Energy Supply and Conservation
Office of Energy Efficiency and Renewable Energy

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Energy Supply and Conservation					
Hydrogen Technology	166,772	157,199	-1,572	155,627	195,801
Biomass and Biorefinery Systems R&D	87,471	91,634	-916	90,718	149,687
Solar Energy	84,255	83,953	-840	83,113	148,372
Wind Energy	40,631	39,249	-392	38,857	43,819
Geothermal Technology	25,256	23,299	-233	23,066	0
Hydropower	4,880	500	-5	495	0
Vehicle Technologies	161,326	183,943	-1,839	182,104	166,024
Building Technologies	65,155	69,966	-700	69,266	77,329
Industrial Technologies	73,371	57,429	-574	56,855	45,563
Distributed Energy Resources	59,069	0	0	0	0
Federal Energy Management Program	19,882	19,166	-192	18,974	16,906
Facilities and Infrastructure	11,389	26,315	-263	26,052	5,935
Weatherization and Intergovernmental Activities	325,452	320,067	-3,201	316,866	225,031
Program Direction	98,215	99,524	-995	98,529	91,024
Program Support	16,837	13,456	-135	13,321	10,930
Subtotal, Energy Supply and Conservation	1,239,961	1,185,700	-11,857	1,173,843	1,176,421
Use of prior year balances	-5,648	0	0	0	0
Total, Energy Supply and Conservation	1,234,313[b]	1,185,700	-11,857	1,173,843	1,176,421

[a] Includes a rescission of $11,857,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $12,740,000 was transferred to the SBIR program and $1,529,000 was transferred to the STTR program.

Preface

The Department of Energy seeks to add significant value to national and economic security by providing increased energy security and a healthy environment. Technologies developed by the Office of Energy Efficiency and Renewable Energy (EERE) provide a diverse supply of reliable, affordable, and environmentally sound energy through investment, development, and partnership in a focused and prioritized portfolio of energy conservation technologies and clean, renewable domestic energy resources. Research advancing these energy technologies provides consumers choices they can use to make their homes, schools, businesses, factories and vehicles more productive. Developing renewable sources of energy can enhance the Nation's energy security and economic growth by harnessing abundant, naturally occurring, domestic sources of energy that expand our energy resource base and have less impact on the environment than conventional sources. The balanced and focused portfolio of research, development, demonstration and deployment programs supported by EERE is an important contributor to the development and use of applied energy science and R&D to achieve energy solutions. The ability to make and effect sound energy policy depends on productive investment in a diverse technology portfolio that will efficiently and effectively address the complex requirements for simultaneously improving national energy security, providing for a cleaner environment, and ensuring continued economic growth. Energy pathway choices the United States makes today will have lasting implications for decades to come. Thus, developing advanced, efficient and affordable clean energy technologies now is critical for this and future generations—the EERE portfolio approach is at the forefront of those efforts. In this FY 2007 budget request, EERE continues to refine its program portfolio to accelerate and expand contributions to those critical national objectives, developing renewable energy and efficiency technologies and processes with the energy use and partnering community to enable use in homes, schools, businesses, factories and vehicles.

EERE's request includes a Presidential Initiative. Announced in 2003, the President's Hydrogen Fuel Initiative works through partnerships with industry, government and technology programs to develop the technologies and infrastructure needed to produce, store, and distribute hydrogen, and to use it in stationary, portable, and vehicular applications. Additionally, two programs—Biomass and Biorefinery Systems R&D and Solar Energy—have been selected by the Secretary for significant acceleration and designated Secretarial Initiatives. By expanding and accelerating our Biomass research and development activities we will help reduce our dependence on foreign oil by speeding development of domestically produced transportation fuel (ethanol) and other products largely derived from oil today. This initiative complements the energy security R&D presently underway in the Hydrogen Technology and Vehicle Technologies programs. Accelerating our Solar Energy R&D will help diversify our national electricity supply options, reduce the need for new natural gas-fired power plants, and improve the environment. Accelerating research on advanced solar technologies will also speed the creation of higher-efficiency solar energy systems that are essential to achieving net zero energy homes and buildings. These systems can also help reduce the strain on our aging national energy transmission and distribution systems while critical expansions and upgrades are installed. EERE will also continue to advance the use of clean and efficient energy technologies and products through the Weatherization and State Energy Partnerships formula grants programs, leveraging the capabilities and resources of the States to manage and deliver market-ready energy services to the low-income community.

Within the Energy Supply and Conservation Appropriation, EERE has 13 programs: Hydrogen Technology (thirteen subprograms); Biomass and Biorefinery Systems R&D (five subprograms); Solar Energy (four subprograms); Wind Energy (three subprograms); Geothermal Technology (three

subprograms); Vehicle Technologies (ten subprograms); Building Technologies (eight subprograms); Industrial Technologies (three subprograms); the Federal Energy Management Program (four subprograms); Facilities and Infrastructure (two subprograms); Weatherization and Intergovernmental Activities (eight subprograms); Program Support (three subprograms); and Program Direction.

