,050,000**
• Developed and demonstrated advanced sensors and instrumentation to fill gaps in materials protection, accounting and control technologies. • For electrochemical processing, developed and demonstrated an integrated suite of sensors and instruments (e.g., actinide sensor, voltammetry, level/density sensor, microfluidic sampler), and analysis and performance assessment tools (e.g., fundamental models, pattern recognition and statistical inference methods, facility performance models). • Developed and demonstrated concepts and approaches and associated technologies and analysis tools for safeguards and security of used fuel extended storage. • Evaluated additional process monitoring in partnership with H-Canyon to demonstrate multi-isotope process monitoring for safeguards utilization in aqueous reprocessing. • Developed advanced sensors for neutron detection (e.g., solid state) applicable to both monitoring and assay applications. • Continued international engagement to help influence and support the advanced safeguards of the nuclear energy enterprise.	• Continue development of promising sensor technologies to decrease measurement uncertainty in material accounting technologies for nuclear materials processes. • Improve state of the art in process monitoring for molten salt electrochemical operation by using actinide sensor, voltammetry, level/density sensor, and microfluidic sampling, methods to develop baseline measurements, statistical inference methods, and facility performance models. • Use advanced optical characterization techniques, and advanced process monitoring to support the CoDCon Project. • Improvement and testing of high dose rate solid state neutron detection and metal product ingot characterization activities. • Continue international engagement to help influence and support the advanced safeguards of the nuclear energy enterprise.	• Narrowing of the scope of R&D for advanced instrumentation to focus on the most promising technologies.

Fuel Cycle Research and Development
Used Nuclear Fuel Disposition R&D

Description

This subprogram supported research and development (R&D) to identify alternatives to Yucca Mountain and conducted scientific research and technology development to enable transportation of used nuclear fuel and wastes generated by existing nuclear fuel cycles.

In FY 2018, the activities in Used Nuclear Fuel Disposition R&D will be discontinued. Interim storage and transportation planning scope is being moved under the new Yucca Mountain and Interim Storage Programs.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Used Nuclear Fuel Disposition R&D $62,500,000	**$0**	**-$62,500,000**
• Inspection and preparation of the High Burnup Spent Fuel Data project cask for storage commenced, as well as extraction of the 25 sister rods, their shipment to ORNL and commencement of the non-destructive analysis. • Development of the detailed multi-model transportation test plan between DOE and ENSA in Spain, obtained the transportation cask system, determined the placement of accelerometers and strain gages on the surrogate assemblies through modeling at PNNL, obtained and tested the sampling equipment and batteries. • Thermal analysis of three loaded canisters was completed. • A model was developed to combine temperature, humidity, salt, and other data to determine the areas of the country where storage canister stress corrosion cracking is of high or lower risk. • Security accomplishments helped refine and alter the design of Consolidated Interim Storage Facility design to mitigate potential security risks. Additional work also analytically quantified potential radiation releases from worst-case terrorism events. • Assessed the technical feasibility of direct disposal of dual-purpose canisters, and single-purpose canisters, used for dry storage of used nuclear fuel. • Development of thermodynamic databases and models to evaluate the stability of barrier	• No funding is being requested.	• The activities in Used Nuclear Fuel Disposition R&D will be discontinued. Interim storage and transportation planning scope is being moved under the new Yucca Mountain Nuclear Waste Repository and Interim Storage account.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
materials and their interactions with fluids at various physico-chemical conditions relevant to subsurface repository environments. • Developed modeling approach and toolset for modeling of fuel and cladding in storage and transportation environments and uncertainty quantification methodology to quantify degradation mechanisms during storage and transportation of high-burnup fuels. • Evaluated regional and sub-regional geotechnical information for a drilling project including the development of reference designs for disposal of alternative waste forms and borehole seals research and planning. • Initiated a field test to examine the viability of large diameter, deep borehole disposal of high-level waste, including the start of drilling an experimental borehole at a volunteer site. • Conducted analyses, lab and field tests, including collaborations with international partners, to evaluate three main rock types for geologic disposal. • Developed a disposal system modeling and analysis capability that supports the prioritization of Disposal Research R&D and the evaluation of disposal system performance, including uncertainty, for a range of disposal options. • Designed and researched alternative safety approaches for the development of standardized transportation, aging, and disposal canisters for used nuclear fuel. • Evaluated design alternatives and conducted preliminary design activities for a used nuclear fuel trans-loading capability supporting research purposes for fuel currently stored at INL.		

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Continued activities related to acquisition of transportation rolling stock, transportation casks, and ancillary equipment, including preliminary design and acquisition of prototype rail cars for testing. • Continued activities associated with exploring potential alternative disposal options from some DOE-managed high level waste and spent nuclear fuel.		

Fuel Cycle Research and Development
Integrated Waste Management System

Description

This subprogram developed and implemented the design of an integrated waste management system (IWMS).

In FY 2018, the activities in integrated Waste Management System will be discontinued. Interim storage and transportation planning scope is being moved under the new Yucca Mountain and Interim Storage Programs.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Integrated Waste Management System $22,500,000	**$0**	**-$22,500,000**
• Planned for the implementation of interim storage as a component of the waste management system, with an initial focus on a pilot interim storage facility (ISF) accepting spent nuclear fuel (SNF) from shut-down reactor sites. This included evaluation of design and operational concepts for storage and transportation. • Prepared for future large-scale transportation of SNF to facilitate the acceptance of spent nuclear fuel at a pilot ISF within the next ten years. • Continued to expand the evaluation of shut-down sites to prepare for and enable transportation; refined routing studies and capabilities; developed plans and cost estimates for "campaigning" fuel shipments; developed and maintained transportation system functional requirements. • Identified and evaluated opportunities for standardization and integration within the nuclear waste management system, including developed design options for multi-purpose storage, transportation, and disposal components and systems. • Expanded and maintained the Used Nuclear Fuel Storage, Transportation & Disposal Analysis Resource and Data System (UNF-ST&DARDS) database. • Worked with State Regional Groups and Tribes (SRG+T) to plan transportation activities including evaluation of approaches to implement requirements to provide funds and training to	• No funding is being requested.	• The activities in Integrated Waste Management System will be discontinued. Interim storage and transportation planning scope is being moved under the new Yucca Mountain Nuclear Waste Repository and Interim Storage account.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
public safety officials of units of government through whose jurisdiction SNF may be transported. • Initiated and executed a listening campaign to support the development of a draft process for the consent based siting of nuclear waste storage and disposal facilities. • Prepared for the future award for the development of a generic design and Topical Safety Analysis Report (TSAR) for a pilot interim storage facility.		

Fuel Cycle Research and Development
Fuel Resources

Description

The Fuel Resources subprogram sought to identify and implement actions the Department could take to assure that economic nuclear fuel resources remain available. The program evaluated nuclear fuel resources and developed recovery technologies to enable increased fuel resources. Priority attention focused on developing the technology for extraction of uranium from seawater. Seawater contains more than 4 billion tons of dissolved uranium. This unconventional uranium resource, combined with a suitable extraction cost, provided a price cap and ensured centuries of uranium supply even with aggressive world-wide growth in nuclear energy applications. A key objective was to develop advanced adsorbent materials that can simultaneously enhance uranium sorption capacity, selectivity, kinetics, and materials durability to reduce the technology cost and uncertainties.

The strategy was to take advantage of recent developments in (1) high performance computing, (2) advanced characterization instruments, and (3) nanoscience and nano-manufacturing technology to enable technical breakthroughs. The technology-driven, science-based research and development efforts were focused on: simulating and predicting structural and functional relationships using modern computational tools; applying advanced quantum beam characterization tools to understand dynamic chemical processes at the atomic and molecular levels; and synthesizing novel nanoscale adsorbent materials with architectures tailored for specific chemical performance.

In FY 2018, funding is being discontinued for this subprogram since it had successfully reached the initial goals of doubling the sorption capacities of uranium recovery from seawater, along with a significant reduction in the technical uncertainties.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Fuel Resources $5,200,000	**$0**	**-$5,200,000**
• Significantly increased the uranium sorption capacity using irradiation (e-beam) induced and chemical grafting methods. • The research team supported by Fuel Resources subprogram received another R&D100 Award in 2016 for its discovery of innovative new adsorbent materials. • Made significant progress toward understanding and modeling the mechanisms involved in binding of uranium and competing metals (e.g., vanadium) in seawater. • Utilized data from the marine testing of developed adsorbents at marine test sites to formulate engineering models of kinetic and equilibrium mechanisms. • Successfully developed a new acrylic fiber adsorbent preparation process which was less costly for potential technology scale-up.	• No funding is being requested.	• The decrease from $5,200,000 to $0 reflects completion of this R&D effort and no funding is requested. The subprogram had successfully reached the initial goals of doubling the sorption capacities of uranium recovery from seawater, along with a significant reduction in the technical uncertainties.

Nuclear Energy
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Fuel Cycle R&D (FCR&D) - Complete Fuel Cycle research and development activities that allow the FCR&D program to support the attainment of a sustainable fuel cycle.**		
Target	90 % of annual milestones met	90 % annual milestone met	90 % annual milestone met
Result	Met - 96	TBD	TBD
Endpoint Target	The R&D milestones represent progress toward several key fuel cycle outcomes: (1) Support the Administrations' waste management strategy to begin operation of a pilot interim storage facility by 2021 and a larger interim storage facility by 2025, and make demonstrable progress to facilitate the availability of a geologic repository by 2048; (2) Conduct feasibility studies on accident tolerant fuel concepts, and qualify the fuel that would lead to lead fuel rod or assembly irradiation in a commercial power reactor in 2022; (3) Perform long-term R&D on advanced technologies that could lead to the next generation of sustainable fuel cycle options that have the potential to improve resource utilization and energy generation, reduce waste generation, enhance safety, and limit proliferation risk.		

Nuclear Energy Enabling Technologies

Overview

The Nuclear Energy Enabling Technologies (NEET) program sponsors research and development (R&D) and strategic investments in research capabilities to develop innovative and crosscutting nuclear energy technologies. The Crosscutting Technology Development (CTD) subprogram focuses on innovative research that directly supports and enables the development of new, next generation reactor designs and fuel cycle technologies. Also, this program includes a strong investment in modeling and simulation tools for reactor and fuel system technologies. Further, the program provides access to unique nuclear energy research capabilities through the Nuclear Science User Facilities (NSUF). Collectively, NEET-sponsored activities support the goals, objectives, and activities of the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative to make these technology advancements accessible to industry through public-private partnerships.

Highlights of the FY 2018 Budget Request

NEET will continue to support next generation reactor and fuel cycle technologies through competitively-awarded crosscutting research in digital instrumentation and control technologies; innovative manufacturing and factory fabrication technology; and advanced cooling technology concepts.

NEET continues to support on-going research and capability development activities in advanced modeling and simulation through the Nuclear Energy Advanced Modeling and Simulation (NEAMS) subprogram.

The Energy Innovation Hub for Modeling and Simulation has completed its work scope initially awarded in FY 2010 and no funds are requested for FY 2018; however, the computational tools and capabilities developed by the HUB in support of light water reactor technologies are integrated into the NEAMS program.

Nuclear Energy Traineeship funds are not requested in FY 2018.

Nuclear Energy Enabling Tehcnologies
Funding ($K)

	FY 2016 Enacted[1]	FY 2017 Annualized CR[2]	FY 2018 Request	FY 2018 vs FY 2016
Nuclear Energy Enabling Technologies				
Crosscutting Technology Development	17,000	-	37,000	+20,000
Nuclear Energy Advanced Modeling and Simulation	27,200	-	34,200	+7,000
Energy Innovation Hub for Modeling and Simulation	24,300	-	0	-24,300
Nuclear Science User Facilities	41,100	-	34,160	-6,940
Nuclear Energy Traineeships	2,000	-	0	-2,000
Total, Nuclear Energy Enabling Technologies	**111,600**	**111,388**	**105,360**	**-6,240**

SBIR/STTR:

- FY 2016 Transfer: SBIR $3,288; STTR $493
- FY 2017 Projected: SBIR $3,501; STTR $492
- FY 2018 Request: SBIR $3,372 ; STTR $474

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Nuclear Energy Enabling Technologies
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Crosscutting Technology Development: The increase from $17,000,000 to $37,000,000 reflects an expansion of the program to address the technical and regulatory development in support of all next generation reactor technologies, including small modular reactors. Crosscutting Technology Development will support leading edge research to improve the economics, quality, and efficiencies of nuclear technologies. No funds are being requested for nuclear cybersecurity and hybrid energy systems as part of Crosscutting as these work scopes are transferred to the Light Water Reactor Sustainability subprogram within Reactor Concepts RD&D.	**+20,000**
Nuclear Energy Advanced Modeling and Simulation: The increase from $27,200,000 to $34,200, 000 supports the integration of the VERA code from the Hub subprogram and the RELAP-7 code from the Light Water Reactor Sustainability program into the NEAMS subprogram.	**+7,000**
Energy Innovation Hub for Modeling and Simulation: The Energy Innovation Hub for Modeling and Simulation has completed its work scope initially awarded in FY 2010 and no funds are requested for FY 2018; however, the computational tools and capabilities developed by the HUB in support of light water reactor technologies are integrated into the NEAMS program.	**-24,300**
Nuclear Science User Facilities: The overall decrease from $41,100,000 to $34,160,000 reflects fully forward funding the building design and construction activities for the Idaho National Laboratory Materials and Fuels Research Collaboration facility in FY 2016 and increased research support for resumption of operations of the Transient Reactor Test Facility.	**-6,940**
Nuclear Energy Traineeships: No funds are requested in FY 2018.	**-2,000**
Total, Nuclear Energy Enabling Technologies	**-6,240**

Crosscutting Technology Development

Description

The Crosscutting Technology Development (CTD) subprogram competitively awards innovative R&D to universities, national laboratories, and industry to develop innovative solutions to crosscutting nuclear energy technology challenges. CTD is coordinated with NE's other R&D programs to ensure that developed technologies and capabilities are part of an integrated investment strategy aimed at improving safety, reliability, and economics of nuclear technologies.

Characteristics of the activities within this program include:

- High-risk research that could overcome current technological limitations.
- Development of enabling technologies that have applicability across multiple technical areas.
- New capabilities needed by the NE R&D enterprise.
- Leading edge R&D to improve the economics, quality, and efficiencies of nuclear technologies.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Crosscutting Technology Development		
$17,000,000	**$37,000,000**	**+$20,000,000**
• Competitively solicited and awarded ten new multi-year R&D projects in high priority crosscutting R&D areas. • Competitively solicited and awarded three strategic infrastructure investments to three national laboratories. • The Hybrid Energy Systems (HES) technology development roadmap was completed and issued March 17, 2016, and program was approved for continuation.	• Competitively solicit and award new fully funded R&D projects in high priority crosscutting R&D areas with applicability to next generation reactor and fuel cycle technologies: advanced sensors and instrumentation, advanced methods for manufacturing, advanced cooling technologies, transient testing R&D, and other stakeholder-identified areas.	• Provides funding for early-stage, innovative R&D focused on the economics, quality, and efficiencies of nuclear component manufacturing, fabrication, and plant construction of next generation reactor technologies. • Provides funding to conduct leading edge manufacturing and fabrication R&D for nuclear component prototypic conditions and materials. • No FY 2018 funds under CTD are being requested for nuclear cybersecurity and hybrid energy systems. Those activities are transferred to Light Water Reactor Sustainability subprogram within the Reactor Concepts RD&D program. • Research infrastructure investments have been transferred to the Nuclear Science User Facilities subprogram.

Nuclear Energy Advanced Modeling and Simulation

Description

The Nuclear Energy Advanced Modeling and Simulation (NEAMS) subprogram develops cutting edge advanced modeling and simulation tools for the acceleration of early-stage next generation reactor concepts. NEAMS engages scientists and engineers in developing state-of-the-art, multi-scale models of physics and chemistry that drive advanced computational methods for simulations of advanced nuclear energy systems. NEAMS is developing a computational ToolKit which is comprised of both reactor and fuel systems analysis capabilities in support of light water reactor and non-water reactor systems. Computational tools developed under the NEAMS program define the state-of-the-art in nuclear simulation, not available commercially. Advanced modeling and simulation capabilities also support NE program priorities, such as the Transient Reactor Test (TREAT) experiments in support of fuels with enhanced accident tolerance.

In FY 2018, other NE advanced modeling and simulation activities, such as the VERA code and the RELAP-7 code, are consolidated in the NEAMS research. This comprehensive and integrated approach will permit more efficient development and distribution of advanced modeling and simulation capabilities in support of the existing fleet of light water reactors and the next generation of water-cooled and non-water cooled systems. NEAMS will continue leading edge research to validate computation tools.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Nuclear Energy Advanced Modeling and Simulation		
$27,200,000	**$34,200,000**	**+$7,000,000**
• Enhanced the BISON and MARMOT fuel code capabilities to include modeling accident conditions, additional validation cases, improved fuel microstructure models, and released for use. • Enhanced the capabilities of the Reactors Product Line and released the SHARP code package Revision 1 for use along with the SHARP Validation and Assessment Report. • Improved the Integration of the ToolKit components; implemented the BISON-SHARP integration process into NEAMS Workbench development. • Initiated expanded effort to validate NEAMS Toolkit components through the use of experimentation, benchmarking, and collaborations with end user partners via the Steam Generator Flow-Induced Vibration and Accident Tolerant Fuel High-Impact Problem projects. • Extended current modeling and simulation efforts for TREAT mission support through development of enhanced multi-physics coupling capabilities critical to experiment simulation and design, and needed for future validation.	• Release VERA update with new simulation capabilities for a pressurized-water reactor control rod ejection accident and boiling water reactor operating conditions. • Release, in coordination with the Gateway for Accelerated Innovation in Nuclear, an updated NEAMS Toolkit and Workbench with expanded predictive capability in transient and accident conditions, and with applicability to a broader range of advanced fuels and reactor concepts. • Issue RELAP-7 beta version to nuclear stakeholders for testing of full reactor simulation and analysis. • Use NEAMS tools to improve operational efficiency of Transient Reactor Test facility and expand its testing regimes. • Advance validation of NEAMS simulation tools by solving high-impact problems important to the nuclear energy stakeholders, and by applying high-resolution data from other research activities, e.g. Halden Reactor. • Provide advanced modeling and simulation tools to the Nuclear Regulatory Commission to support future confirmatory analysis. • Advance NEAMS capabilities to support used fuel disposition research.	• Integrate VERA and RELAP-7 research activities into NEAMS.

Energy Innovation Hub for Modeling and Simulation

Description

The Energy Innovation Hub for Modeling and Simulation was established in July 2010 as the first DOE Energy Innovation Hub with the singular purpose of applying DOE advanced computing science to model complex real world phenomena and conditions in the Nation's fleet of pressurized light water reactors. The Oak Ridge National Laboratory led a consortium (CASL – Consortium for Advanced Simulation of Light Water Reactors) of national laboratories, universities, and industry partners to manage the program. The Hub successfully created a virtual reactor model of an actual Pressurized Water Reactor and the Virtual Environment for Reactor Applications (VERA) tool set was successfully used to analyze and understand key challenges to the safety and economics of reactor operations. With the successful completion of the Hub's initial workscope, the VERA research activities will be consolidated into the NEAMS subprogram in FY 2018.

Energy Innovation Hub for Modeling and Simulation

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Energy Innovation Hub for Modeling and Simulation $24,300,000	**$0**	**-$24,300,000**
• Expanded Hub Industry Council membership to include vendors of boiling water reactors (BWRs) and small modular reactors (SMRs) and additional electrical utility users. • Released Version 3.5 of the Virtual Environment for Reactor Applications (VERA). • Released an educational version of VERA, called VERA-EDU for use by educators and students. • Demonstrated the ability of VERA to study the impact of boron-containing fuel deposits that cause power shifts and cladding corrosion. • Established VERA working group to maintain the developed modeling and simulation capabilities, support the user community, and support VERA code upgrades and distribution.	• No funds are being requested in FY 2018.	• VERA tools are available to industry stakeholders. • Remaining VERA research activities will be consolidated within the NEAMS subprogram to improve efficiencies by leveraging capabilities and resources.

Nuclear Science User Facilities

Description

The Nuclear Science User Facilities (NSUF) subprogram is the nation's designated nuclear energy user facility. As a partner facility consortium, the NSUF connects a broad range of exceptional nuclear research capabilities, expert mentors and experimenters. The NSUF represents a "prototype laboratory for the future," promoting the use of unique nuclear research facilities and encouraging active university, industry, and laboratory collaboration in relevant nuclear science research. The NSUF, through competitive solicitations, provides a mechanism for research organizations to collaborate, conduct experiments and post-experiment analysis, and utilize high performance computing at facilities not normally accessible to these organizations. On an annual basis, researchers propose projects to be conducted at these unique facilities, with timelines ranging from a few months to several years. When projects are awarded, the NSUF program pays for experiment support and laboratory services at the partner user facilities. In this manner, researchers benefit from the introduction to new techniques, equipment, and personnel.

The NSUF provides access at no-cost to the user to the Idaho National Laboratory's Advanced Test Reactor (ATR), Transient Reactor Test (TREAT) facility, post-irradiation examination (PIE) facilities at the Materials and Fuels Complex, and high performance computing capabilities such as Falcon, complementing the existing Advanced Scientific Computing Research User Facilities. Additional NSUF capability includes PIE assets at the Center for Advanced Energy Studies; research reactors at Oak Ridge National Laboratory, Massachusetts Institute of Technology, and North Carolina State University; beam line capabilities at the Advanced Photon Source in coordination with the Illinois Institute of Technology; the Intermediate Voltage Electron Microscope at Argonne National Laboratory (ANL); irradiation experiment design and fabrication capabilities at Pacific Northwest National Laboratory; hot cells and fabrication capabilities at Westinghouse; and examination facilities at the Universities of Wisconsin, Michigan, California-Berkeley, Purdue, and Nevada-Las Vegas, all partnered with the NSUF to bring additional user facilities to the research community.

Nuclear Science User Facilities

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Nuclear Science User Facilities		
$41,100,000	**$34,160,000**	**-$6,940,000**
• Nuclear Science User Facilities (NSUF) competitively selected and fully funded 12 projects for irradiation and/or post-irradiation services. • NSUF awarded a total of 40 rapid turnaround experiments (RTEs). All 30 RTE projects awarded in FY 2015 were completed. • Three research capability enhancement awards were competitively selected and fully funded. • The Nuclear Energy Infrastructure Database (NEID) was released to the public. • High performance computing capabilities were provided to users by adding new partner facilities. NSUF provided access to INL's primary high performance computing system, Falcon. • NSUF supported a number of scientific capability enhancements for the INL Transient Reactor Test (TREAT) facility; began the conceptual design of the Materials and Fuels Research and Collaboration Facility; and increased capabilities offered to the nuclear energy research and development community.	• Provide facility access awards in the three FY 2018 RTE solicitations and the FY 2018 Consolidated Innovative Nuclear Research (CINR) solicitation. All fully funded. • Invest in select domestic infrastructure capabilities to better support the advancement of applied R&D, including TREAT capability enhancements. • Continue the design and construction of the Materials and Fuels Complex (MFC) Research and Collaboration Facility project. • Continue and expand NSUF's access to unique nuclear science capabilities and expertise. These collaborations will allow more efficient use of the NSUF program funds by leveraging facility and capability investments. • Continue to enhance the Nuclear Energy Infrastructure Database (NEID), the Nuclear Fuels and Materials Library (NFML), and the NSUF proposal database. These tools will allow researchers to better utilize nuclear energy R&D capabilities and collaborate on similar activities.	• The overall decrease from $41,100,000 to $34,160,000 reflects fully forward funding building design and construction activities in FY 2016 and increased research support for resumption of operations of TREAT.