This Overview will describe Strategic Context, Mission, Benefits, Strategic Goals, and Funding by General Goal. These items together put the appropriation request in perspective. The Annual Performance Results and Targets, Means and Strategies, and Validation and Verification sections address how the goals will be achieved and how performance will be measured. Finally, this Overview will address R&D Investment Criteria, Program Assessment Rating Tool (PART), Major Achievements, and Significant Program Shifts.

Strategic Context

Following publication of the Administration's National Energy Policy, the Department developed a Strategic Plan that defines its mission, four strategic goals for accomplishing that mission, and seven general goals to support the strategic goals. Each appropriation has developed quantifiable goals to support the general goals. Thus, the "goal cascade" is the following:

Department Mission → Strategic Goal (25 yrs) → General Goal (10-15 yrs) → Program Goal (GPRA Unit) (10-15 yrs)

To provide a concrete link between budget, performance, and reporting, the Department developed a "GPRA[a] Unit" concept. Within DOE, a GPRA Unit defines a major activity or group of activities that support the core mission and aligns resources with specific goals. Each GPRA Unit has completed or will complete Program Assessment Rating Tool (PART). A unique program goal was developed for each GPRA unit. A numbering scheme has been established for tracking performance and reporting.[b]

The goal cascade accomplishes two things. First, it ties major activities for each program to successive goals and, ultimately, to DOE's mission. This helps ensure the Department focuses its resources on fulfilling its mission. Second, the cascade allows DOE to track progress against quantifiable goals and to tie resources to each goal at any level in the cascade. Thus, the cascade facilitates the integration of budget and performance information in support of the GPRA and the President's Management Agenda (PMA).

Another important component of our strategic planning – and the President's Management Agenda – is use of the Administration's R&D Investment Criteria to plan and assess programs and projects. The criteria were developed in 2001 and further refined with input from agencies, Congressional staff, the National Academy of Sciences, and numerous private sector and nonprofit stakeholders.

The chief elements of the R&D investment criteria are quality, relevance, and performance. Programs must demonstrate fulfillment of these elements. For example, to demonstrate relevance, programs are expected to have complete plans with clear goals and priorities. To demonstrate quality, programs are expected to commission periodic independent expert reviews. There are several other requirements, many of which R&D programs have and continue to undertake.

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[a] Government Performance and Results Act of 1993

[b] The numbering scheme uses the following numbering convention: First 2 digits identify the General Goal (01 through 07); second two digits identify the GPRA Unit; last four digits are reserved for future use.

An additional set of criteria was established for R&D programs developing technologies that address industry issues. Some key elements of the criteria include: the ability of the programs to articulate the appropriateness and need for Federal assistance; relevance to the industry and the marketplace; identification of a transition point to industry commercialization (or of an off-ramp if progress does not meet expectations); and the potential public benefits, compared to alternative investments, that may accrue if the technology is successfully deployed.

The OMB-OSTP guidance memo to agencies dated August 12, 2004, describes the R&D Investment Criteria fully and identifies steps agencies should take to fulfill them. (The memo is available on-line at www.ostp.gov/html/fy05developingpriority.pdf.) Where appropriate throughout these justification materials, especially in Significant Program Shifts and Explanation of Funding Changes subheadings, specific R&D Investment Criteria and requirements are cited to explain the Department's allocation of resources.

Mission

The mission of the Office of Energy Efficiency and Renewable Energy is to strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that promote energy efficiency and productivity, bring clean, reliable, and affordable energy technologies to the marketplace, and make a difference in the everyday lives of Americans by enhancing their energy choices and quality of life.

Benefits

EERE pursues this mission through a balanced, focused and prioritized portfolio of research, development, demonstration and deployment efforts aimed at improving the energy efficiency of our economy and increasing the productive use of domestic renewable energy resources. Making greater use of our abundant, clean domestic renewable energy resources and using all of our energy resources more productively will provide significant economic, environmental, and security benefits to the United States. Energy and economic security is enhanced as dependence on imported petroleum and, natural gas is reduced and the mix of domestic energy resources increases. Energy bills are lower and consumers are less susceptible to energy price fluctuations. Emissions are lowered today and for decades to come. Reliability is enhanced as reduced demands and distributed resources lower the loads on our centralized energy infrastructure so that there is reduced potential for wide-spread energy outages. Renewable energy can provide economic development opportunities, especially in areas rich in solar, wind, and biomass resources. Renewable energy technologies also enhance energy security by diversifying our energy resource portfolio, effectively lowering energy costs and reducing exposure to energy supply interruptions and price volatility. Finally, the balanced portfolio proposed will limit risk to achieving these benefits by significantly reducing technological risks and institutional barriers through strategic investments in the highest-performing, most promising next-generation technologies currently outside the scope of private sector R&D.