Nuclear Energy Traineeships

Description

The Nuclear Energy Traineeships subprogram provided competitively-awarded university-led traineeships to support graduate level training through a tailored academic graduate program that delivered unique and innovative curriculum with rigorous thesis or dissertation research requirement aligned with the identified critical industry-driven workforce need. No funds are being requested in FY 2018.

Nuclear Energy Traineeships

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Nuclear Energy Traineeships		
$2,000,000	**$0**	**-$2,000,000**
• A 5-year Cooperative Agreement was competitively awarded to Washington State University (WSU) to provide training for up to 18 graduate students in radiochemistry. • EM teamed with NE and contributed an additional $1million for a total award amount of $3 million.	• No funds are being requested in FY 2018.	• No funds are being requested in FY 2018.

Nuclear Energy Enabling Technologies Capital Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE))					
Capital Equipment > $500K (including MIE)	n/a	n/a	500	0	0
Plant Projects (GPP and IGPP)	n/a	n/a	9,500	0	0
Accelerator Improvement Projects (AIP) (<$5M)	n/a	n/a	0	0	0
Total, Capital Operating Expenses	n/a	n/a	0	0	0

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Nuclear Energy Enabling Technologies
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**NEET- Mod & Sim Hub - Complete 90% of annual research and development milestones to support the wider applicability and deployment of virtual reactor modeling and simulation tools set for predictive simulation of Light Water Reactors by 2020.**		
Target	90 % annual milestones met	90 % annual milestones met	90 % annual milestones met
Result	Met - 100	TBD	TBD
Endpoint Target	These milestones represent annual progress toward virtual reactor modeling and simulation tools set for predictive simulation of Light Water Reactors by 2020.		

Radiological Facilities Management

Overview

Within the Radiological Facilities Management (RFM) program, the Research Reactor Infrastructure (RRI) subprogram supports the continued operation of U.S. university research reactors by providing university research reactor fuel services, as well as maintenance of, and safety upgrades to, supporting fuel fabrication equipment and facilities.

Highlights of the FY 2018 Budget Request

In FY 2018, in support of its mission and objectives, the RRI subprogram will provide project management, technical support, quality engineering and inspection, and nuclear material support to 25 research reactors located at 24 U.S. universities. Major program deliverables will be to procure new plate fuel elements and ship them to supported universities and also procure new Training, Reactor, Isotope, General Atomics (TRIGA) fuel elements from the TRIGA International fuel fabrication facility in Romans, France. Also, the program ships used plate and TRIGA reactor fuel elements from supported universities to DOE used fuel receipt facilities. Continued delays and uncertainties associated with the schedule for resumption of production at the TRIGA International fuel fabrication facility has the potential to disrupt the continued operability of a subset of the 12 TRIGA university research reactors serviced by the RRI subprogram. To partially mitigate this uncertainty, the Department will continue its policy of reusing lightly irradiated TRIGA fuel in DOE inventory that was initiated in FY 2017 and other initiatives to evaluate alternatives to the current TRIGA reactor fuel sole-source supply issue.

Radiological Facilities Management

Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Radiological Facilities Management				
Space and Defense Infrastructure	18,000	17,966	0	-18,000
Research Reactor Infrastructure	6,800	6,787	9,000	+2,000
Total, Radiological Facilities Management	**24,800**	**24,753**	**9,000**	**-15,800**

[1]The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Radiological Facilities Management
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Space and Defense Infrastructure: The decrease from $18,000,000 to $0 represents no funding requested in FY 2018 for Oak Ridge Infrastructure. Infrastructure used for Office of Nuclear Energy research and development is fully funded through associated program budgets.	**-18,000**
Research Reactor Infrastructure: The increase from $6,800,000 to $9,000,000 mitigates annual increases to fresh fuel prices imposed by vendors.	**+2,200**
Total, Radiological Facilities Management	**-15,800**

Description

Consistent with Congressional direction, this subprogram provided funds in FY 2016 to support Oak Ridge National Laboratory (ORNL) hot cells. In FY 2018, Office of Nuclear Energy facility use is fully funded through associated program budgets.

Space and Defense Infrastructure

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Space and Defense Infrastructure $18,000,000	**$0**	**-$18,000,000**
• Completed procurement and installation of HEPA filters for the main hot cell and glovebox exhaust system in the Radiochemical Engineering Development Center. • Procured exhaust fans and dampers for ventilation system upgrades at the Irradiated Fuels Examination Facility. • Procured the lab area HEPA housing to replace the aging HEPA housing that is a Safety Class component. • Completed electrical upgrades for the Motor Control Center at the Radiochemical Engineering Development Center. • Replaced pump motors, valves, and other components on the Radiochemical Engineering Development Center Cooling Tower.	• No funding is requested.	• Decrease represents no funding requested in FY 2018 for Oak Ridge Infrastructure.

Radiological Facilities Management
Research Reactor Infrastructure

Description

The Research Reactor Infrastructure (RRI) subprogram provides fresh reactor fuel to, and removes used fuel from, 25 operating university research reactors to support their continued operation. This provides continued test reactor capability to universities, coupled with research, development, and educational opportunities in support of U.S. nuclear energy initiatives.

The continued operation of U.S. university research reactors plays an important role in developing future scientists and engineers in the U.S. This subprogram sustains unique capabilities for research and development and educational opportunities supporting U.S. energy initiatives. Used nuclear fuel shipments support U.S. and DOE non-proliferation and national security objectives.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Research Reactor Infrastructure		
$6,800,000	**$9,000,000**	**+$2,200,000**
• A total of 33 plate fuel elements were delivered to University of Missouri (MURR) (24) and Massachusetts Institute of Technology (MIT) (9). • Four used fuel shipments to Savannah River Site (SRS) were completed. • Completed Research Reactor Infrastructure (RRI) project management, quality assurance, nuclear material accountability, and transportation cask maintenance. • Completed activities needed for Nuclear Regulatory Commission (NRC) review and approval of BEA Research Reactor (BRR) cask Safety Analysis Report (SAR) amendment and procured associated universal "basket" to support shipment of university fuel types that lacked an approved basket. • Continued funding of safety upgrades to allow resumption of university research reactor fuel fabrication operations at Training, Reactor, Isotope, General Atomics (TRIGA) International in Romans, France. Funding of this project was initiated by National Nuclear Security Administration (NNSA) in FY 2014 and assumed by NE in FY 2015.	• Procure 40 and deliver between 33 and 36 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. • Ship up to two cask loads of lightly-irradiated 8.5 wt% standard TRIGA fuel elements from the Irradiated Fuel Storage Facility at INL to selected U.S. university research reactor facilities. • Procure initial order of TRIGA fuel elements from the TRIGA International fuel fabrication facility in Romans, France upon resumption of operations. • Complete up to 5 used fuel shipments to SRS and the INL, pending resolution of moratorium on such shipments to the INL. • Continue RRI project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• The increase mitigates annual increases to fresh fuel prices imposed by vendors. • Provide the Massachusetts Institute of Technology Reactor with 1MT (about 500 gallons) of heavy water (D2O) and dispose of the spent heavy water. • Shipment of two Lightly Irradiated TRIGA Fuel shipment from the Irradiated Fuel Storage Facility (IFSF) to selected U.S. university research reactor facilities.

Idaho Facilities Management

Overview

The mission of the Idaho Facilities Management (IFM) program is to manage the planning, acquisition, operation, maintenance, and disposition of the Office of Nuclear Energy (NE)-owned facilities and capabilities at the Idaho National Laboratory (INL). The IFM program maintains Department of Energy (DOE) mission-supporting facilities and capabilities at the INL in a safe, compliant status (with DOE Orders, federal laws and regulations, and state agreements) to support the Department's nuclear energy research, testing of naval reactor fuels and reactor core components, and a diverse range of national security technology programs that support the National Nuclear Security Administration (NNSA) and other federal agencies such as the Department of Homeland Security in the areas of critical infrastructure protection, nuclear nonproliferation, and incident response.

The IFM program enables long-term nuclear research and development (R&D) activities by providing the expertise, facilities, equipment, and nuclear materials necessary to conduct a wide array of experimental activities in a safe and compliant manner. The Advanced Test Reactor (ATR) provides unique irradiation capability to further nuclear fuel and reactor component research in support of advanced nuclear reactor design activities. The Materials and Fuels Complex (MFC) contains a comprehensive range of fuel and experiment fabrication, and pre- and post-irradiation examination capabilities used to assess material and fuel characteristics, and performance in varying reactor environments. A limited number of facilities at the Idaho Nuclear Technology and Engineering Center (INTEC) are utilized to support material consolidation and storage, fuel cycle research and development, and National and Homeland Security (N&HS) activities.

Highlights of the FY 2018 Budget Request

In FY 2018, the IFM program strategic priorities are to maximize the utility of existing facilities and capabilities through focused sustainment activities and cost-effective rehabilitation. Activities focus on safe and compliant operation of the INL's nuclear research reactor and non-reactor research facilities, while conducting limited corrective and cost-effective preventative maintenance activities necessary to sustain this core infrastructure. Critical capability improvements and/or replacements will be accomplished through operating activities, general plant, and line item capital projects, if deemed necessary. In FY 2018, these activities include:

- Continuing investments at the ATR and Advanced Test Reactor Critical Facility (ATRC) to improve reliability and availability of the ATR in order to meet research customer demands. This strategy, jointly developed with Naval Reactors (NR), will increase efficiency and irradiation days by prioritizing plant, equipment, and experimental loop investments.
- Continuing preliminary design activities and performance baseline development activities for the Sample Preparation Laboratory (SPL) Project at the INL to satisfy near-term advanced Post-Irradiation Examination (PIE) capabilities needed to improve understanding of nuclear fuels and material performance.
- Resuming operations at the Transient Reactor Test Facility (TREAT) following completion of readiness activities. TREAT will allow for transient testing of nuclear fuels and materials which is an important step in developing and qualifying new nuclear fuels.

Idaho Facilities Management
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Idaho Facilities Management				
INL Nuclear Research Reactor Operations and Maintenance	100,244	-	100,682	+438
INL Non-Reactor Nuclear Research Facility Operations and Maintenance	75,340	-	81,839	+6,499
INL Engineering and Support Facility Operations and Maintenance	32,459	-	6,500	-25,959
INL Regulatory Compliance	12,539	-	9,119	-3,420
Construction	2,000	1,996	6,000	+4,000
Total, Idaho Facilities Management	**222,582**	**222,159**	**204,140**	**-18,442**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Idaho Facilities Management
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
INL Nuclear Research Reactor Operations and Maintenance: The increase from $100,244,000 to $100,682,000 reflects funding for investments in Advanced Test Reactor (ATR) and Advanced Test Reactor Critical Facility (ATRC) to improve reliability and availability, funding for the resumption of transient testing at the Transient Reactor Test Facility (TREAT) including initiating operations in FY 2018, cost of ATR fuel, and staff required to maintain and operate ATR consistent with Departmental programmatic and safety requirements.	**+438**
INL Non-Reactor Nuclear Research Facility Operations and Maintenance: The increase from $75,340,000 to $81,839,000 reflects funding for operations of key nuclear facilities at the Materials and Fuels Complex (MFC) as well as operational activities associated with the Remote-Handled Low-Level Waste Disposal Facility.	**+6,499**
INL Engineering and Support Facility Operations and Maintenance: The decrease from $32,459,000 to $6,500,000 reflects the completion of non-nuclear site-wide infrastructure investments, decommissioning and demolition of legacy facilities, and emergency vehicle replacements. FY 2016 also included one-time investment in the INL site-wide power distribution system.	**-25,959**
INL Regulatory Compliance: The decrease from $12,539,000 to $9,119,000 reflects funding for activities associated with the 1995 Idaho Settlement Agreement such as the disposition of 2m^3 of legacy waste and the stabilization of Experimental Breeder Reactor II (EBR-II) material at reduced shipment levels. There are no impacts to schedule.	**-3,420**
Construction: The increase from $2,000,000 to $6,000,000 reflects pre-CD-2/3 design funding for the Sample Preparation Laboratory (SPL) Project.	**+4,000**
Total, Idaho Facilities Management	**-18,442**

Idaho Facilities Management
INL Nuclear Research Reactor Operations and Maintenance

Description

This subcategory supports nuclear research reactor operations and maintenance at the Advanced Test Reactor (ATR) for the Idaho National Laboratory (INL), including the associated support infrastructure, the ATR Critical Facility (ATRC), the Transient Reactor Test Facility (TREAT), and the Neutron Radiography Reactor (NRAD). The NRAD and TREAT facilities are both located at the Materials and Fuels Complex (MFC).

ATR is the primary research reactor at the INL. The ATR supports the majority of NE research and development (R&D) programs, as well as Naval Reactors (NR) Program work in support of the U.S. Navy nuclear fleet and National Nuclear Security Administration (NNSA) programs including Global Threat Reduction Initiatives to support conversion of research and test reactors to low-enriched uranium fuel. The ATR is also used by universities, laboratories, and industry, and is the primary scientific capability of the Nuclear Science User Facilities. Research and development demand for neutron irradiation at ATRC and neutron radiography and small component test irradiation at NRAD has increased significantly over the past several years. All programmatic work is funded by the sponsoring federal programs. The cost to other users is determined in accordance with Department of Energy (DOE) regulations and depends upon the demands on the reactor and the nature of the user.

This subcategory also provides funding to support activities related to the resumption of a domestic transient fuel testing capability utilizing the TREAT Reactor. The remaining activities associated with the resumption of operations at the TREAT Reactor are focused on readiness activities. TREAT is scheduled to resume operations in FY 2018.

To satisfy the irradiation needs of ATR users, significant efforts will continue in FY 2018 to refurbish and replace major ATR components and systems in order to improve the availability and reliability of ATR. This strategy, jointly developed with NR, will address a significant portion of the Top 100 Plant Heath Committee items and eliminate the majority of ATR deferred maintenance items by the completion of the next Core Internals Change-out. Funding for infrastructure investments at ATR and ATRC are split between NE and NR. The NR FY 2018 Budget Request includes $12 million to support this effort and the NE FY 2018 Budget Request includes $9.6 million. Investment funds are split between NR (defense) and NE (non-defense) based on usage of available test loops at 5/9ths and 4/9ths, respectively.

INL Nuclear Research Reactor Operations and Maintenance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
INL Nuclear Research Reactor Operations and Maintenance $100,244,000	**$100,682,000**	**+$438,000**
• Maintained and operated the Idaho National Laboratory (INL) reactors and supporting infrastructure while accommodating business model impacts. • Maintained a two year minimum Advanced Test Reactor (ATR) fuel inventory and sufficient ATR critical spares. • Continued preparatory activities for the ATR Core Internals Change-out (CIC). • Maintained an operating efficiency greater than 74.15%, by operating 124.51 days. • Continued replacement of electrical equipment at ATR that is past the end of useful life. • Completed replacement of the ATR Evaporation Pond 1 Liner. • Initiated investments to improve ATR and ATR Critical Facility (ATRC) availability and reliability. • Completed Transient Reactor Test Facility (TREAT) fuel inspections and fire protection upgrades. • Initiated mock operations at TREAT to support training and prepare for reactor operations. • Completed integrated function testing of TREAT reactor plant systems.	• Continue investments to improve ATR and ATRC availability and reliability such as refurbishments and replacements of reactor systems and components. • Maintain a two year minimum ATR fuel inventory and sufficient ATR critical spares. • Continue preparatory activities for the ATR CIC. • Maintain an ATR operating efficiency greater than 80% with a target of 191 irridiation days. • Complete readiness activities at TREAT and resume transient testing operations.	• The increase reflects funding for investments in ATR and ATRC to improve availability and reliability, funding for the resumption of transient testing at TREAT including initiating operations in FY 2018, cost of ATR fuel, and staff required to maintain and operate ATR consistent with Departmental programmatic and safety requirements.

Idaho Facilities Management
INL Non-Reactor Nuclear Research Facility Operations and Maintenance

Description

This subprogram provides funding for operations, maintenance, and support for non-reactor nuclear and radiological research facilities primarily located at the Materials and Fuels Complex (MFC). Activities within this category support sustainment of unique nuclear and radiological capabilities that are required to support NE's essential research and development programs. Work scope focuses on maintaining a safe operating envelope while conducting corrective and cost-effective preventative maintenance activities necessary to sustain this core infrastructure. The non-reactor nuclear research facilities support core programmatic research capabilities including:

- Post-Irradiation Examination (PIE) and Fresh Fuel Characterization – Receipt of irradiated fuels/materials, non-destructive examination, destructive examinations and analyses, and mechanical testing of highly radioactive materials.
- Experimental Fuel Fabrication – Glovebox lines, fume hoods, and hot cell capabilities; unique fabrication capabilities; and instrumentation and testing equipment that support research and development (R&D) on multiple fuel types and hazard levels.
- Advanced Separation and Waste Forms – Aqueous separations and pretreatment technologies, and electrochemical separations and waste form development (engineering scale).

Funding is also provided for the management of NE-owned special nuclear material (SNM), including the characterization, packaging, storage, and disposition of surplus SNM. Access to and responsible management of SNM is fundamental to ensuring nuclear material is readily available to support mission activities.

Funding also supports base operations for the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility.

INL Non-Reactor Nuclear Research Facility Operations and Maintenance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
INL Non-Reactor Nuclear Research Facility Operations and Maintenance $75,340,000	**$81,839,000**	**+6,499,000**
• Operated and maintained the Materials and Fuels Complex (MFC) infrastructure and facilities to support facility operations and programmatic work activities. • Performed maintenance within the MFC nuclear facilities and infrastructure, consistent with the approved safety bases. Initiated maintenance activities associated with hot cell windows and manipulators. • Continued off-site disposition of surplus NE-owned special nuclear material consistent with programmatic needs and approved nuclear material allotment forecasts. • Continued implementation of the MFC upgraded documented safety analysis at the Zero Power Physics Reactor (ZPPR) and rescheduled implementation for the Hot Fuels Examination Facility (HFEF). • Completed all preparatory activities for operation of the HFEF and Fuel Conditioning Facility Overpack. • Initiated shipments of spent fuel treatment products from the Transient Reactor Test Facility (TREAT) warehouse to the Material Security and Consolidation Facility. • Completed Critical Decision (CD)-1, Approve Alternative Selection and Cost Range documentation and initiate development of CD-2 documentation, including environmental and the performance baseline, for the Sample Preparation Laboratory (SPL) Project.	• Operate and maintain MFC infrastructure and facilities to support facility operations and programmatic work activities. • Perform maintenance within the MFC nuclear facilities and infrastructure consistent with the approved safety bases. • Continue off-site disposition of surplus NE-owned special nuclear material consistent with programmatic needs and approved nuclear material allotment forecasts. • Continue Hot Fuels Examination Facility modifications required to receive TREAT experiments. • Perform operational activities for the Remote-Handled Low-Level Waste Disposal Facility (RHLLW) Project not covered in the line item capital project.	• The increase reflects funding for operations of key nuclear facilities at the MFC as well as operational activities associated with the RHLLW project.

Description

This subcategory provides funds to support Federally-funded program activities and community regulatory support activities to meet obligations defined in crosscutting agreements and contracts such as: Shoshone-Bannock Tribes, Defense Contract Audit Agency, site environmental monitoring, Payment in Lieu of Taxes, and the National Oceanic and Atmospheric Administration.

INL Engineering and Support Facility Operations and Maintenance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
INL Engineering and Support Facility Operations and Maintenance $32,459,000	**$6,500,000**	**-$25,959,000**
• Initiated the refurbishment and replacement of Idaho National Laboratory (INL) power distribution infrastructure including the Supervisory Control and Data Acquisition (SCADA) system and site substation replacements. • Conducted planned disposition work for non-nuclear excess buildings. • Conducted planned roof repair and replacement activities utilizing cool roof technology. • Initiated procurement of replacement emergency services vehicles and associated equipment such as firefighting apparatus.	• Continue to support Federally funded activities to maintain operations at the INL such as Nuclear Regulatory Commission (NRC) certificates for casks, payment-in-lieu-of-taxes, and environmental monitoring to support State requirements.	• The decrease reflects the completion of non-nuclear site-wide infrastructure investments, decommissioning and demolition of legacy facilities, and emergency vehicle replacements. FY 2016 also included one-time investment in the INL site-wide power distribution system.

Idaho Facilities Management
INL Regulatory Compliance

Description

This subcategory supports activities for continued compliance with State and Federal environmental laws and other regulations that are under the purview of the NE owner responsibilities. Compliance activities focus on air, soil, and water monitoring and waste disposal consistent with Federal and State permit requirements and agreements such as the Idaho National Laboratory (INL) Site Treatment Plan. Regulatory activities also include efforts that support continued compliance with the 1995 Settlement Agreement with the State of Idaho, which governs management and disposition of used nuclear fuel and transuranic wastes at the INL.

INL Regulatory Compliance

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
INL Regulatory Compliance $12,539,000	**$9,119,000**	**-$3,420,000**
• Continued regulatory compliance program management. • Met Idaho National Laboratory (INL) Site Treatment Plan milestones for treatment of two cubic meters of mixed low level waste (MLLW). • Completed transfer(s) of used nuclear fuel from wet storage in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of Experimental Breeder Reactor II (EBR-II) used nuclear fuel. • Supported Remote-Handled Low-Level Waste (RHLLW) Disposal Facility Project operational activities, including initiation of infiltration testing and analysis to demonstrate facility performance consistent with the performance assessment developed in accordance with Departmental requirements and commence documentation development to support facility operations.	• Continue regulatory compliance program management. • Meet INL Site Treatment Plan milestones for treatment of two cubic meters of MLLW. • Complete transfer(s) of used nuclear fuel from wet storage in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of EBR-II used nuclear fuel.	• The decrease reflects the funding necessary for activities associated with the 1995 Idaho Settlement Agreement such as the disposition of two cubic meters of legacy waste and the stabilization of EBR-II material at reduced shipment levels. There are no impacts to schedule.

Idaho Facilities Management
Construction

Description

Line-item capital projects are sometimes required at the Idaho National Laboratory (INL) to maintain its ability to support mission goals. These projects help achieve the Department's and the NE's strategic objectives by maintaining site services and providing critical information for future decisions. This activity is focused on two primary objectives: (1) identification, planning, and prioritization of projects required to meet NE program objectives, and (2) development and execution of these projects within approved cost and schedule baselines as such projects are deemed necessary. While the Department's acquisition management process does not guarantee that a project will be completed once the initial information gathering and preliminary design phase are complete, it does provide an important decision-making framework that, when well executed, allows only the most critically necessary, cost-effective projects to proceed to construction.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Construction $2,000,000	**$6,000,000**	**+$4,000,000**
Sample Preparation Laboratory (16-E-200) ($2,000,000) • Completed conceptual design activities in support of Critical Decision (CD)-1, "Approve Alternative Selection and Cost Range". • Achieved CD-1, "Approve Alternative Selection and Cost Range".	*Sample Preparation Laboratory (16-E-200) ($6,000,000)* • Continue preliminary design activities in support of CD-2/3, "Approve Performance Baseline/Approve Start of Construction".	*Sample Preparation Laboratory (16-E-200) ($+4,000,000)* • The increase in funding is to support pre-CD-2/3 design and analysis activities for the Sample Preparation Laboratory (SPL) Project.