EERE has demonstrated its ability to perform and deliver results of notable quality over its tenure. Research and development sponsored by the Office of Energy Efficiency and Renewable Energy has been awarded 43 R&D 100 awards – known as the "Oscars of Innovation" – between 2001 and 2005. The most recent independent review of EERE programs, a study of a sample of EERE energy efficiency portfolio over more than 20 years by the National Academy of Science's National Research Council found significant economic benefits associated with three of the 17 programs reviewed. The estimated total realized economic benefits (predominately from three programs in the sample portfolio) returned

approximately $30 billion (valued in 1999 dollars), from the roughly $7 billion (1999 dollars) total Federal energy efficiency Research, Development, Demonstration and Deployment (RDD&D) investment over that period. The study also indicated there were yet unrealized benefits likely to be achieved. Consistent with the PMA, additional work is underway to enable the programs to more effectively measure and estimate past and potential benefits.

Our portfolio will deliver significant future public benefits in energy, economic and environmental security we have quantified based on EERE benefits estimation models. EERE estimates that U.S. consumption of non-renewable energy resources would, given current policies, a business-as-usual energy future, stable investment, and achievement of technology plans, be 8 Quads lower in 2025 and over 30 Quads lower in 2050 as a result of being able to realize the energy efficiency and renewable energy improvements proposed in this budget. We have not estimated the cumulative benefits from the program nor costs to achieve these savings. Benefits of this magnitude could offset virtually all of the expected growth in energy consumption from 2010 through 2050. More detailed, integrated and comprehensive economic, and energy security benefits estimates and their sensitivities are provided in the Expected Integrated Program Outcomes section at the end of this Overview and in individual program sections.

Strategic, General, and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Energy Supply and Conservation appropriation supports the following goals:

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The programs funded within the Energy Supply and Conservation appropriation have the following eleven Program Goals that contribute to the General Goals in the "goal cascade." These goals are:

- Program Goal 04.01.00.00: Hydrogen Technology: Develop fuel cell and hydrogen production, delivery and storage technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. Development of these technologies will also make our clean domestic energy supplies more flexible, dramatically reducing or even ending dependence on foreign oil.
- Program Goal 04.08.00.00: Biomass. Develop biorefinery-related technologies associated with the different biomass resource pathways to the point that they can compete in terms of cost and performance and are used by the Nation's transportation, energy, chemical, agriculture, forestry, and power industries to meet their respective market objectives. This helps the Nation expand its clean, sustainable energy supplies, improve its energy infrastructure, and reduce its greenhouse gases emissions, fossil energy consumption and dependence on foreign oil.
- Program Goal 04.03.00.00: Solar Energy. The Solar Program goal is to improve performance of solar energy systems and reduce development, production, and installation costs to competitive

levels, thereby accelerating large-scale usage across the Nation and making a significant contribution to a clean, reliable and flexible U.S. energy supply.

- Program Goal 04.05.00.00: Wind Energy. By 2016, complete program technology research and development, collaborative efforts, and provide the technical support and outreach needed to overcome barriers – energy cost, energy market rules and infrastructure, and energy sector acceptance – to enable wind energy to compete with conventional fuels throughout the Nation in serving and meeting the Nation's energy needs.
- Program Goal 04.07.00.00: Geothermal. With the completion of final reporting on funded projects, the Geothermal Program's goal is to closeout this program and to effectively transition remaining program activities and information (e.g., R&D results, technical data and findings) to private/public sector programs.
- Program Goal 04.02.00.00: Vehicle Technologies. The Vehicle Technologies Program goal is developing technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, and to be cost and performance competitive. Manufacturers and consumers can then use these technologies to help the Nation reduce both petroleum use and greenhouse gas emissions.
- Program Goal 04.04.00.00: Building Technologies. The Buildings Technologies Program goal is to develop cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.
- Program Goal 04.60.00.00: Industrial Technologies. The Industrial Technologies Program goal is to partner with our most energy-intensive industries in strategic planning and specific RD&D to develop the technologies needed to use energy efficiently in their industrial processes and cost-effectively generate much of the energy they consume. The result of these activities will save feedstock and process energy, improve the environmental performance of industry, and help America's economic competitiveness.
- Program Goal 04.13.00.00: Federal Energy Management Program. The Federal Energy Management Program goal is to provide technical and financial assistance to Federal agencies and thereby lead the Nation by example in the use of energy efficiency and renewable energy. Through the Federal Government's own actions, FEMP's target is to facilitate energy efficiency and renewable energy investments each year from FY 2007 through FY 2011 that will result in lifecycle energy savings of 17 trillion Btus each year from FY 2007 through FY 2011. Renewable energy investments are accounted for in this target as displaced conventional energy usage. This target includes only those investments at Federal agencies that can be quantified and directly related to FEMP activities.
- Program Goal 04.09.00.00: (Weatherization). The goal of Weatherization Assistance Program Grants is to increase the energy efficiency of dwellings occupied by low-income Americans, thereby reducing their energy costs. DOE works directly with States and certain Native American tribes that contract with local governmental or non-profit agencies to deliver weatherization services.
- Program Goal 04.10.00.00: (State Energy Program). The State Energy Program (SEP) goal is to strengthen and support the capabilities of States to promote energy efficiency and adopt renewable

energy technologies, helping the Nation achieve a stronger economy, a cleaner environment and greater energy security.