Idaho Facilities Management
Capital Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2016 Current	FY 2017 Annualized CR[1]	FY 2018 Request
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE))						
Plant Projects (GPP) (<$10M)	n/a	0	0	0	0	0
Total, Capital Operating Expenses	**n/a**	**0**	**0**	**0**	**0**	**0**
Plant Projects (GPP) (Total Estimated Cost (TEC) <$10M)						
Total Plant Projects (GPP) (Total Estimated Cost (TEC) <$5M)	n/a	1,474	2,393	2,393	0	0
Total, Plant Projects (GPP) (Total Estimated Cost (TEC) <$10M)	**n/a**	**1,474**	**2,393**	**2,393**	**0**	**0**
Total, Capital Summary	**n/a**	**1,474**	**2,393**	**2,393**	**0**	**0**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Idaho Facilities Management
Construction Projects Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2016 Current	FY 2017 Annualized CR[1]	FY 2018 Request
13-D-905, Remote-Handled Low-Level Waste Disposal Project, INL (Summary represents NE costs; Project is co-funded with NR)						
Total Estimated Cost (TEC)	21,767	21,767	0	0	0	0
Other Project Costs (OPC)*	18,996	14,552	1,504	1,504	2,940	0
Total Project Cost (TPC) Project Number 13-D-905	**40,763**	**36,319**	**1,504**	**1,504**	**2,940**	**0**
16-E-200, Sample Preparation Laboratory, INL						
Total Estimated Cost (TEC)	83,000	0	2,000	2,000	1,996	6,000
Other Project Costs (OPC)*	12,000	6,431	1,500	1,500	2,800	0
Total Project Cost (TPC) Project Number 16-E-200	**95,000**	**6,431**	**3,500**	**3,500**	**4,796**	**6,000**
Total All Construction Projects						
Total Estimated Cost (TEC)	104,767	21,767	2,000	2,000	1,996	6,000
Total Other Project Costs (OPC)	30,996	20,983	3,004	3,004	5,740	0
Total Project Cost (TPC) All Construction Projects	**135,763**	**42,750**	**5,004**	**5,004**	**7,736**	**6,000**

*Indicates a project where the cost of the Conceptual Design Report is estimated to exceed $3M.

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Idaho Facilities Management
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Facility Availability - Idaho Facilities Management Program - Enable nuclear research and development activities by providing operational facilities and capabilities, as measured by availability percentages.**		
Target	80 % availability	80 % availability	80 % availability
Result	Met - 82.6	TBD	TBD
Endpoint Target	Maintain the percentage of facilities and capabilities that are available for research and development activities at 90% or better.		
Performance Goal (Measure)	**Plant and Construction: Cost and Schedule Baseline Variance - Execute line item construction projects within approved cost profiles and schedules, using cost performance index and schedule performance index (using earned value measurement systems), with the green level maintaining indexes between 0.9 and 1.10, the yellow level between 0.8 and 1.20 and the red level less than 0.8 or greater than 1.20.**		
Target	90 % of projects with cost performance indexes and schedule performance indexes between 0.9 and 1.15	90 % of projects with cost performance indexes and schedule performance indexes between 0.9 and 1.15	90 % of projects with cost performance indexes and schedule performance indexes between 0.9 and 1.15
Result	Met - 100	TBD	TBD
Endpoint Target	Maintain the total percentage of projects with good cost and schedule indexes at 90% or better.		

16-E-200, Sample Preparation Laboratory
Idaho National Laboratory
Project is for Design and Construction

Significant Changes and Summary

Significant Changes
This Construction Project Data Sheet (CPDS) is an update of the FY 2017 CPDS and does not include a new start for the budget year.

Summary
The most recent DOE O 413.3B approved Critical Decision (CD) is for CD-1, which was approved on September 30, 2016. Approval of CD-1 established a cost range for the design and construction of the Sample Preparation Laboratory (SPL) of $72.7M to $98.2M, with a CD-4 date of 3Q FY 2024.

Due to the smaller footprint of the new Laboratory, siting location has changed precluding the need to demolish an existing structure.

This project data sheet supports continuation of design and other related activities necessary to support approval of CD-2/3, Approve Performance Baseline and Approve Start of Construction. The SPL will provide sample preparation for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This capability will augment non-destructive examination, elemental analysis, and radiological capabilities already present or being developed at INL. The SPL will, when coupled with existing facilities and recapitalization efforts, fulfill near-term capabilities necessary for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and material performance at the micro-, nano-, and atomic scales. In accordance with the National Environmental Policy Act (NEPA) (42 USC§ 4321 et seq.), a thorough analysis of the environmental consequences of the design, construction, and operation of the SPL was completed to support CD-1 approval.

The proposed laboratory will require equipment that will allow high hazard materials to be routinely prepared and tested in a safe, secure, and environmentally-controlled environment. In addition, this laboratory will contribute to the suite of capabilities fulfilling near-term advanced post-irradiation examination needs that will serve as a center for advanced fuels and materials characterization, as well as development of new processes, tools, and instruments to further research.

The Sample Preparation Laboratory Project is a non-major acquisition project with a TPC range between $72.7 and $98.2M. The project is currently conducting design and associated activities necessary to establish the final scope of the project and to support approval of CD-2/3, Approve Performance Baseline and Approve Start of Construction. The FY 2018 Total Estimated Cost (TEC) funding will be used to support facility design and associated documentation necessary for approval of CD-2/3.

A Level 2 Federal Project Director has been assigned to this project.

Critical Milestone History

	CD-0	Conceptual Design Complete	CD-1	Final Design Complete	CD-2/3	D&D Complete	CD-4
FY2016	1/31/2011	4QFY 2014	3QFY 2015	TBD	TBD	TBD	TBD
FY2017	6/18/2015	3QFY 2016	3QFY 2016	TBD	TBD	N/A	TBD
FY2018	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range [Note: Original Mission Need Statement was approved 1/31/2011; an updated Mission Need Statement was approved 6/18/15]
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Design Scope and Project Cost and Schedule Ranges
Final Design Complete – Estimated/Actual date the project design will be/was complete(d)
CD-2/3 – Approve Project Performance Baseline and Approve Start of Construction
D&D Complete –Completion of D&D work (see Section 9)
CD-4 – Approve Start of Operations or Project Closeout
PB – Indicates the Performance Baseline

	Performance Baseline Validation	CD-3A
FY 2016	TBD	TBD
FY 2017	TBD	TBD
FY 2018	TBD	TBD

CD-3A – Long Lead for equipment.

Project Cost History

	TEC, Design	TEC, Construction	TEC, Total	OPC Except D&D	OPC, D&D	OPC, Total	TPC
FY 2016	10,000	68,000	78,000	17,000	0	17,000	95,000
FY 2017[a,b]	10,000	73,000	83,000	12,000	0	12,000	95,000
FY 2018[c]	13,385	72,615	86,000	12,200	0	12,200	98,200

a. Project costs revised based on preliminary scoping of project based on updated Mission Need Statement approved 3QFY 2015.
b. Project costs are preliminary pending CD-2 approval and represent the high end of the cost range.
c. Project costs reflect upper end of the cost range approved at CD-1.

No construction, excluding approved long lead procurement, will be performed until the project performance baseline has been validated and CD-2/3 has been approved.

Project Scope and Justification

Scope
The Sample Preparation Laboratory (SPL) will be designed and constructed to receive irradiated materials and to prepare samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. The improved sample preparation and analytical capabilities provided by SPL will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC).

SPL will provide the required capabilities to allow high hazard materials to be routinely prepared and tested in a safe, secure, and environmentally controlled environment. To meet this objective, SPL will be designed and constructed to include the following specific capabilities:

- Next generation radiation-shielded enclosures designed for regular manned access when radioactive samples are not present. The shielded enclosures will be flexible and reconfigurable to accommodate operational requirements for use with modern characterization instruments.
- The facility will be designed to meet stringent vibration, electrical and magnetic field, acoustic, and temperature fluctuation requirements for advanced analytical equipment with the ability to support development and deployment of equipment, instruments, and models to meet future nuclear fuel development R&D needs over a 40-year period.

- The facility will be designed to provide operational flexibility and streamlined workflow processes, including handling of radioactive fuels and materials.
- The facility will include enhanced material handling capabilities using robotics and vision technologies in radioactive sample, specimen, and equipment handling applications.
- The facility will include state-of-the art sample preparation technologies and equipment.
- The facility will support advanced data collection and management capabilities to enable efficient use by advanced modeling and simulation assets.
- The facility will provide interim storage for radioactive material experiments subject to examination.
- The facility will be designed to include radioactive waste management capabilities.

The initial complement of scientific instruments will be procured, remotized (as needed), and tested as part of the project prior to installation in the facility.

The SPL facility will be an alpha-limited post-irradiation examination facility and operate in conjunction with the Hot Fuel Examination Facility, Analytical Laboratory, IMCL, and offsite facilities to provide the overall capability to analyze and characterize irradiated and non-irradiated nuclear material samples. The SPL facility will not replace these facilities; it will function synergistically with them. Having most of these facilities located within a single security-protected site (i.e., MFC) supports efficient nuclear material control, security, and management.

Facility operations will include cask receipt and unloading, experiment decontamination, sample preparation (e.g., machining, grinding, and polishing), sample storage, waste packaging, and various microstructure and thermal examinations. The majority of these operations will take place within shielded cells and enclosures due to the radioactivity of the materials handled. These include the Sample Preparation Line, the Mechanical Properties Test Cell (MPTC), and the shielded instrument rooms.

A wide variety of samples will be handled in the facility. Non-alpha emitting samples will include solids or contained powders. In some cases, very small quantities of non-dispersible alpha-emitting material (i.e., fuels) may be received in the form of metallurgical mounts for examination using the advanced examination capabilities deployed at SPL. Nuclear materials and samples will be received in containers ranging from the Battelle Energy Alliance, LLC (BEA) research reactor cask to shielded/non-shielded 55 gallon drums, incorporating a truck lock for cask and related container handling. The primary method of sample transfer within the SPL facility will be via a progressive pass-along process through the sample preparation line of hot cells. Once processed in the hot cells, the materials will be distributed to the MPTC, a glove box, IMCL, or to the individual shielded instrument rooms. Transfer of samples within the SPL facility will be via a pneumatic transfer system. Samples will also be transferred within the facility and to other facilities via small shielded pigs or casks that mate to the outside of the hot cells. Samples will be appropriately shielded and confined to protect workers, equipment, and the facility. Preliminary key performance parameters (KPPs) were established for the project at CD-1. KPPs are defined as a vital characteristic, function, requirement, or design basis that, if changed, would have a major impact on the facility or system performance, scope, schedule, cost, risk, or the ability of an interfacing project to meet its mission requirements. The KPPs represent the minimum acceptable scope for successful delivery of SPL. Achievement of KPPs will be a prerequisite for approval of CD-4. If project performance is sustained, management reserve and/or contingency funds can be allocated to contingent scope or infrastructure enhancements to improve facility performance. The KPPs provided herein are preliminary, pre-baseline objectives. The final KPPs will be established as part of CD-2/3.

Performance Measure	Performance Parameter	Contingent Scope
Shielded sample preparation capability inclusive of work areas for cask receipt, material handling,	Five sample preparation workstations/windows	N/A

gross source material sizing, and fine sample preparation		
Shielded specimen examination/testing capability, inclusive of instrumentation/hardware and shielded enclosure	Three shielded scientific instrument enclosures Three advanced scientific instruments Mechanical Properties Test Cell with three testing stations and associated equipment/instruments	Up to one additional shielded instrument enclosure and up to four additional non-shielded instrument enclosures Up to five additional advanced scientific instruments

The proposed facility will be a Hazard Category 3 nuclear facility. Design and construction of the facility will include provisions for meeting the Guiding Principles for Federal Leadership in High Performance and Sustainable Building per Executive Order 13693 *"Planning for Federal Sustainability in the Next Decade*."

Funds appropriated under this data sheet may be used to provide independent assessments related to project planning and execution.

Justification

The behavior of fuels and materials in a nuclear reactor irradiation environment is the limiting factor in nuclear plant safety, longevity, efficiency, and economics. During the last 15 years, nano-scale (10^{-9} meter) characterization of nonnuclear materials has become routine, with capabilities for sub-angstrom (10^{-10}meter) investigation becoming increasingly available to researchers in other fields. An understanding of nuclear fuel and material performance in the nuclear reactor internal environment at this scale is critical to the development of the innovative fuels and materials required for tomorrow's nuclear energy systems.

Existing post-irradiation examination and thermal and mechanical property testing capabilities at U.S. Department of Energy (DOE) laboratories, universities, and in the private sector are widely dispersed. Current post-irradiation examination capabilities serve basic needs for fuel examination, material handling, and waste disposal, but are limited in their ability to function on the micro-, nano-, and atomic scale. Advanced characterization of radioactive samples at nano-scale to micro-scale length resolutions will support the development of modern computer codes that could enable order of magnitude improvements in the time and cost of developing new fuels.

The SPL will support a variety of programs and users by receiving irradiated nuclear materials and by preparing samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This improved sample preparation capability will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC). The new SPL may also provide source material and sample storage capability. The laboratory will, when coupled with existing facilities and recapitalization efforts, fulfill near-term advanced post-irradiation capabilities necessary for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and materials performance at the micro-, nano-, and atomic scales. This new understanding will allow for the development of innovative fuels and materials that can be used by the nuclear energy community. Irradiation-driven phenomena can only be understood through conducting a scientific program that includes experimental irradiation testing and post-irradiation examination, materials characterization, and testing coupled with modeling and simulation.

The project is being conducted in accordance with the project management requirements in DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets.

Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Total Estimated Cost (TEC)			
Design			
FY 2016	2,000	2,000	2,000
FY 2017	6,000	6,000	6,000
FY 2018	5,385	5,385	TBD
Outyears	TBD	TBD	TBD
Total, Design	**TBD**	**TBD**	**TBD**
Construction			
FY 2017	0	0	0
FY 2018	615	615	TBD
Outyears	TBD	TBD	TBD
Total, Construction	**TBD**	**TBD**	**TBD**
TEC			
FY 2016	2,000	2,000	2,000
FY 2017	6,000	6,000	6,000
FY 2018	6,000	6,000	TBD
Outyears	TBD	TBD	TBD
Total, TEC	**TBD**	**TBD**	**TBD**
Other Project Cost (OPC)			
OPC			
FY 2012	3,931	3,931	1,677
FY 2013	500	500	2,643
FY 2014	2,000	2,000	754
FY 2015	0	0	555
FY 2016	1,500	1,500	1,960
FY 2017	2,800	2,800	842
FY 2018	0	0	TBD
Outyears	TBD	TBD	TBD
Total, OPC	**TBD**	**TBD**	**TBD**
Total Project Cost (TPC)			
FY 2012	3,931	3,931	1,677
FY 2013	500	500	2,643
FY 2014	2,000	2,000	754
FY 2015	0	0	555
FY 2016	3,500	3,500	3,960
FY 2017	8,800	8,800	6,842
FY 2018	6,000	6,000	TBD
Outyears	TBD	TBD	TBD
Total, TPC	**TBD**	**TBD**	**TBD**

Details of Project Cost Estimate

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design			
Design	10,785	8,500	N/A
Contingency	2,600	1,500	N/A
Total, Design	**13,385**	**10,000**	**N/A**
Construction			
Site Work	2,230	6,000	N/A
Equipment	8,545	15,000	N/A
Construction	56,840	40,500	N/A
Contingency	5,000	11,500	N/A
Total, Construction	72,615	73,000	N/A
Total, TEC	**86,000**	**83,000**	**N/A**
Contingency, TEC	7,600	13,000	N/A
Other Project Cost (OPC)			
OPC except D&D			
Conceptual Planning	1,310	1,930	N/A
Conceptual Design	821	4,500	N/A
Hot startup	4,220	2,000	N/A
Other OPC Costs	4,549	2,370	N/A
Contingency	1,300	1,200	N/A
Total, OPC	12,200	12,000	N/A
Contingency, OPC	1,300	1,200	N/A
Total, TPC	98,200	95,000	N/A
Total, Contingency	**8,900**	**14,200**	**N/A**

Schedule of Appropriation Requests

($K)

Request		Prior Years	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Outyears	Total
FY 2016	TEC	2,000	TBD	TBD	TBD	TBD	TBD	0	0	78,000
	OPC	7,931	TBD	TBD	TBD	TBD	TBD	0	0	17,000
	TPC	9,931	TBD	TBD	TBD	TBD	TBD	0	0	95,000

FY 2017	TEC	2,000	6,000	TBD	TBD	TBD	TBD	TBD	TBD	83,000
	OPC	7,931	2,800	TBD	TBD	TBD	TBD	TBD	TBD	12,000
	TPC	9,931	8,800	TBD	TBD	TBD	TBD	TBD	TBD	95,000
FY 2018	TEC	2,000	6,000	6,000	TBD	TBD	TBD	TBD	TBD	86,000
	OPC	7,931	2,800	0	TBD	TBD	TBD	TBD	TBD	12,200
	TPC	9,931	8,800	6,000	TBD	TBD	TBD	TBD	TBD	98,200

Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	3QFY 2023
Expected Useful Life (number of years)	40
Expected Future Start of D&D of this capital asset (fiscal quarter)	3QFY 2063

(Related Funding requirements)

(dollars in thousands)

	Annual Costs		Life Cycle Costs	
	Current Total Estimate	**Previous Total Estimate**	**Current Total Estimate**	**Previous Total Estimate**
Operations	2,960	N/A	281,187	N/A
Utilities	374	N/A	35,528	N/A
Maintenance & Repair	4,930	N/A	468,327	N/A
Total	**8,264**	**N/A**	**785,042**	**N/A**

Expected operations and maintenance costs will be established at CD-1.

D&D Information

The new area being constructed in this project is not replacing existing facilities.

	Square Feet
New area being constructed by this project at INL……	44,000
Area of D&D in this project at INL……	0
Area at INL to be transferred, sold, and/or D&D outside the project including area previously "banked" ……	0
Area of D&D in this project at other sites ……	0
Area at other sites to be transferred, sold, and/or D&D outside the project including area previously "banked" ……	0
Total area eliminated ……	0

Site location, building name or numbers, and square footages of existing facilities to be replaced: N/A

As a new Laboratory facility, the proposed SPL is not subject to Freeze the Footprint (>50% lab space).

Acquisition Approach

As a Hazard Category 3 nuclear facility, design and construction of the SPL must be integrated with ongoing nuclear operations activities. Design and construction must also be coordinated/integrated with nuclear R&D programs. Therefore, a design-bid-build project delivery method managed by the INL management and operating contractor will be used for the design and construction of the SPL. A fixed price construction subcontract is anticipated for construction of the SPL.

Idaho Sitewide Safeguards and Security

Overview

The Idaho Sitewide Safeguards and Security (S&S) program supports the Idaho National Laboratory (INL) complex nuclear facility infrastructure and enables the Office of Nuclear Energy (NE) to conduct research and development (R&D) in support of multiple program missions. The S&S program benefits the site infrastructure and users by providing the safeguards and security functions required at DOE sites to enable R&D utilizing nuclear materials and protected information. In addition to NE R&D activities, S&S enables a range of national security programs that support the National Nuclear Security Administration (NNSA) and other Federal agencies including the Department of Homeland Security in the areas of critical infrastructure protection, nuclear nonproliferation and incident response. Safeguards and security functions through the INL S&S program also enable the Department of the Army, the Department of the Navy, and NNSA Naval Reactors mission activities.

Highlights of the FY 2018 Budget Request

The FY 2018 Budget Request provides direct funding for the INL S&S base program. Strategic Partnership Projects (SPP) will continue to fund an allocable share of the S&S program via full cost recovery. Extraordinary security requirements, such as dedicated security for special projects or exercises, will be a direct charge to DOE and SPP customers.

In FY 2018, the S&S program will continue to sustain program functionality at the level necessary to assure high confidence in the protection of INL assets and a high degree of customer service by maintaining effective staffing levels, proactive preventative and corrective maintenance programs, and a robust cybersecurity program. The FY 2018 Budget Request will focus on continued implementation of infrastructure investments, capital improvements, emerging technology investments, and enhanced cybersecurity program capabilities to adequately secure site assets; including:

- Completing critical physical security infrastructure investments required to maintain an S&S program consistent with Departmental requirements such as initiating designs, related analyses, and modifications to support a multi-year effort to enhance physical security infrastructure across several INL complexes.
- Supporting physical security systems life-cycle replacements including installation of the Argus Host and Network Equipment upgrades and Delta Barrier installation.
- Supporting eight large and medium scale force-on-force exercises designed to implement program management activities which allow for risk-informed decision making and directly test the efficacy of the protection methodology and posture.
- Maintaining an effective cybersecurity program through the addition of lifecycle hardware/software upgrades and replacements including continuous monitoring, maintaining Industrial Control Systems, essential cybersecurity positions and associated training.
- Additional protective force staff to support security infrastructure Phase I Implementation Plan activities consistent with Departmental protection requirements.

Idaho Sitewide Safeguards and Security
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Idaho Sitewide Safeguards and Security				
Protective Forces	65,611	-	73,881	+8,270
Security Systems	11,632	-	10,075	-1,557
Security Infrastructure	11,681	-	6,839	-4,842
Information Security	3,721	-	4,674	+953
Personnel Security	6,749	-	7,624	+875
Material Control & Accountability	4,456	-	4,876	+420
Program Management	7,845	-	8,175	+330
Cybersecurity	14,466	-	16,856	+2,390
Total, Idaho Sitewide Safeguards and Security	**126,161**	**125,921**	**133,000**	**+6,839**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Idaho Sitewide Safeguards and Security
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Protective Forces: The increase from $65,611,000 to $73,881,000 reflects costs for additional protective force staff to support security infrastructure Phase I Implementation Plan activities consistent with Departmental protection requirements, the site labor wage agreement and cost model. Funding also supports protective force equipment, training, facilities, and management.	**+8,270**
Security Systems: The decrease from $11,632,000 to $10,075,000 reflects completion of physical security systems life-cycle replacement of vehicle explosive detection technology and implementation of a rapid deployment security system for incident response. Funding continues to implement rapid deployment intrusion detection capabilities, complete preventative/corrective maintenance, and scheduled lifecycle replacements of physical security systems including installation of the Argus Host and network equipment upgrade and Delta Barriers.	**-1,557**
Security Infrastructure: The decrease from $11,681,000 to $6,839,000 reflects funding to partially execute Implementation Plan Phase 2A to support a multi-year effort to enhance physical security infrastructure across several Idaho National Laboratory (INL) complexes.	**-4,842**
Information Security: The increase from $3,721,000 to $4,674,000 provides funds to maintain information security services for key Idaho National Laboratory (INL) facilities consistent with the site operational needs.	**+953**
Personnel Security: The increase from $6,749,000 to $7,624,000 reflects funds to maintain personnel security services for key INL facilities consistent with the site operational needs including Homeland Security Presidential Directive 12 (HSPD-12) badging and smart card administration requirements.	**+875**
Material Control & Accountability: The increase from $4,456,000 to $4,876,000 provides funds to maintain accounting and control of special nuclear material (SNM) at key INL facilities consistent with the site operational needs.	**+420**
Program Management: The increase from $7,845,000 to $8,175,000 supports analyses required by the new Design Basis Threat and Departmental Orders in addition to life-cycle replacement of equipment and ammunition as well as planned performance assurance activities and eight force-on-force exercises including two related to security enhancements.	**+330**
Cybersecurity: The increase from $14,466,000 to $16,856,000 supports the addition of essential cybersecurity specialists, lifecycle hardware/software upgrades for classified and unclassified systems, including maintaining Industrial Control Systems, and network forensics capabilities for increased intrusion detection and response.	**+2,390**
Total, Idaho Sitewide Safeguards and Security	**+6,839**

Idaho Sitewide Safeguards and Security

Description

The S&S program funds Office of Nuclear Energy (NE) base physical and cybersecurity activities for the Idaho National Laboratory (INL), providing protection of the Department of Energy's (DOE) nuclear materials, classified and unclassified matter, government property, personnel and other vital assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause adverse impacts on our national security; program continuity; or the health and safety of employees, the public, or the environment.

Protective Forces

Protective Forces provides security police officers (SPO's) and other specialized personnel, equipment, training, and management needed during normal and security emergency conditions for adequate protection of site assets consistent with site security plans. Protective force personnel are deployed 24 hours a day, 7 days a week, across 890 square miles to deter, detect, delay, and respond to adversarial threats.

Security Systems

Physical Security Systems provides preventative and corrective maintenance and performance testing of intrusion detection and assessment systems, entry and search control equipment, barriers, secure storage, lighting, sensors, entry/access control devices, locks, explosives detection, and tamper-safe monitoring. Ensures 24 hour a day, 7 days a week operation of approximately 4,600 security alarms and 6,100 security locks at multiple security areas.

Security Infrastructure

Security Infrastructure provides critical security infrastructure investments and protection enhancements necessary to ensure adequate protection of assets consistent with Departmental requirements. These include, but are not limited to: upgrades, refurbishments or replacement of protective force training and muster facilities; physical security systems or equipment required by Departmental Orders, such as perimeter intrusion detection and assessment systems, closed-circuit televisions, central and/or secondary alarm stations; and other similar activities.

Information Security

Information Security provides for the protection and control of classified and sensitive matter that is generated, received, transmitted, used, stored, reproduced, and/or destroyed. The Classified Matter Protection and Control Program and Operations Security Program ensure that classified and sensitive unclassified matter is appropriately managed and adequately protected and controlled to prevent access by unauthorized individuals and that those individuals that do have access are trained to handle classified matter. Information Security executes the Technical Security Countermeasures (TSCM) program and conducts TSCM surveys.

Personnel Security

Personnel Security provides access to classified and sensitive information and assignment of personnel in sensitive positions through the clearance program, adjudication, security awareness and education, U.S. citizen and foreign visitor control, Human Reliability Program, psychological/medical assessments, and administrative review costs. Personnel security includes both contractor and federally funded activities.

Materials Control and Accountability

Material Control & Accountability (MC&A) provides the personnel, equipment, and services required to account for and control special nuclear materials (SNM) from diversion. MC&A is accomplished through the administration of a robust formal inventory process that allows security personnel to locate and track specific quantities of SNM in real time, state of the art measurement equipment, non-destructive analysis, and a robust tamper indicating device program.

Program Management

Program Management includes policy oversight, development, and update of site security plans; vulnerability assessments and performance testing to ensure adequate protection of SNM; investigations into incidents of security concern; and issuance of security infractions. The activities completed within Program Management allow for risk-informed decision making, support a performance-based Safeguards and Security (S&S) program, and directly test the efficacy of the protection methodology/posture.

Cybersecurity

Cybersecurity maintains the staffing, computing infrastructure, and network security configuration necessary to support classified and unclassified information and electronic operations. The Cybersecurity program uses a graduated risk approach based on data sensitivity and impact of loss/compromise to ensure that electronic or computer information systems, are protected in a manner consistent with upholding key priorities; including importance to national security, support of Department of Energy (DOE) missions and programs, vulnerability to threats, and the magnitude of harm that would result from an information system and industrial control systems compromise.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Protective Forces $65,611,000	**$73,881,000**	**+$8,270,000**
• Provided funds to maintain a Protective Force consistent with the Site Security Plan, approved site labor wage agreement, and Idaho National Laboratory (INL) cost model changes, including associated training activities and facilities required to maintain protective force qualifications. • Provided funding to purchase Protective Force equipment such as ammunition, weapons, protective gear and vehicles.	• Provides funds for additional protective force staff to support security infrastructure Phase I Implementation Plan activities consistent with the Site Security Plan, approved site labor wage agreement, and INL cost model, including associated training activities and facilities required to maintain protective force qualifications. • Provides funding to purchase Protective Force equipment such as ammunition, weapons, protective gear and vehicles.	• Reflects funds for additional protective force staff to support security infrastructure Phase I Implementation Plan activities, protective force equipment, training, facilities, and management.
Security Systems $11,632,000	**$10,075,000**	**-$1,557,000**
• Provided funds for staff and equipment to plan and conduct preventative and corrective maintenance on physical security systems at multiple security areas. • Supported the operation of INL central alarm stations, development and modification of security alarm systems and life cycle replacement of systems.	• Provides funds for staff and equipment to plan and conduct preventative and corrective maintenance on physical security systems at multiple security areas. • Supports the operation of INL central alarm stations, development and modification of security alarm systems and life cycle replacement of systems. • Provides funds for Argus Host and Network Equipment upgrades and installation of Delta barriers.	• Reflects projected physical security systems life cycle replacement needs and implementation of rapid deployment intrusion detection capabilities.
Security Infrastructure $11,681,000	**$6,839,000**	**-$4,842,000**
• Completed design and initiated construction of the upgrade to the Perimeter Intrusion Detection and Assessment System (PIDAS) at the Materials and Fuels Complex (MFC). • Completed the upgrade to the Central Alarm System (CAS) at MFC.	• Partially executes Implementation Plan Phase 2A by performing design work, related analyses, and modifications to support a multi-year effort to enhance physical security infrastructure across several INL complexes.	• Reflects funding to partially execute Implementation Plan Phase 2A physical security enhancement activities.
Information Security $3,721,000	**$4,674,000**	**+$953,000**
• Provided funds to implement information security activities to protect classified and sensitive unclassified matter including Classified	• Provides funds to implement information security activities to protect classified and sensitive unclassified matter including Classified	• Reflects funds necessary to maintain information security services consistent with site operational demands.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	
Personnel Security $6,749,000	**$7,624,000**	**+$875,000**
• Provided funds for federal and contractor personnel security programs including processing, tracking and adjudication of security investigations, and in support of DOE Order 206.2, Identity, Credential and Access Management (ICAM), which requires the implementation of a trusted framework and common identity infrastructure for access to DOE facilities and systems the issuance of the Homeland Security Presidential Directive-12 (HSPD-12) badge, foreign visits and assignments, and management of the human reliability program including medical examinations.	• Provides funds for federal and contractor personnel security programs including processing, tracking and adjudication of security investigations, HSPD-12 badging and smart card administration, foreign visits and assignments, and management of the human reliability program including medical examinations.	• Reflects funds necessary to maintain personnel security services consistent with the site operational demands.
Material Control & Accountability $4,456,000	**$4,876,000**	**+$420,000**
• Provided funds to maintain the site's special nuclear material (SNM) planning documents, database, tracking systems, coordinate on-and off-site material movements, and to conduct SNM inventories.	• Provides funds to maintain the site's SNM database and tracking systems, coordinate on- and off-site material movements, and to conduct SNM inventories.	• Reflects funds necessary to maintain Material Control & Accountability (MC&A) services consistent with the site operational demands.
Program Management $7,845,000	**$8,175,000**	**+$330,000**
• Provided funds to maintain and develop, update, and maintain security program documentation, implementation plans in response to changing DOE order requirements, vulnerability/risk assessments and the conduct of performance testing which ensures effective safeguards and security program performance.	• Provides funds to maintain and develop, update, and maintain security program documentation, vulnerability/risk assessments and to conduct performance testing to assure program effectiveness including supporting analyses required by the new Design Basis Threat and Departmental Orders. • Provides funds to support force of force exercises which directly test the efficacy of the protection methodology and posture and allow for risk-informed decision making.	• Reflects increased performance assurance activities and life-cycle replacement of equipment and ammunition.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Cybersecurity $14,466,000	**$16,856,000**	**+$2,390,000**
• Maintained an effective cybersecurity program consistent with the Department's measured risk management and vulnerability and incident management strategies including staffing, training, tools, hardware/software lifecycle replacement, and certification and accreditation for classified and unclassified systems. • Established Idaho National Laboratory (INL) Industrial Control Systems cybersecurity program.	• Maintains an effective cybersecurity program consistent with the Department's measured risk management and vulnerability and incident management strategies including staffing, training, tools, hardware/software lifecycle replacement, and certification and accreditation for classified and unclassified systems. • Continue to maintain INL Industrial Control Systems cybersecurity program. • Implement formal cloud assurance program across Idaho National Laboratory.	• Reflects funds necessary to maintain cybersecurity services consistent with the site operational demands and provides for increased intrusion detection and response capabilities to mitigate dynamic cybersecurity threats. Threat landscape is changing exponentially with more sophisticated malware and attacks. Continue to focus on new areas such as Industrial Control Systems.

Idaho Sitewide Safeguards and Security
Capital Summary ($K)

	Total	Prior Years	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE))					
Capital Equipment > $500K (including MIE)	n/a	1,500	1,500	1,500	1,500
Plant Projects (GPP)	n/a	0	11,681	3,875	3,875
Total, Capital Operating Expenses	**n/a**	**1,500**	**13,181**	**5,375**	**5,375**
Capital Equipment > $500K (including MIE)					
Total Non-MIE Capital Equipment (>$500K)	n/a	1,500	1,500	1,500	1,500
Total, Capital Equipment (including MIE)	**n/a**	**1,500**	**1,500**	**1,500**	**1,500**
Plant Projects (GPP)					
Materials and Fuels Complex (MFC) Perimeter Intrusion Detection and Assessment System (PIDAS) Upgrade	n/a	0	8,281	0	0
MFC Central Alarm System (CAS) Upgrade	n/a	0	3,400	0	0
Live Fire Shoot House Refurbishment	n/a	0	0	3,875	3,875
Total, Plant Projects (GPP)	**n/a**	**0**	**11,681**	**3,875**	**3,875**
Total, Capital Summary	**n/a**	**1,500**	**13,181**	**5,375**	**5,375**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

International Nuclear Energy Cooperation

Overview

International Nuclear Energy Cooperation's (INEC) mission is to lead the Department's international engagement related to civil nuclear energy, including analysis, development, coordination and implementation of international civil nuclear energy policy and the integration of the Office of Nuclear Energy's (NE) international nuclear technical activities. These activities contribute to international bilateral and multilateral engagement and civil nuclear energy research and development (R&D) activities with countries who are considering development of, or currently have a civilian nuclear power sector. INEC utilizes workshops and expert-based exchange fora to engage industry, stakeholders and foreign governments on international civil nuclear issues such as training, financing, and safety.

A key element of INEC's mission is its support to advocacy for the U.S. commercial nuclear sector, including industry vendors and utilities, via direct engagement with foreign governments. Such support can lead to increased nuclear exports, which in turn contribute to domestic infrastructure development and job creation.

INEC provides the Department the ability to meet growing demands for engagement with international partners on civil nuclear policy, research, development and demonstration (RD&D) and related activities. INEC engages both bilaterally and multilaterally to support broader U.S. policy and commercial goals related to the safe and secure deployment of nuclear energy globally and allow more effective integration of NE international RD&D and policy interests, including increasing proliferation resistance of new and existing technologies. INEC also leverages nuclear energy efforts in coordination with the Department of Energy's (DOE) National Nuclear Security Administration, Office of Environmental Management, and Office of International Affairs; the National Security Council; Department of State; the Department of Commerce; and the Nuclear Regulatory Commission to facilitate U.S. nuclear energy RD&D, nuclear safety, policy, and commercial interests internationally.

Highlights of the FY 2018 Budget Request

In FY 2018, INEC will continue to support existing international engagement with advanced and developing nuclear energy countries in coordination with the Department of State and other agencies. INEC will also continue to advance multilateral collaboration with the International Atomic Energy Agency (IAEA), the Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA), and the International Framework for Nuclear Energy Cooperation (IFNEC). INEC will continue its program for international nuclear energy education outreach, modeled after the Department of State's International Military Education and Training program, which supports diplomatic, nonproliferation, climate, and international economic objectives for the safe and secure use of peaceful uses of nuclear technology in emerging countries developing nuclear energy programs. In FY 2018, INEC will support international nuclear safety activities with a focus on improving our domestic commercial nuclear safety and promoting global use of U.S. nuclear safety practices. INEC will continue its engagement with the nuclear industry to learn and apply knowledge from the ongoing Fukushima Daiichi accident follow-on activities. Long term assessments will provide analytical and policy support to interested international partners, while near term assessments will provide important characterizing information about unplanned international commercial nuclear events that will be used to inform DOE leadership; all work will be performed in coordination with other USG agencies.

International Nuclear Energy Cooperation
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
International Nuclear Energy Cooperation				
International Nuclear Energy Cooperation	3,000	2,994	2,500	-500
Total, International Nuclear Energy Cooperation	**3,000**	**2,994**	**2,500**	**-500**

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International Nuclear Energy Cooperation
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
International Nuclear Energy Cooperation: The decrease from $3,000,000 to $2,500,000 reflects a reduced funding requirement following the completion of bilateral and multilateral activities that achieved their objectives in FY2017. This funding level will accommodate $1,206,000 in continuing multilateral and bilateral engagement, and $550,000 for nuclear safety activities.	**-500**
Total, International Nuclear Energy Cooperation	**-500**

International Nuclear Energy Cooperation

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
International Nuclear Energy Cooperation		
$3,000,000	**$2,500,000**	**-$500,000**
• Provided country-specific policy and logistical support required to effectively implement NE's bilateral nuclear energy R&D activities with expert support from national laboratory lead country coordinators. Maintained the existing bilateral and multilateral cooperation commitments. Enhanced technical cooperation with advanced and developing nuclear energy countries globally to support both the Office of Nuclear Energy and U.S. Government strategic priorities and objectives. • Successfully transitioned International Framework for Nuclear Energy Cooperation (IFNEC) Secretariat to Organization for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA). • Provided expertise and technical assistance to the Department of Commerce and U.S. interagency in support of U.S. civil nuclear exports. • Led international engagement supporting multinational approaches to spent nuclear fuel disposal. • Advanced collaboration with the United Kingdom, France, India, and Japan R&D Agreements, implementing arrangements and Action Plan updates completed in 2014 and 2015. • Initiated International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) study on multinational approaches to the back end of the fuel cycle, including transfer of responsibility.	• Provide country-specific policy and logistical support required to effectively implement NE's bilateral nuclear energy R&D activities by employing the expertise of national laboratory country coordinators. Manage implementation of existing bilateral and multilateral cooperation commitments. Continue technical cooperation with advanced and developing nuclear energy countries globally to support Office of Nuclear Energy and U.S. Government strategic priorities and objectives. • Continue to contribute expertise and technical assistance to the interagency efforts supporting U.S. civil nuclear exports and nuclear supply chain, including serving as the lead nuclear organization in support of US nuclear commercial exports. • Support Secretary and senior DOE leadership on all international nuclear matters, including numerous bilateral meetings and support for international nuclear related missions such as the IAEA. • Continue to manage INERI collaborative partnerships on research and development projects with EURATOM and Republic of Korea that focus on advanced nuclear technologies for improving the cost, safety and proliferation-resistance of nuclear energy systems. • Develop new collaboration opportunities with the United Kingdom, France, India, and Japan through mechanisms such as R&D Agreements, implementing arrangements and Action Plans.	• Completed Research Reactor Training for Vietnamese researchers. • Completed study of water corrosion in Indian BWRs. • Completed modification of Kazakh Sodium Processing Facility. • Partial completion of objectives under China PUNT; reduced funding required. • Ukraine Flex Procedures Workshops completed.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
• Advanced U.S. civil nuclear policy objectives within INPRO ROADMAPS and KIND projects. • Oversaw selection and allocation of Peaceful Uses Initiative funds. • Oversaw NE's participation in the IAEA General Conference and coordinated NE's contributions to the annual NPT Additional Protocol process. • Coordinated development of NE's participation in the OECD-NEA Data Bank as a potential member as well as prepared materials and coordinated NE-1's participation in NEA Steering Committee meetings.	Support China PUNT activities on Working Groups 1 and 6. Conduct cooperative study under the U.S.-South Korean High Level Bilateral Commission on the reliability of supply for the nuclear fuel cycle. • Provide near term and long term assessments of international civil nuclear events to support the office's international nuclear safety mission. • Continue to participate in and coordinate Fukushima Forensics activities that support improved operation and safety of U.S. domestic nuclear power plants.	

Program Direction

Overview

Program Direction provides the federal staffing resources and associated costs required to support the overall direction and execution of the Office of Nuclear Energy (NE) programs. NE has staff strategically located in multiple locations: Washington, D.C., the Idaho Operations Office, and Oak Ridge Operations Office. Activities within the site offices support inherently federal functions that facilitate the efficient execution of DOE programs or directly execute DOE mandated safety, security and business functions. In addition to NE federal personnel, Program Direction supports the coordination of the Energy portfolio by the Office of the Under Secretary for Science and Energy, and select federal staff and support for the Office of Human Capital Service Center.

The Support Services subprogram allows the Department to cost-effectively hire the best available industry experts to support federal staff in managing the nuclear programs and complex activities. The ability to acquire expertise quickly and on an "as needed basis" provides flexibility in team composition as the needs of NE evolve. Program Direction also includes the Other Related Expenses subprogram, which provides NE's directed funding contribution to the Department's Working Capital Fund (WCF). The WCF supports specific Departmental services and activities that are shared across DOE including: enhanced cyber security architecture, employee health and testing services, and consolidated training and recruitment initiatives; all established in previous fiscal years and supported in FY 2018.

In addition to appropriated funds, NE also manages approximately $140.0 million dollars annually from other activities including: Strategic Partnerships Program and reimbursable funding from the National Aeronautics and Space Administration (NASA) and the Department of Defense (DoD).

The Program Direction request reflects NE's continued effort to optimize support for its federal programs through continued efficiency and cost-effectiveness; and to ensure a measured and effective oversight of NE mission activities. Federal staff supported by the Program Direction account are responsible for ensuring the appropriate planning, oversight, and execution of all activities within the responsibility of the Office of Nuclear Energy.

Highlights of the FY 2018 Budget Request

The Nuclear Energy Program Direction Budget Request reflects a decrease of $13.5 million from the FY 2016 Enacted Budget. This decrease reflects the transfer of 53 federal staff and associated support activities to the new Yucca Mountain and Interim Storage Program (YMIS).

Program Direction
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Program Direction Summary				
Washington Headquarters				
Salaries and Benefits	31,277	-	21,433	-9,844
Travel	907	-	597	-310
Support Services	4,076	-	3,450	-626
Other Related Expenses	7,856	-	6,139	-1,717
Total, Washington Headquarters	**44,116**	**-**	**31,619**	**-12,497**
Oak Ridge Operations Office				
Salaries and Benefits	465	-	447	-18
Travel	4	-	3	-1
Support Services	345	-	300	-45
Other Related Expenses	591	-	525	-66
Total, Oak Ridge Operations Office	**1,405**	**-**	**1,275**	**-130**
Idaho Operations Office				
Salaries and Benefits	25,551	-	25,045	-506
Travel	532	-	425	-107
Support Services	1,555	-	1,325	-230
Other Related Expenses	6,841	-	6,811	-30
Total, Idaho Operations Office	**34,479**	**-**	**33,606**	**-873**
Total Program Direction				
Salaries and Benefits	57,293	-	46,925	-10,3688
Travel	1,443	-	1,025	-418
Support Services	5,976	-	5,075	-901
Other Related Expenses	15,288	-	13,475	-1,813
Total, Program Direction	**80,000**	**79,848**	**66,500**	**-13,500**
Federal FTEs	**351**	**342**	**291**	

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Support Services				
Technical Support				
Mission Related	2,500	-	2,100	-400
Advisory and Assistance	185	-	150	-35
Total, Technical Support	2,685	-	2,250	-435
Management Support				
Administrative	1,483	-	1,250	-233
IT	1,808	-	1,575	-233
Total Management Support	3,291	-	2,825	-466
Total, Support Services	**5,976**	**-**	**5,075**	**-901**
Other Related Expenses				
Working Capital Fund	7,170	-	6,250	-920
Training	300	-	225	-75
Miscellaneous	6,089	-	5,800	-289
Rents and Utilities	1,729	-	1,200	-529
Total, Other Related Expenses	**15,288**	**-**	**13,475**	**-1,813**

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Program Direction

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Program Direction $80,000,000	**$66,500,000**	**-$13,500,000**
Salaries and Benefits $57,293,321	**$46,924,984**	**-$10,368,337**
• Provides salaries and benefits for 351 federal staff.	• Provides salaries and benefits for 291 federal staff.	• Decrease reflects a reduction of 7 on board staff which will be achieved through attrition, as well as, transfers 53 NE funded employees to establish the new YMIS program. All associated costs for those employees are included in this transfer.
Travel $1,443,010	**$1,025,000**	**-$418,010**
• Provides for travel of the federal staff including any necessary permanent change of duty status costs.	• Provides for travel of the federal staff including any necessary permanent change of duty status costs, particularly associated with the federal staff at Department of Energy (DOE) overseas offices.	• Change reflects a realignment of NE travel to support current workforce needs, as well as, transfers funds to support employee travel of the YMIS program.
Support Services $5,976,100	**$5,075,000**	**-$901,100**
• Provides for technical and administrative support services for the Nuclear Energy (NE) federal staff including access to and participation with external and international nuclear energy organizations.	• Provides for technical and administrative support services for the NE federal staff.	• Funding for external nuclear energy organizations that supports the mission of the YMIS have been transferred accordingly.
Other Related Expenses $15,287,569	**$13,475,016**	**-$1,812,553**
• Provides for NE's share of goods and services procured through the Department's Working Capital Fund (WCF); rents and utilities associated with the Idaho Operations Office and allocated share of such costs for the Nevada Site Office; federal training expenses; and other miscellaneous expenses. • Provides $10,000 for official reception and representation expenses.	• Provides for NE's share of goods and services procured through the Department's Working Capital Fund; rents and utilities associated with the Idaho Operations Office; federal training expenses; and other miscellaneous expenses.	• Decrease reflects a transfer of funds to support WCF, training, rent, and other miscellaneous expenses associated with YMIS. • No request of funding for official reception and representation expenses.

Nuclear Energy
Research and Development ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Basic	32,430	32,369	9,940	-22,490
Applied	734,146	733,561	592,188	-141,958
Development	121,639	120,598	98,111	-23,528
Subtotal, R&D	**888,215**	**886,528**	**700,239**	**-187,976**
Equipment	0	0	0	0
Construction	0	0	0	0
Total, R&D	**888,215**	**886,528**	**700,239**	**-187,976**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Nuclear Energy
Safeguards and Security ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Idaho Sitewide Safeguards and Security				
Protective Forces	**65,611**	**-**	**73,881**	**+8,270**
Security Systems	**11,632**	**-**	**10,075**	**-1,557**
Security Infrastructure	**11,681**	**-**	**6,838**	**-4,842**
Information Security	**3,721**	**-**	**4,674**	**+953**
Personnel Security	**6,749**	**-**	**7,624**	**+875**
Material Control & Accountability	**4,456**	**-**	**4,876**	**+420**
Program Management	**7,845**	**-**	**8,175**	**+330**
Cyber Security	**14,466**	**-**	**16,857**	**+2,390**
Total, Safeguards and Security	**126,161**	**125,921**	**133,000**	**+6,839**

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Nuclear Energy
Facilities Maintenance and Repair

The Department's Facilities Maintenance and Repair activities are tied to its programmatic missions, goals, and objectives. The Facilities Maintenance and Repair activities funded by this budget are displayed below are intended to halt asset condition degradation.

Costs for Direct-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
Idaho National Laboratory	34,133	34,167	34,007	8,936
Total, Direct-Funded Maintenance and Repair	**34,133**	**34,167**	**34,007**	**8,936**

Costs for Indirect-Funded Maintenance and Repair (including Deferred Maintenance Reduction) ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost	FY 2017 Planned Cost	FY 2018 Planned Cost
Idaho National Laboratory	19,847	20,309	21,258	28,726
Total, Indirect-Funded Maintenance and Repair	**19,847**	**20,309**	**21,258**	**28,726**

Report on FY 2016 Expenditures for Maintenance and Repair

This report responds to legislative language set forth in Conference Report (H.R. 108-10) accompanying the Consolidated Appropriations Resolution, 2003 (Public Law 108-7) (pages 886-887), which requests the Department of Energy provide an annual year-end report on maintenance expenditures to the Committees on Appropriations. This report compares the actual maintenance expenditures in FY 2016 to the amount planned for FY 2016, including Congressionally directed changes.