Contribution to General Goal

Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, Program Support, and Program Direction contribute to General Goal 4 working together and with science, supply, productivity and process management programs to reduce the probability and potential magnitude of energy based disruptions and to improve the Nation's mix of affordable energy options.

These integrated programs directly contribute to the departmental goal by: (1) reducing demand-side pressure (mitigates costs) on our energy markets; (2) reducing energy imports; (3) diversifying the mix of domestic energy production; (4) providing smaller and decentralized alternative and non-fuel based sources of electricity generation that are inherently less susceptible to interruption or attack; (5) increasing our ability to adjust demand loads as needed, particularly those that can help reduce peaks and shift power readily during energy emergencies; and (6) providing principal energy technologies and pathways enabling the nation and the world to achieve the Nation's energy and Climate Change Technology Program goals.

The current portfolio of technologies will achieve the significant benefits documented below. This year, we expect our efforts to integrate our energy (and science) programs to improve comparability among the departmental energy programs; improve prioritization based on more reliable data and analysis; accelerate development of innovative, teamed solutions; and focus integrated resources on the most pressing challenges.

EERE expectations, assumptions, and caveats about future energy technologies and markets, are described briefly in the Benefits and in greater detail in the Expected Integrated Program Outcomes that follows. EERE's modeling of the benefits of its integrated portfolio indicates the portfolio can be expected to contribute directly to the DOE Strategic Plan energy security goal for 2025 and beyond. Specifically, our modeling estimates the integrated portfolio is expected to: (1) reduce future demand for traditional energy sources by approximately 8 Quads in 2025 and over 30 Quads in 2050 (beyond the efficiency and renewable improvements expected in the absence of these programs); and (2) reduce the need for new electricity capacity by more than 131 gigawatts (GW) in 2025. Oil savings would be roughly 1.7 million barrels per day (mbpd) in 2025 and over 11 mbpd in 2050[a] Individual program activities planned for and funded by this appropriation would contribute to these improvements in the following ways under these business-as-usual conditions:[b]

- Hydrogen Technology contributes to this goal by developing lower-cost means of producing and delivering hydrogen in large quantities from natural gas and renewable resources, developing integrated fuel cell and hydrogen delivery infrastructure technologies, and improving fuel cell durability while reducing their cost. Specific targets for 2010 include reducing the cost of producing hydrogen from renewables to achieve $2.85/gge untaxed at the station (5000 psi), reducing the cost of producing hydrogen from natural gas (distributed) to $2.50/gge untaxed at the station, and

[a] Key assumptions, methodologies and much greater detail important to understanding these estimates are provided in the Expected Integrated Program Outcomes section.
[b] Individual program contributions are not strictly additive because of overlap in the markets addressed.

developing storage technology that enables greater than 300-mile vehicle driving range. The key intermediate technology goal for fuel cells is reducing the production cost of the fuel cell power system to $45/kW by 2010. Collectively these technologies could displace 0.3 million barrels per day (mbpd) of oil in 2025, and as these technologies enter the market in significant numbers, oil displacement will increase to over 5 mbpd in 2050, under these expected market conditions. Additionally, they provide the option for substantially faster growth in hydrogen use if energy markets demand more rapid change.