Nuclear Energy
Total Costs for Maintenance and Repair ($K)

	FY 2016 Actual Cost	FY 2016 Planned Cost
Idaho National Laboratory	53,980	54,476
Total, Maintenance and Repair	**53,980**	**54,476**

Each year, the "Planned Cost" for maintenance and repair is a minimum target amount. The Nuclear Energy program met its planned minimum target in FY 2016.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Argonne National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	12,944	12,900	5,360
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	8,527	5,455	5,030
Reactors Concepts RD&D			
Reactors Concepts RD&D	17,560	17,370	11,800
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	725	425	70
Total, Argonne National Laboratory	**39,756**	**36,150**	**22,260**
Brookhaven National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	2,145	2,100	1,440
Reactors Concepts RD&D			
Reactors Concepts RD&D	85	85	85
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	0	30	5
Total, Brookhaven National Laboratory	**2,230**	**2,215**	**1,530**
Chicago Operations Office			
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	410	400	400
Total, Chicago Operations Office	**410**	**400**	**400**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Idaho National Laboratory			
University Research Program			
University Research	7	0	0
Fuel Cycle R & D			
Fuel Cycle R & D	42,499	42,300	27,895
Radiological Facilities Management			
Radiological Facilities Management	6,581	6,722	8,933
Idaho Facilities Management			
Idaho Facilities Management	215,514	214,734	197,640
Idaho Sitewide Safeguards and Security			
Idaho Sitewide Safeguards and Security	122,723	122,399	129,900
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	49,412	41,034	35,438
Reactors Concepts RD&D			
Reactors Concepts RD&D	51,598	47,956	38,200
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	1,155	474	448
SMR Licensing Technical Support			
SMR Licensing Technical Support	1,000	0	0
Total, Idaho National Laboratory	**490,489**	**475,619**	**438,454**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Idaho Operations Office			
University Research Program			
University Research	4,973	0	0
Fuel Cycle R & D			
Fuel Cycle R & D	70,646	70,600	25,475
Radiological Facilities Management			
Radiological Facilities Management	42	42	42
Idaho Facilities Management			
Idaho Facilities Management	5,488	5,875	6,000
Idaho Sitewide Safeguards and Security			
Idaho Sitewide Safeguards and Security	3,000	3,100	3,100
Program Direction-NE			
Program Direction-NE	34,479	34,322	33,606
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	10,718	20,401	30,400
Reactors Concepts RD&D			
Reactors Concepts RD&D	38,212	38,464	19,580
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	35	1,170	1,285
SMR Licensing Technical Support			
SMR Licensing Technical Support	60,600	61,723	0
Supercritical Transformational Electric Power Generation			
Supercritical Transformational Electric Power Generation	4,815	0	0
Total, Idaho Operations Office	**233,008**	**235,697**	**119,488**
Kansas City Site Office			
Idaho Facilities Management			
Idaho Facilities Management	280	250	0
Total, Kansas City Site Office	**280**	**250**	**0**
Lawrence Berkeley National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	2,020	2,000	220
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	997	800	425
Total, Lawrence Berkeley National Laboratory	**3,017**	**2,800**	**645**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Lawrence Livermore National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	826	1,000	325
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	400	200	100
Reactors Concepts RD&D			
Reactors Concepts RD&D	50	50	50
Total, Lawrence Livermore National Laboratory	**1,276**	**1,250**	**475**
Los Alamos National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	11,600	11,600	6,460
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	2,823	2,300	2,300
Reactors Concepts RD&D			
Reactors Concepts RD&D	200	200	0
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	50	0	0
Total, Los Alamos National Laboratory	**14,673**	**14,100**	**8,760**
Oak Ridge National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	25,268	25,200	10,000
Radiological Facilities Management			
Radiological Facilities Management	17,930	17,966	0
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	30,971	26,329	7,060
Reactors Concepts RD&D			
Reactors Concepts RD&D	18,395	15,325	13,500
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	410	385	280
SMR Licensing Technical Support			
SMR Licensing Technical Support	200	0	0
Total, Oak Ridge National Laboratory	**93,174**	**85,205**	**30,840**
Oak Ridge Office			
Fuel Cycle R & D			
Fuel Cycle R & D	200	300	200
Program Direction-NE			
Program Direction-NE	1,405	1,375	1,275
Total, Oak Ridge Office	**1,605**	**1,675**	**1,475**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Pacific Northwest National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	10,781	10,700	5,000
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	1,648	105	105
Reactors Concepts RD&D			
Reactors Concepts RD&D	1,775	1,775	900
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	100	0	0
Total, Pacific Northwest National Laboratory	**14,304**	**12,580**	**6,005**
Sandia National Laboratories			
Fuel Cycle R & D			
Fuel Cycle R & D	13,102	13,000	1,000
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	1,224	1,100	100
Reactors Concepts RD&D			
Reactors Concepts RD&D	3,870	3,790	3,000
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	190	0	0
SMR Licensing Technical Support			
SMR Licensing Technical Support	200	0	0
Supercritical Transformational Electric Power Generation			
Supercritical Transformational Electric Power Generation	0	4,760	0
Total, Sandia National Laboratories	**18,586**	**22,650**	**4,100**
Savannah River National Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	3,441	3,500	775
Total, Savannah River National Laboratory	**3,441**	**3,500**	**775**
SLAC National Accelerator Laboratory			
Fuel Cycle R & D			
Fuel Cycle R & D	275	0	0
Total, SLAC National Accelerator Laboratory	**275**	**0**	**0**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
University Research Program			
University Research	20	4,990	0
Fuel Cycle R & D			
Fuel Cycle R & D	8,053	8,213	4,350
Radiological Facilities Management			
Radiological Facilities Management	97	23	25
Idaho Facilities Management			
Idaho Facilities Management	1,300	1,300	500
Idaho Sitewide Safeguards and Security			
Idaho Sitewide Safeguards and Security	438	422	0
Program Direction-NE			
Program Direction-NE	44,116	44,151	31,619
Nuclear Energy Enabling Technologies			
Nuclear Energy Enabling Technologies	4,470	13,264	24,002
Reactors Concepts RD&D			
Reactors Concepts RD&D	9,973	16,434	6,885
International Nuclear Energy Cooperation			
International Nuclear Energy Cooperation	335	510	412
SMR Licensing Technical Support			
SMR Licensing Technical Support	500	658	0
Supercritical Transformational Electric Power Generation			
Supercritical Transformational Electric Power Generation	185	230	0
Total, Washington Headquarters	**69,487**	**90,195**	**67,793**
Y-12 National Security Complex			
Radiological Facilities Management			
Radiological Facilities Management	150	0	0
Total, Y-12 National Security Complex	**150**	**0**	**0**
Total, Nuclear Energy	**986,161**	**984,286**	**703,000**

Yucca Mountain and Interim Storage
Proposed Appropriation Language

NUCLEAR WASTE DISPOSAL

For Department of Energy expenses necessary for nuclear waste disposal activities to carry out the purposes of the Nuclear Waste Policy Act of 1982, Public Law 97–425, as amended (the ''NWPA''), including the acquisition of any real property or facility construction, or expansion, and interim storage activities, $90,000,000, to remain available until expended, and to be derived from the Nuclear Waste Fund: Provided, That of the funds made available in this Act for nuclear waste disposal and defense nuclear waste disposal activities, 1.62 percent shall be provided to the Office of the Attorney General of the State of Nevada solely for expenditures, other than salaries and expenses of State employees, to conduct scientific oversight responsibilities and participate in licensing activities pursuant to the NWPA: Provided further, that of the funds made available in this Act for nuclear waste disposal and defense nuclear waste disposal activities, 2.91 percent shall be provided to affected units of local government, as defined in the NWPA, to conduct appropriate activities and participate in licensing activities under Section 116(c) of the NWPA: Provided further, That of the amounts provided to affected units of local government, 7.5 percent of the funds provided for the affected units of local government shall be made available to affected units of local government in California with the balance made available to affected units of local government in Nevada for distribution as determined by the Nevada affected units of local government: Provided further, That of the funds made available in this Act for nuclear waste disposal and defense nuclear waste disposal activities, 0.16 percent shall be provided to the affected federally-recognized Indian tribes, as defined in the NWPA, solely for expenditures, other than salaries and expenses of tribal employees, to conduct appropriate activities and participate in licensing activities under section 118(b) of the NWPA: Provided further, that of the funds made available in this Act for nuclear waste disposal and defense nuclear waste disposal activities 3.0 percent shall be provided to Nye County, Nevada, 0.05 percent shall be provided to Clark County, Nevada, and 0.46 percent shall be provided to the State of Nevada as payment equal to taxes under section 116(c)(3) of the NWPA: Provided further, that within 90 days of the completion of each Federal fiscal year, the Office of the Attorney General of the State of Nevada, each affected federally-recognized Indian tribe, and each of the affected units of local government shall provide certification to the Department of Energy that all funds expended from such payments have been expended for activities authorized by the NWPA and this Act: Provided further, that failure to provide such certification shall cause such entity to be prohibited from any further funding provided for similar activities: Provided further, that none of the funds herein appropriated may be: (1) used for litigation expenses; or (2) used to support multi-State efforts or other coalition building activities inconsistent with the restrictions contained in this Act: Provided further, that all proceeds and recoveries realized by the Secretary in carrying out activities authorized by the NWPA, including but not limited to any proceeds from the sale of assets, shall be credited to this account, to remain available until expended, for carrying out the purposes of this account.

DEFENSE NUCLEAR WASTE DISPOSAL

For nuclear waste disposal activities to carry out the purposes of Public Law 97–425, as amended, including the acquisition of real property or facility construction or expansion, and interim storage activities, $30,000,000, to remain available until expended.

Yucca Mountain and Interim Storage
($K)

FY 2016 Enacted	FY 2017 Annualized CR [1]	FY 2018 Request
0	0	120,000

Overview
The mission of the Yucca Mountain and Interim Storage programs is to accelerate progress on fulfilling the Federal Government's obligations to address nuclear waste, enhance national security, and reduce future taxpayer burden.

Preface
With the resumption of the Yucca Mountain licensing process and initiation of a robust interim storage program, the FY 2018 Budget Request proposes resuming the receipt of funds through two separate appropriation accounts, the Nuclear Waste Disposal and Defense Nuclear Waste Disposal appropriations. The overview narrative and detailed justification for the entire program, as supported by both accounts, is presented here.

The programs implement the Administration's decision to resume the Yucca Mountain license application process for disposal of spent nuclear fuel (SNF) and high level waste (HLW) while establishing a robust interim storage capability. The FY 2018 Budget Request includes the reestablishment of organizational, essential management, and subject matter expert, capabilities needed for the resumed participation in the Nuclear Regulatory Commission (NRC) licensing process for disposal of SNF and HLW, consistent with the provisions of the Nuclear Waste Policy Act (NWPA).

The Yucca Mountain and Interim Storage programs are critical to enhancing the national and economic security goals of the nation. The management of SNF and HLW must protect the health, safety of citizens and the environment in the United States. The programs are also essential for supporting national security objectives, along with Department of Energy strategic goals.

The Nation's commercial and defense spent nuclear fuel and high level waste must be safely and permanently isolated to minimize the risk to human health and the environment. Effective management of these materials will ensure that our country maintains national security, supports cleanup of weapons sites, continues operation of the U.S. Navy's nuclear-powered vessels, and advances our international non-proliferation goals. Ultimately, the success of the program ensures the safe and secure management of SNF and HLW currently located at numerous above ground sites across the United States.

Highlights and Major Changes in the FY 2018 Budget Request
The FY 2018 Yucca Mountain and Interim Storage Programs' FY 2018 Budget Request is dedicated to resuming the NRC licensing process for Yucca Mountain and initiation of a robust interim storage program. Prior year activities that supported the participation of the Office of Civilian Radioactive Waste Management (OCRWM) in the NRC licensing process were suspended in FY 2010, but will be resumed under the FY 2018 Budget Request.

This request provides for a program office to provide policy direction and perform functions necessary to the licensing process. This request provides for legal support to represent the Department in the licensing process, as well as to respond to litigation and other legal matters related to the NWPA. It provides for technical and scientific support necessary to support an affirmative case for the license and to respond to any challenges to the license application. It also provides for the document management activities associated with the licensing process.

The FY 2018 Budget Request includes funding to develop a robust interim storage enabling near-term consolidation of nuclear waste and safely storing it while a repository is completed.

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

The Program Direction budget has been structured to support both licensing and interim storage. Program Direction is needed for a variety of activities including the salaries of Federal Employees working in furtherance of the NWPA. FY 2018 Program Direction support for the Yucca Mountain and the Interim Storage programs is estimated as follows:

($ in Thousands)

	Yucca Mountain	Interim Storage	Total
Yucca Mountain	90,400		90,400
Interim Storage		6,600	6,600
Program Direction	19,600	3,400	23,000
Total	**110,000**	**10,000**	**120,000**

Financial Assistance and Payments-Equal-to-Taxes

Based on the full funding request of $120 Million and consistent with the percentages identified within the Appropriation language, the following table represents a total of $9,835,000 in funding to provide financial assistance to the State of Nevada, Affected Units of Local Government (AULG), affected Native American tribes, and Payments-Equal-to-Taxes (PETT). The proposed FY 2018 funding profile is as follows.

Funding Purpose	Proposed Amount (in thousands)
Oversight § 116(c), State of Nevada	$1,940
Oversight § 116(c), AULG	$3,493
Oversight § 118(b), Timbisha Shoshone	$194
PETT § 116(c), State of Nevada	$549
PETT § 116(c), Nye County	$3,598
PETT § 116(c), Clark County	$61
TOTAL	$9,835

Yucca Mountain and Interim Storage
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request	FY 2018 vs FY 2016
Yucca Mountain and Interim Storage				
Yucca Mountain	0	0	90,400	+90,400
Interim Storage	0	0	6,600	+6,600
Program Direction	0	0	23,000	+23,000
Total, YM and Interim Storage	**0**	**0**	**120,000**	**+120,000**
Federal FTEs			83	

[1] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Yucca Mountain and Interim Storage

Overview

The Yucca Mountain and Interim Storage programs will restart licensing activities for the Yucca Mountain nuclear waste repository and initiate a robust interim storage program. These programs will accelerate progress on fulfilling the Federal Government's obligations to address nuclear waste, enhance national security, and reduce future taxpayer burden.

The Nuclear Waste Policy Act (NWPA) of 1982 made the Department of Energy (DOE) responsible for the permanent disposal of U.S. spent nuclear fuel and high-level nuclear waste. The adoption of P.L. 107-200 in July of 2002, designated Yucca Mountain as the site for the national repository.

Consistent with the NWPA and Public Law 107-200, the Department of Energy prepared and submitted to the Nuclear Regulatory Commission (NRC) on June 3, 2008, a License Application (LA) for authorization to construct a repository at Yucca Mountain, which was accepted for docketing by the NRC on September 8, 2008. Subsequently, the previous administration terminated work on the project and sought to withdraw the license application. In 2013, the Court of Appeals for the District of Columbia Circuit issued a writ of mandamus requiring the NRC to complete its review of the license application, subject to the availability of appropriated funds. The Department is requesting funds to resume supporting the licensing review process outlined in the NWPA, as amended.

Highlights of the FY 2018 Budget Request

In FY 2018, the primary focus of the Yucca Mountain and Interim Storage programs is to resume the NRC LA process and to initiate a robust interim storage program.

The Program Direction budget has been structured to support both licensing and interim storage. Program Direction is needed for a variety of activities including the salaries of Federal Employees working in furtherance of the NWPA.

The FY 2018 Budget Request proposes funding from two separate appropriation accounts, Nuclear Waste Disposal ($90 million) and Defense Nuclear Waste Disposal ($30 million).

In addition, the FY 2018 Budget Request includes a mandatory proposal to restart the Nuclear Waste Fund Fee in FY 2020.

Yucca Mountain and Interim Storage
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[1]	FY 2018 Request
Yucca Mountain and Interim Storage			
Yucca Mountain	0	0	90,400
Interim Storage	0	0	6,600
Program Direction	0	0	23,000
Total, Yucca Mountain and Interim Storage	**0**	**0**	**120,000**

[1] The FY 2017 amount shown reflect the P.L. 114-254 continuing resolution level annualized to a full year.

Yucca Mountain and Interim Storage
Explanation of Major Changes ($K)

	FY 2016 vs FY 2018
Yucca Mountain: The increase from $0 to $90,400,000 reflects support to accelerate progress on fulfilling the Federal Government's obligations to address nuclear waste, enhance national security, and reduce future taxpayer burden by resuming the Yucca Mountain licensing process.	**+90,400**
Interim Storage: The increase from $0 to $6,600,000 reflects support to develop an interim storage capability for earlier acceptance of spent nuclear fuel.	**+6,600**
Program Direction: The increase from $0 to $23,000,000 reflects the program direction support required to resume the Yucca Mountain licensing process and support an interim storage program.	**+23,000**
Total, Yucca Mountain and Interim Storage	**+120,000**

Yucca Mountain and Interim Storage

Description
The Yucca Mountain program requests $90.4 million to restart NRC licensing activities for the Yucca Mountain nuclear waste repository. This subprogram includes the following activities: Licensing Support, Litigation, Balance of Plant Infrastructure, Project Support, and Program Management and Integration.

Licensing Support
The Budget Request supports participation in the following activities that will occur during the NRC LA review and hearing phase. These activities include: supporting the NRC administrative hearing process; providing technical and regulatory support of licensing; Safety Analysis Report updates and ongoing LA-configuration control; and consistent managing of all the technical documents, external correspondence, and external communications supporting the above activities. This Budget Request also includes funding for discovery support required during the licensing proceeding. The Budget Request supports the migration of hardware that houses OCRWM legacy systems to support accurate and timely records and information management.

As the license applicant to the NRC, DOE must comply with the licensing process and schedule established by the NWPA and applicable NRC regulations. Moreover, DOE has the burden of proof in the hearing process. To meet this burden effectively and provide NRC an appropriate and sufficient basis on which it can fulfill its statutory obligations, the DOE Office of the General Counsel staff will represent DOE in the administrative litigation aspects of the licensing process. The Office of the General Counsel also will be supported by outside legal counsel. Federal staff will address technical issues with the support of contractors and scientists from entities such as the National Laboratories. Likely activities in support of the licensing process will include:

- Appearance before the Atomic Safety Licensing Boards (ASLBs) as issues are identified and addressed through interactions with the regulator and interveners in the adjudicatory hearing process;
- Identification of likely topics for interrogatories;
- Response to admitted contentions;
- Preparation of anticipatory response plans, responses, and draft testimony and assistance in the preparation of witnesses; and
- Presentation of affirmative case in support of license application and demonstration of compliance with applicable regulatory requirements.

Litigation
The FY 2018 Budget Request provides funding for support of litigation related to the NWPA. This includes litigation related to the Standard Contract for the disposal of commercial spent nuclear fuel. Also, included is support for the management of settlement claims resulting from Standard Contract litigation.

Balance of Plant Infrastructure
The FY 2018 Budget Request provides funding for Yucca Mountain site operations and maintenance. The request provides support of license applicant requirements for continuation of Performance Confirmation Program testing at the site in accordance with requirements under 10 CFR 63, Subpart F, and ability to support access requests under 10 CFR 2 for the NRC or interveners. Activities in FY 2018 will include maintaining the safe operation of the Yucca Mountain site at appropriate levels to support performance confirmation and site access requests in support of the NRC licensing process. Yucca Mountain site operations will ensure implementation of applicable requirements to ensure safe operations, and maintaining regulatory compliance.

Project Support
Project Support includes project management, project support, and coordination activities. Project Management functions include using project management and integration for technical development and control of products, and establishing and maintaining engineering and scientific processes and procedures. Project support functions include project controls, systems engineering, information management, procurement, environmental, safety and health, and general project services (e.g., administrative services, technical support services, communications, facility and fleet operational services). It also includes compliance with National Environmental Policy Act requirements and other compliance management activities and supports and maintains databases for public sharing and systems analysis.

Program Management and Integration

The Program Management and Integration activity provides strategic integration and planning, guidance, quality assurance, budgeting, management of the Nuclear Waste Fund, and program management support in executing the Program's Mission.

A robust Quality Assurance (QA) program ensures effective implementation of requirements under 10 CFR 63.21(c)(2), and 10 CFR 63, Subpart G for nuclear quality assurance and as specified as a commitment in LA section 5.01. Effective implementation of the QA program is performed at the line level incorporating and embracing a nuclear quality culture in all work activities. A QA oversight program is maintained which performs surveillance, audits, and inspections to verify the quality of work in progress; develops and maintains the QA Requirements Description (QARD), identifies conditions adverse to quality; assures that prompt corrective actions are taken by management responsible for performing the work; and verifies the timely implementation, adequacy, and effectiveness of corrective actions.

Program Management and Control will ensure meeting requirements for effective interaction and responsiveness to questions and inquiries by the U.S. Congress, the Office of Management and Budget (OMB), regulatory and oversight bodies, other federal, State, and local government agencies, international entities, program customers and stakeholders, and the public at large. The program will support, as appropriate, international agreements and collaborations. Implementation of an appropriate investment strategy and the prudent management of the Nuclear Waste Fund investment portfolio are also essential to fulfilling the program's fiduciary responsibility under the NWPA.

Safeguards and Security (S&S) functions necessary to support NRC licensing will be resumed. DOE Order requirements for physical security and access control (e.g., badging) will be met. Development of safeguard and security strategies to meet LA commitments, NRC requirements, and Department of Homeland Security requirements will resume in a limited fashion.

The Fee Adequacy Assessment is a requirement of Section 302(a) of the NWPA 1982, as amended, where by the Secretary is to determine annually the adequacy of the fee charged to generators of commercial spent nuclear fuel. In FY 2018, the Department will begin developing a new Fee Adequacy Assessment. The fee adequacy assessment will utilize the prior information used to prepare prior cost estimates until new information is available. The assessment of the fee will utilize updated economic projections and the existing defense and civilian share calculations to ensure that the program remains a full cost recovery program, as required by the NWPA. Activities include interfacing with the Nuclear Waste Fund managers for investment projections, updating the economic forecasts, and interfacing with external auditors for the Department. Additional activities include responding to inquiries on the adequacy of the fee.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2016 vs FY 2018
$0	**$90,400,000**	**+$90,400,000**
	• Undertake pre-closure and post-closure analytical activities, as required, to respond to potentially multiple rounds of highly technical, detailed questions; • Provide technical, scientific, and legal support for court challenges; • Maintain and update the LA and supporting documents as issues resulting from contentions are resolved; • Ensure effective LA configuration control and consistency with supporting documents; • Prepare and review depositions; • Prepare DOE witnesses and testimony for ASLB hearings; • Address discovery, including derivative discovery; • Prepare and respond to interrogatories, and; • Provided support for motions and other legal actions. • Maintain control of all geologic specimens and facilities needed to support licensing efforts • Develop a comprehensive communications strategy that will support the Department's obligation to provide effective and responsive communications with other government agencies, affected units of local government, and Native American tribes and the public.	• The increase supports activities required to restart licensing activities for the Yucca Mountain nuclear waste repository.

Yucca Mountain and Interim Storage

Description

The primary mission of the Interim Storage program is to develop an interim storage capability for earlier acceptance of spent nuclear fuel (SNF).

Nuclear technology has been used in the United States for national defense, research and development, and electric power generation. These activities have produced a large quantity of SNF and high-level radioactive waste (HLW). The largest inventory of SNF comes from commercial electricity generation: approximately 78,000 metric tons of uranium (MTU) through the end of 2016 with potential growth to 140,000 MTU with the current reactor fleet. Nearly all the existing commercial SNF is being stored at the reactor sites where it was generated. Of the 74 commercial reactor sites, 14 sites no longer have an operating reactor. Under current law, the federal government, and specifically DOE, is responsible for providing the safe and permanent disposal of SNF and HLW. Under the NWPA, DOE was to begin accepting SNF and removing it from sites by 1998. Because of the challenges seen in trying to open a repository for SNF and HLW, liabilities due to the partial breach of contract with the utilities will grow to an estimated $23.7 billion by 2071 if waste acceptance begins in 2021, and each year of extension to the start date adds up to $500 million to the federal government's liability. Interim storage of SNF may provide a near-term opportunity for the U.S. Government to begin fulfilling its obligations. Additionally, implementation of interim storage can bring the following added benefits:

- Earlier acceptance of fuel by the federal government;
- Reduction in the number of dispersed storage sites;
- Added system flexibility and opportunity for better integration; and
- Near-term development and demonstration of institutional and technical infrastructures for large-scale management of SNF.

Under this program, activities will be pursued to:

- Develop and plan for a competitive solicitation for commercial interim spent fuel storage services or pursue a federal site for interim storage;
- Accelerate transportation planning, procurements, and NEPA analyses to support a near-term capability for transporting SNF and HLW shipments; and
- Maintain important engagement with regional, state, and tribal transportation authorities to prepare for SNF and HLW shipments; and
- Maintain logistical requirements and analytical capabilities previously developed under the Fuel Cycle Research and Development program.

Interim Storage

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2016 vs FY 2018
$0	**$6,600,000**	**+$6,600,000**
	• Initiate planning for and development of a competitive solicitation for commercial interim spent fuel storage services. • Initiate activities to accelerate transportation planning, procurements, and NEPA analyses to support a near-term capability for transporting SNF and HLW. • Maintain important engagement with regional, state, and tribal transportation authorities to prepare for future SNF and HLW shipments. • Maintain minimal support for logistical requirements and analytical capabilities.	• The increase supports the planning and development activities to initiate a competitive solicitation for commercial interim SNF storage services. • This increase also carries forward some activities initiated under the Fuel Cycle and Research Development program to maintain important engagement with regional, state, and tribal transportation authorities and minimal logistical requirements and analytical capabilities to prepare for future SNF and HLW shipments. • This increase also initiates new activities to accelerate transportation planning, procurements, and NEPA analyses to support a near-term capability for transporting SNF and HLW.

Program Direction

Overview

Program Direction provides the federal staffing resources and associated costs required to support the overall direction and execution of the Yucca Mountain and Interim Storage programs. The programs have staff located in two locations: Washington, D.C. and Las Vegas, NV.

Washington D.C. staff for the Yucca Mountain and Interim Storage programs includes the Office of the General Counsel and Energy Information Administration staff responsible for administrative activities and judicial litigation associated with the restart of the Yucca Mountain Nuclear Waste Repository project, legal issues related to the standard contract, and the Department's responsibilities regarding spent nuclear fuel (SNF) and high level waste (HLW), as specified by the Nuclear Waste Policy Act (NWPA).

The Support Services subprogram allows the Department to cost-effectively hire the best available industry experts to support federal staff in managing the nuclear programs and complex activities. The ability to acquire expertise quickly and on an "as needed basis" provides unlimited flexibility in team composition as the needs of the Yucca Mountain and Interim Storage programs evolve. Program Direction also includes the Other Related Expenses subprogram, which provides funding to the Department's Working Capital Fund (WCF) for common administrative services at Headquarters (HQ). The Department is working to achieve economies of scale through an enhanced WCF. The WCF supports specific Departmental services and activities that are shared across DOE including: enhanced cyber security architecture, employee health and testing services, and consolidated training and recruitment initiatives. These were all established in previous fiscal years and are supported in FY 2018.

Highlights of the FY 2018 Budget Request

The Yucca Mountain and Interim Storage programs' Program Direction request supports 83 federal staff. The program requires a significant commitment of human capital to assure consistency with federal policies and strategies in the planning, engagement, responsiveness, and the adaptation of plans that address changing and dynamic conditions. The Budget Request includes additional staffing for the program office to ensure there is appropriate guidance and oversight throughout the program. Of the 83 funded staff, 53 will be re-aligned from staff currently funded by other DOE Program Direction budgets. 30 new staff members will be hired to provide additional Yucca Mountain license application support activities.

Funding in Program Direction is allocated between Yucca Mountain licensing activities and development of a robust interim storage program as shown in the table below.

($ in Thousands)

	Yucca Mountain	Interim Storage	Total
Yucca Mountain	90,400		90,400
Interim Storage		6,600	6,600
Program Direction	19,600	3,400	23,000
Total	110,000	10,000	120,000

Program Direction Funding ($K)

	FY 2016 Enacted	FY 2017 Enacted Annualized CR[1]	FY 2018 Request
Program Direction Summary			
Washington Headquarters			
Salaries and Benefits	-	-	12,372
Travel	-	-	475
Support Services	-	-	1,277
Other Related Expenses	-	-	1,540
Total, Washington Headquarters	**-**	**-**	**15,664**
Las Vegas, NV			
Salaries and Benefits	-	-	6,468
Travel	-	-	175
Support Services	-	-	473
Other Related Expenses	-	-	220
Total, Las Vegas, NV	**-**	**-**	**7,336**
Total Program Direction			
Salaries and Benefits	-	-	18,840
Travel	-	-	650
Support Services	-	-	1,750
Other Related Expenses	-	-	1,760
Total, Program Direction	**-**	**-**	**23,000**
Federal FTEs	**-**	**-**	**83**

	FY 2016 Enacted	FY 2017 Enacted Annualized CR[1]	FY 2018 Request
Support Services			
Technical Support	-	-	
Mission Related	-	-	520
Advisory and Assistance	-	-	120
Total, Technical Support	-	-	640
Management Support			
Administrative	-	-	510
IT	-	-	600
Total Management Support	-	-	1,100
Total, Support Services	**-**	**-**	**1,750**
Other Related Expenses			
Working Capital Fund	-	-	1,200
Training	-	-	85
Miscellaneous	-	-	255
Rents and Utilities	-	-	220
Total, Other Related Expenses	**-**	**-**	**1,760**

[1] The FY 2017 amount shown reflects the P.L. 114-254 continuing resolution level annualized to a full year.

Program Direction

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2016 vs FY 2018
Program Direction $0	**$23,000,000**	**+$23,000,000**
Salaries and Benefits $0	**$18,840,000**	**+$18,840,000**
	Provides salaries and benefits for 83 federal staff.	53 employees funded in FY 2016 within other program direction budgets are transferred to support this new program. An additional 30 employees will be required to support this new program.
Travel $0	**$650,000**	**+$650,000**
	Provides for travel of the federal staff including any necessary permanent change of duty status costs.	Supports necessary travel required for evolving programmatic requirements of this new program.
Support Services $0	**$1,750,000**	**+$1,750,000**
	Provides for technical and administrative support services for the NE federal staff.	Provides for technical and administrative support services for the Nuclear Energy federal staff including access to and participation with external and international nuclear energy organizations such as the Organization for Economic Co-operation and Development/Nuclear Energy Agency.
Other Related Expenses $0	**$1,760,000**	**+$1,760,000**
	Provides for NE's share of goods and services procured through the Department's Working Capital Fund; rents and utilities associated with the Nevada Site Office; federal training expenses; and other miscellaneous expenses.	Services procured through the WCF will be required to support the administrative functions of the new program as well as training, rent and utilities associated with the Nevada Site Office, along with other miscellaneous costs.

Yucca Mountain and Interim Storage
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Yucca Mountain - Complete 90% of annual program milestones to restart licensing activities for the Yucca Mountain nuclear waste repository and initiate a robust interim storage program.**		
Target	N/A	N/A	90 % of annual milestones met
Result	N/A	N/A	TBD
Endpoint Target	N/A		

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Waste Disposal	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Argonne National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	800
Total, Argonne National Laboratory	**0**	**0**	**800**
Idaho National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	10
Total, Idaho National Laboratory	**0**	**0**	**10**
Idaho Operations Office			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	2,940
Total, Idaho Operations Office	**0**	**0**	**2,940**
Lawrence Berkeley National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	840
Total, Lawrence Berkeley National Laboratory	**0**	**0**	**840**
Los Alamos National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	840
Total, Los Alamos National Laboratory	**0**	**0**	**840**
Nevada Field Office			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	40,736
Total, Nevada Field Office	**0**	**0**	**40,736**
Oak Ridge National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	1,130
Total, Oak Ridge National Laboratory	**0**	**0**	**1,130**
Pacific Northwest National Laboratory			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	910
Total, Pacific Northwest National Laboratory	**0**	**0**	**910**
Sandia National Laboratories			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	35,480
Total, Sandia National Laboratories	**0**	**0**	**35,480**

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Nuclear Waste Disposal	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Savannah River Operations Office			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	1,050
Total, Savannah River Operations Office	**0**	**0**	**1,050**
Washington Headquarters			
Yucca Mountain and Interim Storage			
Yucca Mountain and Interim Storage	0	0	35,264
Total, Washington Headquarters	**0**	**0**	**35,264**
Total, Nuclear Waste Disposal	**0**	**0**	**120,000**

Advanced Reasearch Projects Agency-Energy

Advanced Reasearch Projects Agency-Energy

Advanced Research Projects Agency – Energy
(INCLUDING CANCELLATION OF FUNDS)
Proposed Appropriation Language

For Department of Energy administrative expenses necessary in carrying out the activities authorized by section 5012 of the America COMPETES Act (Public Law 110–69), $20,000,000, to remain available until September 30, 2019: Provided, That of the unobligated balances from prior year appropriations available under this heading, $46,367,000 is hereby permanently cancelled: Provided further, That no amounts may be cancelled from amounts that were previously designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That of the funding made available under this heading for ARPA-E projects in prior Acts, $45,000,000 shall be available for program direction, to remain available until expended: Provided further, That no amounts may be repurposed pursuant to this paragraph from amounts that were designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

The $20,000,000 request for FY 2018 is a $271,000,000 decrease from the FY 2016 enacted level and will be used, along with the requested $45,000,000 use of prior year balances, to execute the termination of the Advanced Research Projects Agency – Energy.

Public Law Authorizations
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-58, "Energy Policy Act of 2005"
P.L. 110-69, "America COMPETES Act of 2007"
P.L. 111-358, "America COMPETES Reauthorization Act of 2010"

Advanced Research Projects Agency - Energy
($K)

FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request[1]
291,000	290,446	20,000

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Overview

The Advanced Research Projects Agency-Energy (ARPA-E) was established by the America COMPETES Act of 2007 following a recommendation by the National Academies in the *Rising above the Gathering Storm* report. As defined by its authorization, ARPA-E catalyzes transformational energy technologies to enhance the economic and energy security of the United States.

As of February 2017, ARPA-E has funded over 580 projects with approximately $1.5 billion through 39 focused programs and open funding solicitations.

Highlights and Major Changes in the FY 2018 Budget Request

The Budget Request proposes to eliminate ARPA-E as described in the President's "America First – A Budget Blueprint to Make America Great Again." No additional "ARPA-E Projects" funding is requested to fund new program development. $20 million in new program direction appropriations is requested to manage existing projects in FY 2018 and begin office closure.

In addition, ARPA-E requests $45 million of prior-year carryover balances previously appropriated for Projects, be reallocated to Program Direction to complete office closure. All Project funds appropriated in prior years would be executed according to prior year appropriation acts, with the exception of the balances that are requested to be cancelled or repurposed. ARPA-E operations would wind down in 2018 and the office would shut down in FY 2019, at which point remaining monitoring and contract closeout activities would be transferred elsewhere within DOE. The Budget assumes that a plan will be developed in FY 2018 to ensure that prudent monitoring and management of ARPA-E contracts and responsible stewardship of taxpayer funds continues after the ARPA-E office closes.

[1] The FY 2018 request also includes a cancellation of $46,367,000 thus the net appropriation for this account is -$26,367,000.

Advanced Research Projects Agency - Energy
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
ARPA-E Projects	261,750	261,252	0	-261,750
Program Direction	29,250	29,194	65,000	35,750
Subtotal, Advanced Research Projects Agency - Energy	**291,000**	**290,446**	**65,000**	**-226,000**
Use of Prior Year Balances	0	0	-45,000	-45,000
Total, Advanced Research Projects Agency - Energy	**291,000**	**290,446**	**20,000**	**-271,000**
Federal FTEs	**56**	**56**	**44**	**-12**

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

SBIR/STTR:

- FY 2016 Current: $10,485 total (SBIR $8,124 / STTR $2,361)
- FY 2017 Projected: $9,536 total (SBIR $8,360 / STTR $1,176)
- FY 2018 Request[1]: $0 total (SBIR $0 / STTR $0)

[1] In FY 2018, ARPA-E is not requesting any Project funding and as such will not make additional Small Business Innovation Research / Small Business Technology Transfer

ARPA-E Projects

Overview

No funding is requested in FY 2018 for the ARPA-E Projects program.

ARPA-E Projects
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
ARPA-E Projects				
Transportation Systems	104,700	---	0	-104,700
Stationary Power Systems	157,050	---	0	-157,050
Total, ARPA-E Projects	**261,750**	**261,252**	**0**	**-261,750**

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

SBIR/STTR:

- FY 2016 Current: $10,485 total (SBIR $8,124 / STTR $2,361)
- FY 2017 Projected: $9,536 total (SBIR $8,360 / STTR $1,176)
- FY 2018 Request[1]: $0 total (SBIR $0 / STTR $0)

[1] In FY 2018, ARPA-E is not requesting any Project funding and as such will not make additional Small Business Innovation Research / Small Business Technology Transfer (SBIR/STTR) program investments using FY 2018 budget authority.

ARPA-E Projects
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Transportation Systems: The Transportation Systems request for FY 2018 is a 104,700 decrease from the FY 2016 enacted level and terminates this activity.	**-104,700**
Stationary Power Systems: The Stationary Power Systems request for FY 2018 is a 157,050 decrease from the FY 2016 enacted level and terminates this activity.	**-157,050**
Total, ARPA-E Projects	**-261,750**

ARPA-E Projects

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
$261,750,000	**$0**	**- $261,750,000**
In FY 2016 ARPA-E released funding opportunity announcements for seven focused programs and awarded $201M to 77 projects for the following technology programs: • $31M (14 projects) to develop innovative materials that will improve the energy efficiency of existing single-pane windows in commercial and residential buildings (SHIELD) • $25M (9 projects) creating innovative components to increase energy efficiency of datacenters (ENLITENED) • $35M (10 projects) technologies that develop new crop breeding approaches for improved root and soil function plants to store more carbon in the ground and take up nutrients and water more efficiently (ROOTS) • $35M (16 projects) develop technologies that use renewable energy to convert air and water into cost-competitive liquid fuels (REFUEL) • $34M (11 projects) create new control technologies that reduce energy consumption of future vehicles by using connectivity and vehicle automation (NEXTCAR) • $3.5M (1 project) to build and operate a testing facility for ARPA-E's MONITOR project teams (MONITOR Test Site) • $37M (16 projects) for developing new processing methods and approaches to device integration to accelerate devices built with high performance ion-conducting solids to commercial deployment (IONICS)	No Project funding requested in FY 2018.	The Budget Request proposes to eliminate ARPA-E with operations winding down in 2018 and the office shutting down in FY 2019, at which point remaining monitoring and contract closeout activities would be transferred elsewhere within DOE. All prior year Project funds would be executed according to prior year appropriations, with the exception of the balances that are requested to be cancelled or repurposed.

ARPA-E
Advanced Research Projects Agency - Energy
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Award Funding - Cumulative percentage of award funding committed 45 days after award selections are announced**		
Target	≥ 70 %	≥ 70 %	N/A
Result	Met – 100	TBD	N/A
Endpoint Target	Measure of efficiency in awarding funds.		

Performance Goal (Measure)	**New Company Formation - Number of new companies formed as a direct result of ARPA-E funding. This is a new performance measure for ARPA-E in FY 2015. As of the end of FY 2013 ARPA-E funded research has led to the formation of at least 24 new companies. That is the baseline from which we would expect to add at least 3 new companies per year.**		
Target	≥ 3 new companies founded	≥ 3 new companies founded	N/A
Result	Met	TBD	N/A
Endpoint Target	Measure of impact of ARPA-E awards on creating new jobs and industries.		

Program Direction – Discretionary Budget Request

Overview

Program Direction provides ARPA-E with the resources required for salaries and benefits of federal staff; travel; support services contracts to provide technical advice and project management assistance; and other related expenses, including the DOE Working Capital Fund.

The ARPA-E Program Directors and Technology-to-Market (T2M) advisors provide awardees with technical guidance, business insight and direction to ensure technical and commercial milestones are achieved by established deadlines. When a project is not achieving the goals of the program, ARPA-E works with the awardee to rectify the issue or, in cases where the issue cannot be corrected, ARPA-E discontinues funding for the project. ARPA-E also has in-house legal, procurement, and contracting staff, co-located with the Program Directors and T2M advisors, to provide additional support. ARPA-E uses support contractors for technical advice and program management assistance.

Highlights of the FY 2018 Budget Request

The FY 2018 Request for Program Direction is $20 million, a $9.25 million decrease from the FY 2016 Enacted level. ARPA-E proposes to supplement the $20 million in new Program Direction appropriations with $45 million in prior year balances.

ARPA-E fully funds (obligates) projects up front and reimburses projects as costs are incurred. Current ARPA-E projects are funded until FY 2021 and require Federal stewardship for meaningful impact. ARPA-E will begin a scale down of both Federal and Contractor staff in FY 2018 and will close the office in FY 2019 with ongoing project management being transferred elsewhere in DOE. The Budget assumes that a plan will be developed in FY 2018 to ensure that prudent monitoring and management of ARPA-E contracts and responsible stewardship of taxpayer funds continues after the ARPA-E office closes.

Program Direction – Appropriations Request
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request	FY 2018 vs FY 2016
Washington Headquarters				
Salaries and Benefits	10,103	--	8,414	-1,689
Travel	1,316	--	769	-547
Support Services	12,858	--	15,066	2,208
Other Related Expenses	4,973	--	4,637	-336
Office Closure Activities Post FY 2018	0	--	36,114	36,114
Subtotal, Program Direction	**29,250**	**29,194**	**65,000**	**35,750**
Use of Prior Year Balances	0	0	-45,000	-45,000
Total, Program Direction	**29,250**	**29,194**	**20,000**	**-9,250**
Federal FTEs	**56**	**56**	**44**	**-12**
Support Services				
Technical Support	4,500	--	5,273	773
Management Support	8,358	--	9,793	1,435
Total, Support Services	**12,858**	**--**	**15,066**	**2,208**
Other Related Expenses				
Rental payments to GSA	2,283	--	2,140	-143
Communications, utilities, and misc. charges	550	--	511	-39
Printing and reproduction	10	--	9	-1
Other services from non-Federal sources	475	--	441	-34
Other goods and services from Federal sources	1,550	--	1,439	-111
Supplies and materials	105	--	97	-8
Total, Other Related Expenses	**4,973**	**--**	**4,637**	**-336**

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Program Direction $29,250,000	**$65,000,000**	**$37,750,000**
Salaries and Benefits $10,103,000	**$8,414,000**	**-$1,689,000**
At the FY 2016 Enacted level, ARPA-E anticipates needing up to 56 Federal FTEs.	At the FY 2018 Request level, ARPA-E anticipates needing up to 44 Federal FTEs.	Reduced salaries and benefits is the result of a planned reduction in federal staff, which will be achieved through a continued hiring freeze and review of where functional consolidation and position reductions can be most effectively achieved. This results in 44 annualized FTEs; 37 projected FTEs at the end of FY 2018. Additional workforce restructuring efforts will be designed through the management and monitoring plan to be developed for ARPA-E in FY 2018.
Travel $1,316,000	**$769,000**	**-$547,000**
At the FY 2016 Enacted level, ARPA-E Program Directors and Technology-to-Market advisers visited performers to monitor ongoing project status.	At the FY 2018 Request level, ARPA-E Program Directors and Technology-to-Market advisers will continue to visit performers to monitor ongoing project status.	-$547,000: Travel reduction commensurate with project reduction.
Support Services $12,858,000	**$15,066,000**	**$2,208,000**
At the FY 2016 Enacted level, ARPA-E maintained support service contractors to support ARPA-E federal staff in the management and oversight of projects and other required functions.	At the FY 2018 Request level, ARPA-E anticipates decreasing support service contractors as projects conclude. Support service contractors will support ARPA-E federal staff in the management and oversight of projects and other required functions.	+$2,208,000: Increase from FY 2016 Enacted levels. However, actual FY 2016 support service cost was $19,569,000 – funded through carryover of unobligated funding from FY 2015. Effective FY 2018 reduction from FY 2016 actual level is -$4,503,000.
Other Related Expenses $4,973,000	**$4,637,000**	**-$336,000**
The FY 2016 Enacted level for other related expenses primarily consists of Working Capital Fund and Information Technology support costs, which are commensurate with the level of FTEs and support services requested.	The FY 2018 Request level for other related expenses primarily consists of Working Capital Fund and Information Technology support costs, which are commensurate with the level of FTEs and support services requested.	-$336,000: Decrease in WCF overhead fund due to staffing reductions.
Office Closure Activities Post FY 2018 $0	**$36,114,000**	**$36,114,000**

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
New activity in FY 2018.	A plan will be developed in FY 2018 to ensure that prudent monitoring and management of ARPA-E contracts and responsible stewardship of taxpayer funds continues after the ARPA-E office closes. The Office Closure Activities Post FY 2018 line will provide funding to complete ARPA-E office closure and cover the estimated cost to manage the current projects through completion from FY 2019 to FY 2021.	Funding provides for closure of the ARPA-E office and award monitoring and management activities.

Advanced Research Projects Agency - Energy
Research and Development ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request**	FY 2018 vs FY 2016
Basic	0	0	0	0
Applied	145,500	145,223	0	-145,500
Development	145,500	145,223	0	-145,500
Subtotal, R&D	291,000	290,446	0	-291,100
Equipment	0	0	0	0
Construction	0	0	0	0
Total, R&D	**291,000**	**290,446**	**0**	**-291,000**

Advanced Research Projects Agency - Energy
Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) ($K)

	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request**	FY 2018 vs FY 2016
ARPA-E Projects				
SBIR	8,124	8,630	0	-8,124
STTR	2,361	1,176	0	-2,361
Total, SBIR/STTR	**10,485**	**9,806**	**0**	**-10,485**

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

**In FY 2018, ARPA-E is not requesting any Project funding and as such will not conduct any new R&D or make additional Small Business Innovation Research / Small Business Technology Transfer (SBIR/STTR) program investments using FY 2018 budget authority.

Department of Energy
FY 2018 Congressional Budget
Funding By Appropriation By Site

($K)

Advanced Researched Projects Agency-Energy	FY 2016 Enacted	FY 2017 Annualized CR*	FY 2018 Request
Washington Headquarters			
Advanced Researched Projects Agency-Energy			
Projects	261,750	261,252	0
Program Direction	29,250	29,194	20,000
Total, Advanced Researched Projects Agency-Energy	**291,000**	**290,446**	**20,000**
Total, Washington Headquarters	**291,000**	**290,446**	**20,000**
Total, Advanced Researched Projects Agency-Energy	**291,000**	**290,446**	**20,000**

*FY 2017 amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above, below that level, a dash (-) is shown.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Advanced Researched Projects Agency-Energy	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Advanced Researched Projects Agency-Energy			
Projects	261,750	261,252	0
Program Direction	29,250	29,194	20,000
Total, Advanced Researched Projects Agency-Energy	**291,000**	**290,446**	**20,000**
Total, Washington Headquarters	**291,000**	**290,446**	**20,000**
Total, Advanced Researched Projects Agency-Energy	**291,000**	**290,446**	**20,000**

Advanced Technology Vehicles Manufacturing Loan Program

Advanced Technology Vehicles Manufacturing Loan Program

Advanced Technology Vehicles Manufacturing Loan Program
(Including Cancellation of Funds)
Proposed Appropriation Language

Of the unobligated balances available from amounts appropriated for the cost of direct loans in section 129 of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (Public Law 110–329), $4,311,615,000 is hereby permanently cancelled.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

The President's FY2018 Budget eliminates the ATVM Loan Program. The Loan Programs Office will utilize unobligated balances carried forward from prior year appropriations to cover loan portfolio monitoring and administrative expenses: including salaries for its full time employees as well as the cost of outside advisors for financial, legal, engineering, credit, and market analysis in addition to the cost of monitoring the existing portfolio. Program's FY 2018 appropriation request is $0. All activities not essential for the continued monitoring of the portfolio will be terminated. LPO is not requesting any new loan authority under the ATVM program and no funding is requested for administrative expenses in FY 2018.