- Biomass and Biorefinery Systems R&D contributes to this goal by developing advanced technologies for producing fuels, chemicals, materials, and power from biomass via biochemical and thermochemical processes by 2010. Additionally, the program would contribute by developing, by 2010, validated cost- and performance-competitive biorefinery technologies that co-produce bio-based fuels, products, and power. This could reduce nonrenewable energy consumption by at least 0.4 Quad in 2025, more than 0.6 Quad by 2050, and potentially more with integrated approaches.
- Solar Energy would contribute to this goal by developing: advanced, increasingly-efficient, lower-cost solar photovoltaic modules and grid application technologies; and concentrating solar power technologies to centrally produce electricity from solar energy at a competitive cost. The Solar Program's technical objectives are to increase the efficiencies of each of its core technologies, which will contribute to lowering the costs of solar power. The target for solar power costs are $.05-.10 $0.18/kWh for PV electric energy in 2015; and $0.10 - $0.12/kWh in large-scale CSP power in 2010. If all of these targets were met, collectively, they could enable the development of more than 67 GW of solar electric capacity additions by 2025 and over 260 GW in 2050, while affording the country a source of clean, fuel-free, and portable electricity.
- Wind Energy contributes to this goal by developing wind technologies that will provide large scale wind production in Class-4 wind conditions at 3.6 cents/kWh onshore and in Class-6 wind conditions at 5 cents/kWh offshore shallow water by 2012; large scale offshore transitional (depths up to 60 meters) wind production in Class-4 wind conditions at 5 cents/kWh by 2016; distributed wind production at 10-15 cents/kWh by 2007; and the market systems and services that would extend wind production to most of the United States, which collectively could result in additional wind capacity of more than 100 GW by 2025 and more than 125 GW by 2050 beyond what is expected to be developed without these program efforts.
- Vehicle Technologies contributes to this goal by developing technologies that enable highly efficient cars and trucks and include power technologies, clean domestic fuels, and lightweight materials. 2010 technology goals include reducing high-power battery cost to $500 for a 25 kW system and improving advanced light-duty engine combustion efficiency to 45 percent. When sustained and combined with other vehicle technologies, these will enable overall Vehicle Technologies oil savings of nearly 1.1 mbpd by 2025 and nearly 6.5 mbpd in 2050 under expected market conditions.
- Building Technologies would contribute to this goal by developing advanced lighting and appliances, which when coupled with improved building system integration and design, will provide marketable technologies that can reduce energy use by up to 70 percent in homes by 2020 and 60-70 percent in commercial buildings by 2025. Interim goals in 2010 include: Building America five technology package research reports that can achieve an average of 40 to 50 percent reduction in whole house end use energy will be developed; and 3 to 5 technology packages that can achieve 30 to 50 percent reduction in the purchased energy use in new, small commercial buildings relative to ASHRAE 90.1-2004 will be developed. Improvements in equipment standards, building codes, and

consumer access to these technologies will also facilitate marketable improvements in the efficiency of existing buildings by 20 percent, which can reduce building energy use by nearly 2 Quads per year in 2025 and nearly 5.4 Quads by 2050.

- Federal Energy Management Program (FEMP) contributes to this goal through project financing, technical assistance, and project evaluation which will facilitate energy efficiency and renewable energy investments that will result in lifecycle energy savings of approximately 17 trillion Btus each year from 2007 to 2011. FEMP is helping agencies reach the goal of Executive Order 13123 for all Federal agencies to reduce energy intensity in Federal buildings by 35 percent by 2010 from 1985 levels, and to reach the goal of the Energy Policy Act of 2005 to reduce energy consumption per square foot by 2 percent per year in the years FY 2006 through FY 2016.
- Weatherization and Intergovernmental Activities contributes to this goal by accelerating adoption of cost-effective efficient technologies through weatherization and state energy grants, and intergovernmental activities which will help reduce energy intensity in all sectors of the economy. A key intermediate goal is the addition of more than half a million weatherized homes by 2012. If the targets are met and sustained it will result in improved quality of life for millions and energy savings of 0.2 Quads in 2025. Additionally, Intergovernmental Activities will lead to the building of approximately 340 MW of generation on American Indian lands by 2010.
- EERE is also working to implement the President's Management Agenda through management efficiencies. The first phase of the EERE 2002 reorganization realigned and consolidated Headquarters organizational and business management structures to improve how EERE programs are managed at Headquarters. In the fall of 2003, EERE began the second phase of the reorganization – designing and implementing common project management practices across EERE field organizations. In October 2004, EERE implemented the Project Management Center (PMC) which provides improved and more cost effective project management, procurement, and financial management services to EERE programs engaged in financial assistance and formal contracts activities in FY 2005.

These technology and market improvements also help prepare the Nation for future energy, environmental and security needs by providing options for additional fuel savings, air emission reductions and electricity reliability improvements beyond those expected under business-as-usual scenarios.

Major FY 2005 Achievements

EERE works closely with industry, National Laboratories, Federal agencies, State energy offices, universities, non-government organizations and other stakeholders in conducting its sponsored R&D, demonstration and deployment activities. In addition to the 6 R&D 100 awards EERE–sponsored research received in FY 2005 for applied technology, FY 2005 investment and collaboration achieved the following:

- Hydrogen Technology. Analysis has shown that DOE-sponsored National Laboratory and private sector R&D on advanced membranes, catalysts and bipolar plates have reduced the cost of automotive fuel cell high-volume systems from $200/kW in 2004 to $125/kW in 2005; which is on target to achieving its $50/kW goal in 2010. To evaluate performance of fuel cell and hydrogen technologies in real-world operating conditions, four hydrogen fueling stations were opened through the Department's Hydrogen Learning Demonstration Project in Washington D.C., California and Michigan. The President's direct participation enabled news coverage that significantly advances

the program's objective to educate the public on the potential benefits and use of Hydrogen. These stations involve diverse hydrogen production and delivery options, including grid electrolysis, natural gas reforming, solar-electrolysis/electricity co-production, and liquid hydrogen delivery. These accomplishments are significant milestones which will support the industry commercialization decision on hydrogen fuel cell vehicles and infrastructure by 2015.

- Solar Energy. The Department of Energy (DOE), through its work with the National Renewable Energy Laboratory and Spectrolab, sponsored production of a solar cell with a world record conversion efficiency of 39 percent. This efficiency exceeds the previous record for this technology by more than one percentage point and is the highest validated efficiency for any solar photovoltaic (PV) technology. This achievement is an important step to meeting the goals of the Solar Program, DOE and the photovoltaic industry to generate clean, solar electricity that is cost-competitive with current generation methods.
- Vehicle Technologies. Automotive Lightweighting Materials - Working with automotive partners and the materials industry, the Office of FreedomCAR and Vehicle Technologies developed magnesium casting technology that provides a 30 percent weight saving relative to the aluminum components it replaces; the technology has been adopted by General Motors for its 2006 model year. Successful commercialization of this technology creates opportunities for magnesium use in vehicles that could result in substantial weight saving and thus fuel economy improvement.
- Building Technologies. Major advances have been made in solid-state lighting (SSL) R&D: DOE sponsored researchers at Cree Inc.'s Santa Barbara Technology Center have demonstrated white light emitting diodes (LEDs) with record efficacies as high as 74 lumens per watt (more than four times as efficient as incandescent sources). Scientists at the University of California-Santa Barbara have pioneered innovations in chip design to produce photonic crystal LEDs that yield up to a 70 percent increase in power compared to regular LEDs. Over the next two decades, DOE-partnered technology breakthroughs like these will move SSL toward DOE's goal of 160 lumens per watt, and significantly reduce lighting energy consumption in buildings.

Funding by General and Program Goal

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.01.00.00, Hydrogen Technology	136,456	122,660	195,801
Program Goal 04.08.00.00, Biomass and Biorefinery Systems R&D	52,139	38,941	149,687
Program Goal 04.03.00.00, Solar Energy	74,135	68,857	148,372
Program Goal 04.05.00.00, Wind Energy	36,072	25,987	43,819
Program Goal 04.07.00.00, Geothermal Technology	23,258	19,354	0
Program Goal 04.06.00.00, Hydropower	4,880	495	0
Program Goal 04.02.00.00, Vehicle Technologies	161,326	170,224	166,024
Program Goal 04.04.00.00, Building Technologies	65,155	63,920	77,329

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Program Goal 04.60.00.00, Industrial Technologies	73,371	56,855	45,563
Program Goal 04.59.00.00, Distributed Energy Resources	59,069	0	0
Program Goal 04.13.00.00, Departmental Energy Management Program/Federal Energy Management Program	19,852	18,974	16,906
Program Goal 04.09.00.00, Weatherization	228,160	241,956	164,198
Program Goal 04.10.00.00, State Energy Programs	46,496	36,135	49,457
Program Goal 04.11.00.00, Intergovernmental Activities	46,827	33,726	11,376
Subtotal, General Goal 4, (Energy Supply and Conservation)	1,027,196	898,084	1,068,532
All Other			
Hydrogen Technology/Congressionally Directed Activities	30,316	32,967	0
Biomass and Biorefinery Systems R&D/Congressionally Directed Activities	35,332	51,777	0
Solar Energy/Congressionally Directed Activities	10,120	14,256	0
Wind Energy/Congressionally Directed Activities	4,559	12,870	0
Geothermal Technology/Congressionally Directed Activities	1,998	3,712	0
Vehicle Technologies/Congressionally Directed Activities	0	11,880	0
Building Technologies/Congressionally Directed Activities	0	5,346	0
Departmental Energy Management Program/Federal Energy Management Program/Congressionally Directed Activities	30	0	0
Weatherization and Intergovernmental Activities/Congressionally Directed Activities	3,969	5,049	0
Facilities and Infrastructure	11,389	26,052	5,935
Program Direction	98,215	98,529	91,024
Program Support	16,837	13,321	10,930
Total, All Other	212,765	275,759	107,889
Total, General Goal 4 (Energy Supply and Conservation)	1,239,961	1,173,843	1,176,421

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased national security and energy security, and improved environmental conditions. DOE has incorporated feedback from OMB into the FY 2007 Budget

Request, and the Department will take the necessary steps to continue to improve performance.

All the EERE technology programs have been reviewed by OMB against the PART criteria. In the FY 2007 budget request, the remaining three EERE programs have completed their PART assessment with OMB.