Public Law Authorizations

- P.L. 110-140,Energy Independence and Security Act of 2007
- P.L. 110–329, Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009

Advanced Technology Vehicles Manufacturing Loan Program
($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request
Administrative Appropriations	$6,000	$5,989	$0
Loan Subsidy Rescission			-$4,311,615[b]

Overview

To support the Administration's commitment to reasserting the proper role of what has become a sprawling Federal Government and reducing deficit spending, the FY2018 President's Budget reflects an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies and focuses resources toward early-stage research and development. This program is being eliminated in the FY 2018 Budget in accordance with Administration priorities, including the focusing of resources toward early-stage research and development. The Loan Programs Office will wind down operations in FY 2018 with the expectation that it will shut down in FY 2019 with remaining loan monitoring and closeout activities transferred to another office. In addition, the Budget proposes to cancel all remaining appropriated credit subsidy.

History

Section 136 of the Energy Independence and Security Act of 2007 established the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program, consisting of direct loans of up to $25 billion in total loan authority to support the development and manufacturing of advanced technology vehicles and associated components in the U.S. The ATVM Loan Program issued 5 total loans, of which $8.06 billion has been obligated and $7.28 billion has been disbursed.

Organization

LPO currently utilizes five interdependent divisions to proactively monitor the portfolio: Portfolio Management Division (PMD), the Risk Management Division (RMD), Technical and Project Management Division (TPMD), Legal Division, and Management Operations Division (MOD).

The Portfolio Management Division (PMD) lead LPO's monitoring functions by approving disbursements, repayments, operating budgets, and long-term forecasts. In the event of non-payment and/or default, PMD leads activities to maximize recoveries either through bankruptcy, note sale, or compromise of the claim. PMD and the Risk Management Division (RMD) also conduct continuous risk assessments of the assets in the portfolio to comply with regulatory requirements such as OMB Circular No. A-129 of the Federal Credit Reform Act of 1990.

The Technical and Project Management Division (TPMD) evaluates technical performance of assets and project management throughout the entire lifecycle of the loan to ensure that the technical requirements of the loan agreement are met. TPMD conducts site visits, provides expertise on project construction status and budget, and identifies potential technical risks that inhibit the borrower's ability to meet requirements and repay the loan. TPMD acts as the lenders' engineers for LPO and evaluates the innovative technical financing, monitoring the portfolio to ensure reasonable prospect of repayment.

LPO Legal Division provides monitoring of loan guarantee agreements and terms of the portfolio and its borrowers to ensure reasonable prospect of repayment. Additionally, Legal Division supports all on-going monitoring activities,

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] Subsidy amounts provided section 129 of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (Public Law 110–329) is rescinded.

negotiations and documentations of waivers, consents, routine loan amendments, approvals and denials of transfer withdrawals, and legal aspects of any project developments.

In FY 2018 LPO will consolidate and streamline the organizational structure of monitoring activities to effectively manage the portfolio of loans while minimizing the administrative burden. In addition, LPO will explore options to reduce or mitigate the expected administrative cost of monitoring over the tenor of the remaining loans. The Loan Programs Office will wind down operations in FY 2018 with the expectation that it will shut down in FY 2019 with remaining loan monitoring and closeout activities transferred to another office

Highlights and Major Changes in the FY 2018 Budget Request

In FY 2018, LPO will commence termination of ATVM direct loan activities and continue to monitor the existing portfolio. As a result of this program change, LPO is requesting no FY 2018 appropriation for its administrative budget and will operate on prior year funds in FY 2018.

Advanced Technology Vehicles Manufacturing Loan Program
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Advanced Technology Vehicles Manufacturing Loan Program				
Administrative Operations, ATVM	6,000	5,989	$0	-6,000
Total, Advanced Technology Vehicles Manufacturing Loan Program	**6,000**	**5,989**	**$0**	**-6,000**
Federal FTEs	**14**	**16**	**4**	**-10**
Loan Subsidy Rescission			**-4,311,615[b]**	

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] Subsidy amounts provided section 129 of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (Public Law 110–329) is rescinded.

Advanced Technology Vehicles Manufacturing Loan Program
Administrative Operations
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[c]	FY 2018 Request
Administrative Operations			
Salaries & Benefits	2,500	3,849	0
Travel	150	130	0
Support Services	2,600	1,390	0
Other Related Expenses	750	620	0
Total, Administrative Operations	**6,000**	**5,989**	**0**

[c] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Administrative Operations
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Administrative Operations	
Salaries and Benefits: LPO will utilize unobligated balances carried forward from prior appropriations to provide salaries and benefits for 4 full time equivalent employees (FTEs).	-2,500
Travel: LPO will utilize unobligated balances carried forward from prior appropriations to support the travel of staff members for site visits, training, and attending meetings and conferences.	-150
Support Services: LPO will utilize unobligated balances carried forward from prior appropriations to support outside expertise in finance, legal, engineering, technology, credit analysis, and market assessments.	-2,600
Other Related Expenses: LPO will utilize unobligated balances carried forward from prior appropriations to support DOE Working Capital Fund and LPO federal staff training.	-750
Total, Administrative Operations	**-6,000**

Administrative Operations

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016 Enacted
Administrative Operations $6,000,000		**-$6,000,000**
Salaries and Benefits $2,500,000	**$0**	**-$2,500,000**
• Provide salaries and benefits to 14 full time equivalent employees to administer the following functions to the office: Director, Legal, Loan Origination, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities.
Travel $150,000	**$0**	**-$150,000**
• Continuation of FY 2015 activities. Supports the travel of staff members for site visits, training, and attending meetings and conferences.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities.
Support Services $2,600,000	**$0**	**-$2,600,000**
• Continuation of FY 2015 activities. Provides range of contract services including administrative support, subject matter experts, legal services, information technology, and publications.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities.
Other Related Expenses $750,000	**$0**	**-$750,000**
• Continuation of FY 2015 activities. Supports DOE Working Capital Fund, DOE IT services and expenses, and ATVM federal staff training.	• No funding is requested.	LPO will operate on unobligated balances carried forward for FY 2018 activities.

Advanced Technology Vehicles Manufacturing Loan Program
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**ATVM Battery Production Capacity - Battery production capacity of 100,000 lithium-ion EV batteries (2,400,000 kWh) established**		
Target	≥ 100,000 Batteries	≥ 100,000 Batteries	≥ 100,000 Batteries
Result	Met - 100,000	TBD	TBD
Endpoint Target	Assist in the development of advanced battery manufacturing capacity to support electric vehicles.		
Performance Goal (Measure)	**ATVM Reduction in Petroleum Usage - Reduction in petroleum usage (in millions of gallons of fuel per year) achieved through the use of advanced technology vehicles manufactured (at least in part) with funding provided through the ATVM loan program as compared to vehicles available in the base year.**		
Target	290 Million Gallons	290 Million Gallons	270 Million Gallons
Result	Not Met - 270	TBD	TBD
Endpoint Target	Assist in the reduction of petroleum usage.		

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Advance Technology Vehicles Man Loan Program	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Energy Transformation Acceleration Fund			
Administrative Expenses	6,000	5,989	0
Total, Washington Headquarters	**6,000**	**5,989**	**0**
Total, Advance Technology Vehicles Man Loan Program	**6,000**	**5,989**	**0**

Title 17 Innovative Technology Loan Guarantee Program

Title 17 Innovative Technology Loan Guarantee Program

Title 17 Innovative Technology Loan Guarantee Program
(Including Cancellation of Funds)
Proposed Appropriation Language

Such sums as are derived from amounts received from borrowers pursuant to section 1702(b) of the Energy Policy Act of 2005 under this heading in prior Acts, shall be collected in accordance with section 502(7) of the Congressional Budget Act of 1974: Provided, That for necessary administrative expenses to carry out this Loan Guarantee program,$2,000,000 is appropriated, to remain available until September 30, 2019: Provided further, That $2,000,000 of the fees collected pursuant to section 1702(h) of the Energy Policy Act of 2005 shall be credited as offsetting collections to this account to cover administrative expenses and shall remain available until expended, so as to result in a final fiscal year 2018 appropriation from the general fund estimated at not more than $0: Provided further, That fees collected under section 1702(h) in excess of the amount appropriated for administrative expenses shall not be available until appropriated: Provided further, That the Department of Energy shall not subordinate any loan obligation to other financing in violation of section 1702 of the Energy Policy Act of 2005 or subordinate any Guaranteed Obligation to any loan or other debt obligations in violation of section 609.10 of title 10, Code of Federal Regulations: Provided further, That the authority provided in prior year appropriations Acts for commitments to guarantee loans under title XVII of the Energy Policy Act of 2005, excluding amounts for commitments made by October 1, 2017, is hereby permanently cancelled: Provided further, That of the unobligated balances from prior year appropriations available under this heading in the American Recovery and Reinvestment Act of 2009 (Public Law 111–5) for the cost to guarantee loans, $383,433,000 is hereby permanently cancelled.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Explanation of Changes

The President's FY2018 Budget eliminates the Title 17 Innovative Technology Loan Guarantee Program. In addition to $2,000,000 in appropriation offset by $2,000,000 in collections, the Loan Programs Office will utilize unobligated balances carried forward from prior year appropriations to cover loan portfolio monitoring and administrative expenses; including salaries for its full time employees as well as the cost of outside advisors for financial, legal, engineering, credit, and market analysis in addition to the cost of monitoring the existing portfolio. Program's final FY 2018 appropriation request is $0. All activities not essential for the continued monitoring of the portfolio will be terminated. LPO will terminate loan origination activities and is not requesting any new loan authority under the Title XVII program.

Public Law Authorizations

- P.L. 109-58, Energy Policy Act of 2005
- P.L. 110-5, Revised Continuing Appropriations Resolution, 2007
- P.L. 111-5, American Recovery and Reinvestment Act of 2009
- P.L. 111-8, Omnibus Appropriations Act, 2009
- P.L. 112-10, Department of Defense and Full-Year Continuing Appropriations Act, 2011

Title 17 Innovative Technology Loan Guarantee Program
($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request
Administrative Appropriations	$17,000	$14,920	$0
Loan Subsidy Rescission			-$383,433[b]

Overview

To support the Administration's commitment to reasserting the proper role of what has become a sprawling Federal Government and reducing deficit spending, the FY2018 President's Budget reflects an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies and focuses resources toward early-stage research and development. This program is being eliminated in the FY 2018 Budget in accordance with Administration priorities, including the focusing of resources toward early-stage research and development. The Loan Programs Office will wind down operations in FY 2018 with the expectation that it will shut down in FY 2019 with remaining loan monitoring and closeout activities transferred to another office.

The Budget eliminates the Title XVII program and proposes to cancel all remaining loan volume authority. In addition, the Budget proposes to cancel $383 million in unobligated credit subsidy appropriated by the American Reinvestment and Recovery Act of 2009 (Public Law 111–5) while retaining $96 million to cover the cost of potential modifications as determined in the national interest by Presidential waiver from rescission under Sec 1306 of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Pub. L 111–203).

History

Section 1703 of the Energy Policy Act of 2005 authorizes DOE to provide loan guarantees for innovative energy projects in categories including renewable energy systems, advanced nuclear facilities, coal gasification, carbon sequestration, energy efficiency, and various other types of projects. Projects supported by DOE loan guarantees must avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases; employ new or significantly improved technologies compared to commercial technologies in service in the United States at the time the guarantee is issued; and offer a reasonable prospect of repayment of the principal and interest on the guaranteed obligation. Section 406 of the American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5 (Recovery Act) amended Title XVII of the Energy Policy Act of 2005 by establishing Section 1705 as a temporary program for the rapid deployment of renewable energy and electric power transmission projects, as well as leading edge biofuels projects. The authority to enter into new loan guarantees under Section 1705 expired on September 30, 2011, but LPO continues to administer and monitor the portfolio of loan guarantees obligated prior to the expiration date.

The Title XVII Loan Guarantee Program issued 33 total loan guarantees, of which $21.24 billion is obligated and $18.46 billion has been disbursed to date.

Organization

LPO currently utilizes five interdependent divisions to proactively monitor the portfolio: Portfolio Management Division (PMD), the Risk Management Division (RMD), Technical and Project Management Division (TPMD), Legal division, and Management Operations Division (MOD).

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] Subsidy amounts provided under P.L. 111-5, American Recovery and Reinvestment Act of 2009 is rescinded.

The Portfolio Management Division (PMD) lead LPO's monitoring functions by approving disbursements, repayments, operating budgets, and long-term forecasts. In the event of non-payment and/or default, PMD leads activities to maximize recoveries either through bankruptcy, note sale, or compromise of the claim. PMD and the Risk Management Division (RMD) also conduct continuous risk assessments of the assets in the portfolio to comply with regulatory requirements such as OMB Circular No. A-129 of the Federal Credit Reform Act of 1990.

The Technical and Project Management Division (TPMD) evaluates technical performance of assets and project management throughout the entire lifecycle of the loan to ensure that the technical requirements of the loan agreement are met. TPMD conducts site visits, provides expertise on project construction status and budget, and identifies potential technical risks that inhibit the borrower's ability to meet requirements and repay the loan. TPMD acts as the lenders' engineers for LPO and evaluates the innovative technical financing, monitoring the portfolio to ensure reasonable prospect of repayment.

LPO Legal Division provides monitoring of loan guarantee agreements and terms of the portfolio and its borrowers to ensure reasonable prospect of repayment. Additionally, Legal Division supports all on-going monitoring activities, negotiations and documentations of waivers, consents, routine loan amendments, approvals and denials of transfer withdrawals, and legal aspects of any project developments.

In FY 2018 LPO will consolidate and streamline the organizational structure of monitoring activities to effectively manage the portfolio of loans while minimizing the administrative burden. In addition, LPO will explore options to reduce or mitigate the expected administrative cost of monitoring over the tenor of the remaining loans. The Loan Programs Office will wind down operations in FY 2018 with the expectation that it will shut down in FY 2019 with remaining loan monitoring and closeout activities transferred to another office.

Highlights and Major Changes in the FY 2018 Budget Request

Title 17 Innovative Technology Loan Guarantee Program Office's final FY 2018 appropriation request is $0, which includes $2,000,000 in appropriation for administrative budget and $2,000,000 in offsetting collections. In addition, LPO will commence termination of Loan Origination activities, request no additional loan authority, and continue to monitor the existing portfolio.

Title 17 Innovative Technology Loan Guarantee Program
Funding by Congressional Control ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Title 17 Innovative Technology Loan Guarantee Program				
Administrative Operations	42,000	41,920	2,000	-40,000
Offsetting Receipts	-25,000	-27,000	-2,000	+23,000
Total, Title 17 Innovative Technology Loan Guarantee Program	**17,000**	**14,920**	**0**	**-17,000**
Federal FTEs	**120**	**118**	**80**	**-40**
Loan Subsidy Rescission			**-383,433[b]**	

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.
[b] Subsidy amounts provided under P.L. 111-5, American Recovery and Reinvestment Act of 2009 is rescinded

Administrative Operations
Funding ($K)

	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2016 vs FY 2018
Administrative Operations				
Salary & Benefits	20,000	20,613	2,000	-18,000
Travel	800	600	0	-800
Support Services	18,000	16,000	0	-18,000
Other Related Expenses	3,200	4,707	0	-3,200
Total, Administrative Operations	**42,000**	**41,920**	**2,000**	**-40,000**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Administrative Operations
Explanation of Major Changes ($K)

	FY 2018 vs FY 2016
Administrative Operations	
Salaries and Benefits: LPO will utilize unobligated balances carried forward from prior appropriations to provide salaries and benefits to 80 full time equivalent employees (FTEs).	**-18,000**
Travel: LPO will utilize unobligated balances carried forward from prior appropriations to support the travel of staff members for site visits, training, and attending meetings and conferences.	**-800**
Support Services: LPO will utilize unobligated balances carried forward from prior appropriations to support outside expertise in finance, legal, engineering, technology, credit analysis, and market assessments.	**-18,000**
Other Related Expenses: LPO will utilize unobligated balances carried forward from prior appropriations to support DOE Working Capital Fund and LPO federal staff training.	**-3,200**
Total, Administrative Operations	**-40,000**

Administrative Operations

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016 Enacted
Administrative Operations $42,000,000	**$2,000,000**	**-$40,000,000**
Salaries and Benefits $20,000,000	**$2,000,000**	**-$18,000,000**
• To provide salaries and benefits to 120 full time equivalent employees to administer the following functions to the office: Director, Legal, Loan Origination, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management.	• In addition to prior year funds, this request will support the salaries and benefits of 80 full time equivalent employees to administer the following functions to the office: Director, Legal, Management Operations, Environmental Compliance, Portfolio Management, Risk Management, and Technical and Project Management.	• In addition to offsetting collection, LPO will operate on unobligated balances carried forward for FY 2018 activities
Travel $800,000	**$0**	**-$800,000**
• Continuation of FY 2015 activities. Supports the travel of staff members for outreach to applicants, site visits, as well as attending meetings and conferences.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities
Support Services $18,000,000	**$0**	**-$18,000,000**
• Continuation of FY 2015 activities. Provides range of contract services including administrative support, subject matter experts, legal services, information technology, and publications.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities
Other Related Expenses $3,200,000	**$0**	**-$3,200,000**
• Continuation of FY 2015 activities. Supports DOE Working Capital Fund, Energy IT Services - Desktop Services, expenses, and LGP federal staff training.	• No funding is requested.	• LPO will operate on unobligated balances carried forward for FY 2018 activities

Title 17 Innovative Technology Loan Guarantee Program
Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**CO2 Reductions Loans Guarantee - Estimated annual CO2 emissions reductions of projects receiving loan guarantees that have achieved commercial operations compared to 'business as usual' energy generation. (metric tons, mt)**		
Target	≥ 21,200,000 mt	≥ 21,200,000 mt	≥ 21,200,000 mt
Result	Not Met - 18,300,000	TBD	TBD
Endpoint Target	Assist in the reduction of CO2 emissions.		
Performance Goal (Measure)	**Generation Capacity of Projects Receiving Loan Guarantees - Annual generation capacity from projects receiving DOE loan guarantees that have achieved commercial operations. (Gigawatts, GW)**		
Target	≥ 4 GW	≥ 4 GW	≥ 4 GW
Result	Met - 4	TBD	TBD
Endpoint Target	Assist in the development of electricity generation capacity.		

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Innovative Tech Loan Guarantee Prog	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Administrative Operations			
Administrative Operations	17,000	16,968	0
Total, Washington Headquarters	**17,000**	**16,968**	**0**
Total, Innovative Tech Loan Guarantee Prog	**17,000**	**16,968**	**0**

Energy Information Administration

Energy Information Administration

Energy Information Administration
Proposed Appropriation Language

For Department of Energy expenses necessary in carrying out the activities of the Energy Information Administration, $118,000,000, to remain available until expended.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Public Law (P.L.) Authorizations

P.L. 83-703, Atomic Energy Act (1954)
P.L. 93-275, 15 U.S.C. 761, Federal Energy Administration Act (1974)
P.L. 93-319, Energy Supply and Environmental Coordination Act (1974)
P.L. 94-163, Energy Policy and Conservation Act (1975)
P.L. 94-385, 15 U.S.C. 790, Energy Conservation and Production Act (1976)
P.L. 95-91, 42 U.S.C. 7135, Department of Energy Organization Act (1977)
P.L. 95-620, 42 U.S.C. 8301, Powerplant and Industrial Fuel Use Act (1978)
P.L. 95-621, Natural Gas Policy Act (1978)
P.L. 96-294, Energy Security Act (1980)
P.L. 97-229, 42 U.S.C. 6245, Energy Emergency Preparedness Act (1982)
P.L. 97-415 Nuclear Regulatory Commission Authorization Act (1983)
P.L. 99-58, National Coal Imports Reporting Act (1985)
P.L. 99-58, 42 U.S.C. 6201, Energy Policy and Conservation Act Amendments of 1985
P.L. 100-42, 42 U.S.C. 8312, Powerplant and Industrial Fuel Use Act Amendments of 1987
P.L. 102-486, 42 U.S.C. 13385, Energy Policy Act (1992)
P.L. 107-347, Title V of E-Government Act of 2002, Confidential Information Protection and Statistical Efficiency Act of 2002
P.L. 109-58, 42 U.S.C. 15801, Energy Policy Act of 2005
P.L. 110-140, Energy Independence and Security Act (2007)
P.L. 112-81, National Defense Authorization Act for Fiscal Year 2012
P.L. 112-158, Iran Threat Reduction and Syria Human Rights Act of 2012
P.L. 113-125, Reliable Home Heating Act of 2014
P.L. 114-11, Energy Efficiency Improvement Act of 2015

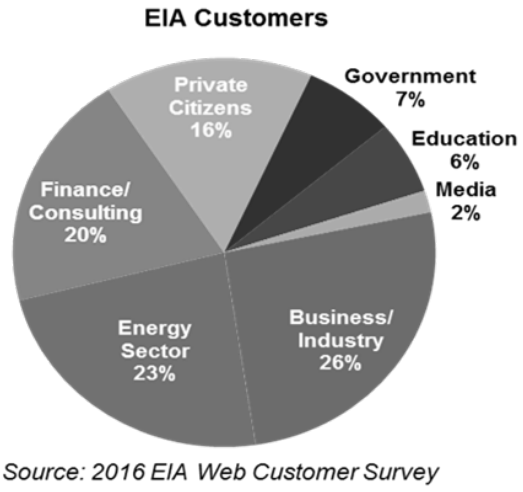
Energy Information Administration
Congressional Control: National Energy Information System (NEIS)
($K)

FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request
122,000	121,768	118,000

Overview

The U.S. Energy Information Administration (EIA) is the statistical and analytical agency within the U.S. Department of Energy (DOE). EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. EIA is the nation's premier source of energy information and, by law, its data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government.

EIA conducts a wide range of data collection, analysis, forecasting, and dissemination activities to ensure that its customers, including Congress, federal and state government, the private sector, the broader public, and the media, have ready access to timely, reliable, and relevant energy information. This information is essential to inform a wide range of energy-related decisions, including utilization strategies; availability of energy sources; business and personal investment decisions; and policy development.



Source: 2016 EIA Web Customer Survey

Highlights of the FY 2018 Budget Request

EIA has evolved its program in recent years to provide an expanding customer base with coverage of increasingly complex and interrelated energy markets. For example, EIA has addressed new energy developments such as the advent of shale gas, tight oil, and distributed solar, as well as the changing economics of nuclear energy, and the removal of restrictions on U.S. crude oil exports. The agency's ability to adapt to a changing industry landscape has been essential to the nation's ongoing dialogue on important energy issues.

The FY 2018 budget request enables EIA to maintain recent program enhancements, continue most core statistical and analysis activities, and follow through on planned cybersecurity initiatives. However, it would not be able to keep pace in addressing key emerging energy issues, including:

- Data and analysis of important regional issues, such as electricity transmission infrastructure and modernization initiatives, the economics of existing nuclear generators, and more granular petroleum supply information, including through an ongoing collaboration with oil and natural gas producing states as part of the National Oil and Gas Gateway
- More timely, relevant energy consumption information through the use of alternative data collection modes to increase operational efficiency and integrate new data such as "behind the meter" measurements of electricity consumption by individual devices and appliances from a representative sample of homes and businesses
- Development of new models for global hydrocarbon supply and international electricity markets to account for the growing importance of foreign markets, including export markets for natural gas, in determining U.S. energy market conditions

Energy Data Program

EIA's comprehensive energy data program conducts surveys of energy suppliers and consumers and then processes and integrates the data to produce a full range of publicly available reports spanning the energy landscape. EIA strives to make high-quality data available in formats and structures that serve the analytical needs of its customers. The energy data program also provides the basis for EIA's energy analysis and forecasting activities, including key inputs for its short- and long-term energy models.