- Industrial Technologies was rated Adequate. The scores in the four components were 80 in purpose, 90 in planning, 91 in management, and 50 in results/accountability. The specific recommendations which the program is actively addressing include: independent assessment of the program's impact on long-term goal of improving industrial energy efficiency; and development of a consistent framework across DOE for analyzing costs and benefits of R&D.
- Federal Energy Management Program was rated Moderately Effective. The scores in the four components were 100 in purpose, 100 in planning, 86 in management, and 50 in results/accountability. The recommendations which the program is actively addressing are ensuring internal program measures' consistency with annual and long-term measures, and program activities contribution to annual and long-term annual measures.
- Biomass and Biorefinery Systems R&D Program was rated Adequate. The scores in the four components were 80 in purpose, 90 in planning, 73 in management, and 42 in results/accountability. The specific recommendations which the program is actively addressing include: improving measures to assess technical progress in promoting commercial "biorefineries" that can produce fuels, chemicals, materials and power from biomass; working to direct earmark activities to support program technical goals as much as possible; and development of a consistent framework across DOE for analyzing costs and benefits of R&D.

Individual programs have taken action to address PART findings and recommendations within their direct control and some have been completely addressed. Many of EERE's FY 2007 performance targets are consistent with and support PART measures; the Department is striving to further improve consistency.

EERE has corporately addressed a recommendation common to all DOE applied R&D PARTs, which is to improve consistency of methods and assumptions used to estimate benefits by developing a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. The Applied R&D programs in DOE have developed common baselines, assumptions and more consistent methods for generating their benefits estimates. The FY 2007 budget is the first to benefit from the inclusion of these commonalities in the management considerations leading to the program prioritization and portfolio selection.

Although benefits estimates calculated to support this budget are not yet entirely comparable, they are increasingly so, and both DOE and EERE continue to improve consistency of programs' methods. EERE continues to address the challenges presented by PART, its constituent evidentiary support -- the Research and Development Investment Criteria (RDIC) and our internal Strategic Management System process through the consolidation of corporate planning, analysis and evaluation activities as represented in this budget for the first time in the Program Support section.

EERE is working with other applied R&D programs to develop a consistent baseline for its administrative (overhead) efficiency measure. EERE is also working with Departmental and OMB staff to incorporate R&D Investment Criteria as appropriate, and expanding the lessons learned in EERE

benefits framework methodology to the applied Energy R&D programs. The individual program responses are provided in their respective budgets.

Significant Policy or Program Shifts

These program shifts and resulting budget prioritization decisions were guided by the R&D Investment Criteria (RDIC). The significant shifts in the program funding are being made to more efficiently accelerate adoption of demonstrated program technologies (delivering benefits) and to provide greater investment in advanced R&D within the EERE portfolio that can more effectively address the critical national priorities of reducing dependence on foreign oil and accelerating the development of clean electricity supply options. Key RDIC is noted in the individual program discussions.

- EERE is changing the way it implements its deployment activities within its portfolio. Following a year-long assessment, EERE has determined that many deployment activities formerly carried out by the Regional Offices, State Energy Program Special Projects, and within the Gateway Subprogram should be realigned. Additionally, EERE has determined that several Gateway activities should no longer be continued. The following summarizes these changes:
  - Program Direction/Regional Offices. EERE will close its six Regional Offices (ROs) by the end of FY 2006, consolidating and realigning functions at the two Project Management Center locations (Golden Field Office and NETL). RO personnel were offered the opportunity to transfer to the PMC, continuing to carry out program-designated deployment efforts and begin to cross-train to support additional project management requirements at the PMC.
  - Gateway Deployment/Rebuild America is being transferred to the Building Technologies Program to better coordinate with advanced building technology research and to accelerate industry and consumer acceptance of advanced building technologies and practices.
  - Gateway Deployment/ENERGY STAR® is being transferred to the Building Technologies Program to better coordinate with emerging advances in building technologies. It is anticipated that this will streamline the introduction of new ENERGY STAR® labeled products and enhance retailer and consumer acceptance.
  - Gateway Deployment/Clean Cities will be transferred to the Vehicle Technologies Program to better coordinate with that program's technologists and researchers, and to improve the overall program effectiveness.
  - Gateway Deployment/Inventions and Innovations will be closed out because of overlap with the Small Business Innovation Research program.
  - Energy Efficiency Information and Outreach activities will end within OWIP; future responsibilities will be transferred to EERE's Office of Technology Advancement and Outreach.
  - Program Support/Technology Advancement and Outreach. EERE will consolidate non-technical outreach and communications efforts within this corporate EERE office. The intent is to develop a coordinated, corporate communications capability that combines currently dispersed efforts into a single, pro-active and visionary approach, including new media as well as traditional means of communications and outreach. Working with NGOs and forming partnerships with business and other governmental entities to leverage resources, new methods of information dissemination and materials designed to break down technology barriers will be developed.

- Hydrogen Technology. In support of the President's Hydrogen Fuel Initiative and the Energy Policy Act of 2005, the FY 2007 budget request reflects a $40 million increase and internally reallocates $43 million that previously funded Congressionally directed activities in FY 2006. The realigned funds will enable the program to restore cost-shared, competitively-awarded hydrogen production and fuel cell R&D projects – slowed or deferred by prior earmarks – and still meet mission-critical technology development targets that will enable industry's 2015 fuel cell vehicle commercialization decision. With this new funding alignment, three-quarters of the hydrogen production and delivery budget will support research on producing of hydrogen from renewable resources, and fuel cell R&D efforts will be restored to approximately FY 2005 levels. Additionally, the program will accelerate work toward its most critical goal – practical and affordable hydrogen storage – while also significantly increasing support for systems analysis and the development of hydrogen safety standards. The increase also begins a new area of activity in FY 2007: development of cost-effective manufacturing processes that could engender a U.S. manufacturing base to support a hydrogen economy.
- Biomass and Biorefinery Systems R&D. To address our most pressing national energy concern – the need to reduce our dependence on foreign oil – EERE will expand biomass R&D to accelerate development of domestically produced transportation fuel (ethanol) and other products largely derived from oil today. The increased investments will significantly reduce technological risks and institutional barriers through strategic investments in the highest-performing, most promising next-generation biotechnologies currently outside the investment range and scope of individual companies' R&D.
- Solar Energy. Significant investment has been added to accelerate solar energy R&D to diversify our national electricity supply options, reduce the need for new natural gas-fired power plants, and improve the environment. Accelerating research on advanced solar technologies that will provide a continuous stream of R&D results to our burgeoning domestic solar industry will also speed the creation of higher-efficiency solar energy systems that are essential to achieving net zero energy homes and buildings.
- Geothermal Technology. The Department plans to close out the Geothermal Technologies Program in FY 2007, archiving and transferring results of its Enhanced Geothermal Systems (EGS work), advanced diagnostics-while-drilling technology (scheduled for completion during FY 2006), and resource assessment findings to the industry. This closeout decision was based upon a review of EERE program funding priorities – which include a broad spectrum of considerations. Important criteria for R&D investment include how close the work is to commercialization and potential public benefits relative to other options. In addition, the 2005 Energy Policy Act modified the Geothermal Steam Act of 1970 in ways that will promote near-term development of geothermal resources.
- Distributed Energy Resources. As directed in the conference report accompanying the FY 2006 Energy and Water Development bill, the Distributed Energy Resources (DER) Program has been transferred to the Office of Electricity Delivery and Energy Reliability (OE). Therefore, the DER Program activities can now be found in the OE Program in FY 2007 funding request.
- Building Technologies. Solid State Lighting will fund critical research (prioritized through industry reviews and RDIC prospective external reviews) in the LED area (phosphors and conversion materials) and in OLEDs (structures for quantum efficiency).

- The reduced Weatherization funding will enable greater investments in advanced R&D within the EERE portfolio that can address critical national priorities: reducing dependence on foreign oil; accelerating the development of clean electricity supply options; and developing highly efficient new technologies and products for our homes and buildings. The Weatherization Program does not provide significant energy benefits (0.1 Quadrillion BTUs in 2025) compared to the potential benefits of other programs. This reduction is part of our shift to advance research and development to promote more fundamental and substantial breakthroughs that can benefit all Americans, including the low-income population.

Expected Integrated Program Outcomes

The program pursues its mission through an integrated portfolio of research, development, demonstration and deployment activities that improve the Nation's energy security, energy efficiency and productivity of our economy while minimizing environmental impacts. Figure 1 (U.S. Nonrenewable Energy Consumption, 1990-2000, and Projections to 2050) depicts the related potential shift in nonrenewable energy consumption. We expect the energy efficiency and renewable energy components of these energy savings to result in lower energy bills and reduced susceptibility to energy price fluctuations; reduced EPA criteria and other pollutants; enhanced energy security as petroleum and natural gas dependence is reduced and domestic fuel supplies increase; and greater energy security and reliability from improvements in energy infrastructure. Indicators of some of these program benefits are provided in the tables below. The results shown in the long-term benefits tables are estimates based on modeling of some of the possible program production technologies. The estimates generated by the model have been rounded to reduce the implied precision. Cumulative benefits of programs and costs to achieve these benefits have not been calculated.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the baseline case assumed for this analysis (essentially the EIA business as usual outlook for components of the economy affecting energy use). This modeling includes competing technologies. Possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies sections in each of the individual contributing programs, could also affect EERE's ability to achieve its strategic goals as could persistent directed funding. Projections of future benefits depend on assumptions relating to how the economy will evolve over time and how rapidly energy efficient technologies will be developed and adopted among other variables. The estimated benefits presented here are predicated on the assumptions included in EIA's Annual Energy Outlook 2005 Reference Case projections.[a]

Some key assumptions about macroeconomic activity, energy demand, and technology results include the following "business-as-usual" assumptions used in the EIA Reference Case:

- Average economic growth of 3.1 percent annually between 2003 and 2025;