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Energy Supply Surveys

The energy supply survey program represents EIA's data foundation and largest operational area, publishing more than 300 reports a year across weekly, monthly, quarterly, and annual product lines. Most recently, EIA began collecting and disseminating near real-time electricity demand data from the nation's balancing authorities, a first for a government statistical agency. The program collects comprehensive data that collectively illustrate the complex flows of energy production, distribution, and end-uses across sectors, including oil and gas, coal, refined products, nuclear power, renewables, biofuels, and electric power. The energy supply survey program employs a broad range of statistical expertise in support of its data collection efforts, including sampling, imputation, estimation, survey frame management, quality assurance, and periodic development of new data collection and survey instruments. Producers, consumers, investors, traders, and analysts use a wealth of EIA energy statistics in their day-to-day activities in the global energy marketplace. For example, the *Weekly Petroleum Status Report* (WPSR) and the *Weekly Natural Gas Storage Report* (WNGSR) typically spur price formation activity to balance markets.

Energy Consumption and Efficiency Surveys

EIA collects and publishes definitive, national, end-use consumption data for commercial buildings, residential buildings, and manufacturing through the use of three, complex, large-scale, multi-year surveys. The Commercial Buildings Energy Consumption Survey (CBECS) provides the only statistically reliable source of information on energy consumption, expenditures, and end-uses in U.S. commercial buildings. The Residential Energy Consumption Survey (RECS) collects information from a nationally representative sample of housing units, including data on energy characteristics of homes, usage patterns, and household demographics. Linked with production and employment data from Census Bureau economic surveys, the Manufacturing Energy Consumption Survey (MECS) provides information on energy throughput and economic and operational characteristics of U.S. manufacturers. These surveys are critical to understanding energy use and are the basis for benchmarking. Because of the scale and complexity of these surveys, EIA is exploring innovative methodologies for collecting valid survey samples at lower cost through different modes (e.g., telephone, mail, web, and third party validation data).

Energy Analysis Program

EIA conducts a robust energy analysis program to bring meaning and context to a rapidly-evolving energy marketplace. The program maintains and operates the National Energy Modeling System (NEMS), the nation's preeminent tool for developing long-term projections of U.S. energy production, consumption, prices, and technologies. EIA's modeling outputs underpin its flagship projections, including the *Annual Energy Outlook* (AEO), *International Energy Outlook* (IEO), and *Short-Term Energy Outlook* (STEO), as well as other special and periodic topical analyses.

In addition to its modeling and forecasting work, the program produces a range of recurring reports, such as *Today in Energy*, *Liquefied Natural Gas (LNG) trade flows,* and *This Week in Petroleum.* Regional data are also used in analysis like the Refinery Outages Report assessing risk and oil-related supply conditions, and monthly reporting on movements of crude oil, ethanol, and propane by rail. The program is staffed with experts in all areas of the energy sector, including fossil fuels, nuclear, renewables, electricity, transportation, and energy efficiency in the built environment.

EIA has expanded the depth and breadth of its international energy coverage, in particular with regard to international trade flows and their impact on the U.S. domestic energy markets. For example, EIA has produced analysis of the implications of removing restrictions on U.S. crude oil and natural gas exports, including modeling of prices, production, and trade effects, and has also published updated country and regional reports on major energy economies.

Communications

EIA's comprehensive communications program interfaces with diverse external customer groups and manages the public website (www.eia.gov), press and media relations, marketing and outreach services, and an employee intranet. EIA's website features state-of-the-art technologies such as customizable data browsers, interactive state, national, and North American energy infrastructure maps, and open data initiatives like Application Programming Interfaces (APIs) that have greatly increased information accessibility to EIA's customers. The design and customization of EIA's website and multimedia content features are updated based on external feedback mechanisms, including web traffic analytics and input from the annual customer satisfaction survey. The program also maintains EIA's award-winning educational products, such as Energy Kids, and executes a robust social media and state outreach strategy.

Resource and Technology Management
This function provides overall business management, analysis, and mission support to EIA and in response to requests from other components of DOE. Activities include workforce development and administration, financial and budget management, acquisition of support services, project management, and program evaluation. The program also manages EIA's information technology (IT) functions to ensure a stable, operable IT infrastructure that meets data confidentiality and cybersecurity requirements. This function also facilitates EIA's participation in cost-effective DOE shared-services programs.

Cybersecurity
EIA will provide sufficient funding to ensure a robust cybersecurity program while continuing to modernize its IT processing platform. EIA is assessing its cybersecurity posture to identify vulnerabilities and outline mitigation strategies.

FY 2018 Crosscuts ($K)

	Cyber-security	Total
	885	885
Total, Crosscuts	**885**	**885**

FY 2016 and Early FY 2017 Key Accomplishments
In FY 2016 and early in FY 2017, EIA continued to deliver on new initiatives that have closed crucial gaps in its information program and provided important new insights into the nation's energy future. For example, EIA has:

- Incorporated weekly export data from U.S. Customs and Border Protection to improve the quality of its weekly petroleum balances, including consumption estimates
- Published near real-time hourly electricity operating data for the Lower 48 states, a first-ever hourly data collection and dissemination by a federal statistical agency
- Delivered in-depth analyses of complex issues like crude oil and LNG export scenarios and regional product supply logistics
- Developed state-of-the-art dissemination tools that have greatly increased 24/7 information accessibility for EIA's customers, including the Coal and Electricity Browsers, State Energy Data Portal, interactive maps, and open data initiatives to enable widespread availability of data through Application Programming Interfaces (APIs)
- Published a daily Southern California Energy Report to enable monitoring of the potential market effects of restrictions at the Aliso Canyon natural gas storage facility via a dashboard that reports daily information for regional electricity and natural gas markets, including data on supply, demand, prices, and weather
- Launched a single Coal Markets product for users to access weekly coal production, prices and new monthly export data in a single place, complementing existing data tools such as EIA's Coal Data Browser, which provides information on aggregate production, mine-level data, and other coal data series
- Added a supplement with estimates of the number of drilled but uncompleted wells (DUCs) in the seven key oil and natural gas producing regions covered by EIA's monthly Drilling Productivity Report, because changes in the number of DUCs can provide further insight into upstream industry conditions
- Published new information on renewable energy, including a review of EIA's data and projections for wind and solar technologies, Wind and Solar Data and Projections from the U.S. Energy Information Administration: Past Performance and Ongoing Enhancements, new data on ethanol and biodiesel by rail in the Petroleum Supply Monthly, and initial collection and publication of data for densified biomass (wood pellets)
- Led development of a North American energy information website, www.nacei.org, as part of a collaboration of the Secretaries of Energy from the United States and Mexico and Canada's Minister of Natural Resources from Canada, providing trade data, infrastructure maps and a glossary of technical terms in English, French, and Spanish
- Published consumption data from the most recent Commercial Buildings Energy Consumption Survey (CBECS) (a quadrennial survey) in tables, a summary report, and a public-use microdata file that enables data users to do custom analysis of energy characteristics and consumption data
- Launched, in collaboration with the states of the Groundwater Protection Council, the first publicly available national database of well level oil and gas data - the National Oil and Gas Gateway, www.noggateway.org; EIA will also make the software available to the states to improve accessibility on their own websites

EIA Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program.

	FY 2016	FY 2017	FY 2018
Performance Goal (Measure)	**Quality of EIA Information Products - Percentage of customers who are satisfied or very satisfied with the quality of EIA information.**		
Target	≥ 90 % of customer satisfaction rating	≥ 90 % of customer satisfaction rating	≥ 90 % of customer satisfaction rating
Result	Met - 93	TBD	TBD
Endpoint Target	This is an ongoing annual performance measure, as information quality is central to EIA's mission.		
Performance Goal (Measure)	**Timeliness of EIA Information Products - Percentage of selected EIA recurring products meet their release date targets (all product types).**		
Target	≥ 95 % of products released on schedule	≥ 95 % of products released on schedule	≥ 95 % of products released on schedule
Result	Met - 97	TBD	TBD
Endpoint Target	This is an ongoing annual performance measure, as timely delivery of energy information is central to EIA's mission.		

Program Direction Funding ($K)

Program Direction	FY 2016 Enacted	FY 2017 Annualized CR[a]	FY 2018 Request	FY 2018 vs FY 2016
Salaries and Benefits	56,389	--	58,319	+1,930
Travel	278	--	278	0
Support Services	44,870	--	38,744	-6,126
Other Related Expenses	20,463	--	20,659	196
Total, Program Direction	**122,000**	**121,768**	**118,000**	**-4,000**
Federal FTEs	**375**	**375**	**370**	**-5**
Support Services				
Technical Support				
Administrative Support Services	9	--	9	0
Human Resources Support Services	4	--	4	0
E-Government Support Services	1	--	1	0
Scientific/Technical and IT Training	40	--	40	0
Data Center (Application Hosting/Housing)	180	--	180	0
IT Management Services	5,508	--	5,508	0
Other Advisory and Assistance Services	37,698	--	31,572	-6,126
Total, Technical Support	**43,440**	**--**	**37,314**	**-6,126**
Management Support				
Program Management	1,430	--	1,430	0
Total, Management Support	1,430	--	1,430	0
Total, Support Services	**44,870**	**--**	**38,744**	**-6,126**
Other Related Expenses				
Communications, utilities, and misc. charges	4,257	--	4,257	0
Training	466	--	466	0
Other goods and services from Federal sources	310	--	310	0
Working Capital Fund	9,694	--	9,890	+196
O&M of IT systems or equipment	1,144	--	1,144	0
Printing, supplies and materials	1,300	--	1,300	0
Equipment	2,967	--	2,967	0
Grants, subsidies, and contributions	325	--	325	0
Total, Other Related Expenses	**20,463**	**--**	**20,659**	**+196**

[a] The FY 2017 Annualized CR amounts reflect the P.L. 114-254 continuing resolution level annualized to a full year. These amounts are shown only at the congressional control level and above; below that level, a dash (–) is shown.

Program Direction

Activities and Explanation of Changes

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Salaries and Benefits $56,389,000	**$58,319,000**	**+$1,930,000**
Provide salaries and benefits for 375 FTEs supporting: • Administrator's office (8 FTEs) • Energy data program (160 FTEs) • Energy analysis (126 FTEs) • Communications (32 FTEs) • Resource and technology management (49 FTEs)	Provide salaries and benefits for 370 FTEs supporting: • Administrator's office (8 FTEs) • Energy data program (157 FTEs) • Energy analysis (124 FTEs) • Communications (32 FTEs) • Resource and technology management (49 FTEs)	Increase reflects cost of living adjustments partially offset by a reduction of 5 FTEs.
Travel $278,000	**$278,000**	**$0**
Provide essential travel for EIA stakeholder engagement—both for representing EIA in public forums and engaging with industry experts.	Provide essential travel for EIA stakeholder engagement—both for representing EIA in public forums and engaging with industry experts.	Holding travel costs to prior year level.
Support Services $44,870,000	**$38,744,000**	**-$6,126,000**
Energy Supply Surveys $18,165,000 Operate core supply data collection program. • Produce more timely data on petroleum product exports, including gasoline, diesel fuel, and propane. • Set the framework for more granular petroleum supply surveys • Continue partnership with the Ground Water Protection Council (GWPC) to host well-level data. • Complete study of drilling costs to bring visibility to breakeven oil prices in key regions.	*Energy Supply Surveys $15,089,000* Operate core supply data collection program. • Adopt and begin implementation of Statistical Methods Improvement Plan.	*Energy Supply Surveys -$3,076,000* Delay data and analysis of important regional issues, such as electricity transmission infrastructure and modernization initiatives, nuclear and coal generation trends, and more granular petroleum supply information. IT modernization efforts consolidated under the Chief Information Officer.
Energy Consumption and Efficiency Surveys $9,321,000 Conduct commercial, residential, and manufacturing surveys. • CBECS 2017 planning, funding, and collection preparation. • RECS 2015 fieldwork for household and suppliers surveys. • Complete and publish RECS cities pilot. • MECS 2014 post-collection processing and publication.	*Energy Consumption and Efficiency Surveys $6,071,000* Conduct commercial, residential, and manufacturing surveys. • Publication of 2016 MECS data. • Award CBECS 2018 and begin project.	*Energy Consumption and Efficiency Surveys -$3,250,000* Delay more timely, relevant energy consumption information through the use of alternative data collection modes to increase operational efficiency and integrate new data such as "behind the meter" measurements of electricity consumption by individual devices and appliances from a representative sample of homes and businesses.

FY 2016 Enacted	FY 2018 Request	Explanation of Changes FY 2018 vs FY 2016
Energy Modeling and Analysis $9,326,000 Continue core forecasting and analysis work leading to the AEO, IEO, STEO and other reports and international capabilities. • Produce full AEO with multiple analytic scenarios and Issues in Focus papers; online update to IEO tables. • Three to five year STEO world supply and demand forecasts. • Continue to work with counterparts in Canada and Mexico to harmonize data, methodologies, and mapping. • Expand rail data methodology to include ethanol, and propane movements.	*Energy Modeling and Analysis $7,326,000* Achieve efficiencies in core forecasting and analysis activities and enhance mid-term analysis. • Produce full IEO and AEO with updated reference cases. • Maintain the flexibility and expertise base to respond to ad-hoc policy analysis needs.	*Energy Modeling and Analysis -$2,000,000* Delay development of new models for global hydrocarbon supply and international electricity markets to account for the growing importance of foreign markets in determining U.S. energy market conditions.
Communications $1,662,000 Maintain communication activities and invest in flexible web platforms to enhance data delivery. • Continue digital government strategy to provide open data sources, expanded use of Application Programming Interface (API) keys, and integration of other administrative statistical data. • Conduct website maintenance and conversion to PHP platform; update API servers.	*Communications $1,662,000* Maintain communication activities and continue development of flexible web platforms to enhance data delivery. • Maintain scope of energy mapping system, and continue to integrate mapping with relevant EIA time-series data sets.	*Communications +$0* Maintain scope of communications program.
Resource and Technology Management $6,396,000 Provide overall business management, IT and network services, and administrative support to EIA offices and staff.	*Resource and Technology Management $8,596,000* Continue providing business management, IT and network services, and administrative support to EIA's offices and staff.	*Resource and Technology Management +$2,200,000* Maintain scope of mission support activities, including a robust cybersecurity program. IT modernization efforts consolidated under the Chief Information Officer.
Other Related Expenses $20,463,000	**$20,659,000**	**+$196,000**
Support the mission by paying for rent and shared services through the DOE Working Capital Fund, IT equipment and licenses, subscriptions, and employee training among other areas.	Support the mission by paying for rent and shared services through the DOE Working Capital Fund, IT equipment and licenses, subscriptions, and employee training among other areas.	Provide for increased WCF cost.

Department Of Energy

FY 2018 Congressional Budget

Funding By Appropriation By Site

($K)

Energy Information Administration	FY 2016 Enacted	FY 2017 Annualized CR	FY 2018 Request
Washington Headquarters			
Energy Information Administration			
National Energy Information System	122,000	121,768	118,000
Total, Washington Headquarters	**122,000**	**121,768**	**118,000**
Total, Energy Information Administration	**122,000**	**121,768**	**118,000**

GENERAL PROVISIONS – DEPARTMENT OF ENRGY
(INCLUDING TRANSFER OF FUNDS)

SEC. 301. (a) No appropriation, funds, or authority made available by this title for the Department of Energy shall be used to initiate or resume any program, project, or activity or to prepare or initiate Requests For Proposals or similar arrangements (including Requests for Quotations, Requests for Information, and Funding Opportunity Announcements) for a program, project, or activity if the program, project, or activity has not been funded by Congress.

(b) (1) Unless the Secretary of Energy notifies the Committees on Appropriations of both Houses of Congress at least 3 full business days in advance, none of the funds made available in this title may be used to—

(A) make a grant allocation or discretionary grant award totaling $1,000,000 or more;

(B) make a discretionary contract award or Other Transaction Agreement totaling $1,000,000 or more, including a contract covered by the Federal Acquisition Regulation;

(C) issue a letter of intent to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B); or

(D) announce publicly the intention to make an allocation, award, or Agreement in excess of the limits in subparagraph (A) or (B).

(2) The Secretary of Energy shall submit to the Committees on Appropriations of both Houses of Congress within 15 days of the conclusion of each quarter a report detailing each grant allocation or discretionary grant award totaling less than $1,000,000 provided during the previous quarter.

(3) The notification required by paragraph (1) and the report required by paragraph (2) shall include the recipient of the award, the amount of the award, the fiscal year for which the funds for the award were appropriated, the account and program, project, or activity from which the funds are being drawn, the title of the award, and a brief description of the activity for which the award is made.

(c) The Department of Energy may not, with respect to any program, project, or activity that uses budget authority made available in this title under the heading "Department of Energy—Energy Programs", enter into a multiyear contract, award a multiyear grant, or enter into a multiyear cooperative agreement unless—

(1) the contract, grant, or cooperative agreement is funded for the full period of performance as anticipated at the time of award; or

(2) the contract, grant, or cooperative agreement includes a clause conditioning the Federal Government's obligation on the availability of future year budget authority and the Secretary notifies the Committees on Appropriations of both Houses of Congress at least 3 days in advance.

(d) Except as provided in subsections (e), (f), and (g), the amounts made available by this title shall be expended as authorized by law for the programs, projects, and activities specified in the "Final Bill" column in the "Department of Energy" table included under the heading "Title III—Department of Energy" in the explanatory statement accompanying this Act.

(e) The amounts made available by this title may be reprogrammed for any program, project, or activity, and the Department shall notify the Committees on Appropriations of both Houses of Congress at least 30 days prior to the use of any proposed reprogramming that would cause any program, project, or activity funding level to increase or decrease by more than $5,000,000 or 10 percent, whichever is less, during the time period covered by this Act.

(f) None of the funds provided in this title shall be available for obligation or expenditure through a reprogramming of funds that—

(1) creates, initiates, or eliminates a program, project, or activity;

(2) increases funds or personnel for any program, project, or activity for which funds are denied or restricted by this Act; or

(3) reduces funds that are directed to be used for a specific program, project, or activity by this Act.

(g) (1) The Secretary of Energy may waive any requirement or restriction in this section that applies to the use of funds made available for the Department of Energy if compliance with such requirement or restriction would pose a substantial risk to human health, the environment, welfare, or national security.

(2) The Secretary of Energy shall notify the Committees on Appropriations of both Houses of Congress of any waiver under paragraph (1) as soon as practicable, but not later than 3 days after the date of the activity to which a requirement or restriction would otherwise have applied. Such notice shall include an explanation of the substantial risk under paragraph (1) that permitted such waiver.

SEC. 302. The unexpended balances of prior appropriations provided for activities in this Act may be available to the same appropriation accounts for such activities established pursuant to this title. Available balances may be merged with funds in the applicable established accounts and thereafter may be accounted for as one fund for the same time period as originally enacted.

SEC. 303. Funds appropriated by this or any other Act, or made available by the transfer of funds in this Act, for intelligence activities are deemed to be specifically authorized by the Congress for purposes of section 504 of the National Security Act of 1947 (50 U.S.C. 3094) during fiscal year 2018 until the enactment of the Intelligence Authorization Act for fiscal year 2018.

SEC. 304. None of the funds made available in this title shall be used for the construction of facilities classified as high-hazard nuclear facilities under 10 CFR Part 830 unless independent oversight is conducted by the Office of Enterprise Assessments to ensure the project is in compliance with nuclear safety requirements.

SEC. 305. None of the funds made available in this title may be used to approve critical decision–2 or critical decision–3 under Department of Energy Order 413.3B, or any successive departmental guidance, for construction projects where the total project cost exceeds $100,000,000, until a separate independent cost estimate has been developed for the project for that critical decision.

SEC. 306. Notwithstanding section 301(c) of this Act, none of the funds made available under the heading "Department of Energy—Energy Programs—Science" in this or any subsequent Energy and Water Development and Related Agencies appropriations Act for any fiscal year may be used for a multiyear contract, grant, cooperative agreement, or Other Transaction Agreement of $1,000,000 or less unless the contract, grant, cooperative agreement, or Other Transaction Agreement is funded for the full period of performance as anticipated at the time of award.

SEC. 307. (a) NEW REGIONAL RESERVES.—The Secretary of Energy may not establish any new regional petroleum product reserve unless funding for the proposed regional petroleum product reserve is explicitly requested in advance in an annual budget submission and approved by the Congress in an appropriations Act.

(b) The budget request or notification shall include—

(1) the justification for the new reserve;

(2) a cost estimate for the establishment, operation, and maintenance of the reserve, including funding sources;

(3) a detailed plan for operation of the reserve, including the conditions upon which the products may be released;

(4) the location of the reserve; and

(5) the estimate of the total inventory of the reserve.

SEC. 308. Uranium Lease and Take-Back Revolving Fund.—There is hereby established in the Treasury of the United States a fund to be known as the "Uranium Lease and Take-Back Revolving Fund" (the Fund), which shall be available without fiscal year limitation, for Department of Energy expenses, including the purchase, construction, and acquisition of plant and capital equipment and other expenses necessary in carrying out section 3173 of the National Defense Authorization Act for Fiscal Year 2013. For initial capitalization, there is appropriated $1,000,000 to the Fund. Notwithstanding 31 U.S.C. 3302, revenues received under section 3173 of such Act in this and subsequent fiscal years shall be credited to the Fund to be available for carrying out the purposes of the Fund without further appropriation. Funds collected in fiscal year 2018 shall be credited as offsetting collections to the Fund, so as to result in a final fiscal year 2018 appropriation from the general fund estimated at not more than $0.

SEC. 309. Treatment of Lobbying and Political Activity Costs as Allowable Costs under Department of Energy Contracts.

(a) Allowable Costs.—

(1) Section 4801(b) of the Atomic Energy Defense Act (50 U.S.C. 2781(b)) is amended—

(A) by striking "(1)" and all that follows through "the Secretary" and inserting "The Secretary"; and

(B) by striking paragraph (2).

(2) Section 305 of the Energy and Water Development Appropriation Act, 1988, as contained in section 101(d) of Public Law 100–202 (101 Stat. 1329–125), is repealed.

(b) Regulations Revised.—The Secretary of Energy shall revise existing regulations consistent with the repeal of 50 U.S.C. 2781(b)(2) and section 305 of Public Law 100–202 and shall issue regulations to implement 50 U.S.C. 2781(b), as

amended by subsection (a), no later than 150 days after the date of the enactment of this Act. Such regulations shall be consistent with the Federal Acquisition Regulation 48 C.F.R. 31.205–22.

SEC. 310. Not to exceed 5 percent of any appropriation made available for Department of Energy activities funded in this Act may be transferred between such appropriations, but no such appropriation, except as otherwise provided, shall be increased or decreased by more than 5 percent by any such transfers, and notification of any such transfers shall be submitted promptly to the Committees on Appropriations of the House of Representatives and the Senate.

SEC. 311. Notwithstanding section 161 of the Energy Policy and Conservation Act (42 U.S.C. 6241), the Secretary of Energy shall draw down and sell one million barrels of refined petroleum product from the Strategic Petroleum Reserve during fiscal year 2018. Proceeds from sales under this section shall be deposited into the general fund of the Treasury during fiscal year 2018.

Title V – General Provisions

SEC. 501. None of the funds appropriated by this Act may be used in any way, directly or indirectly, to influence congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. 1913.

SEC. 502. None of the funds made available by this Act may be used in contravention of Executive Order No. 12898 of February 11, 1994 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations).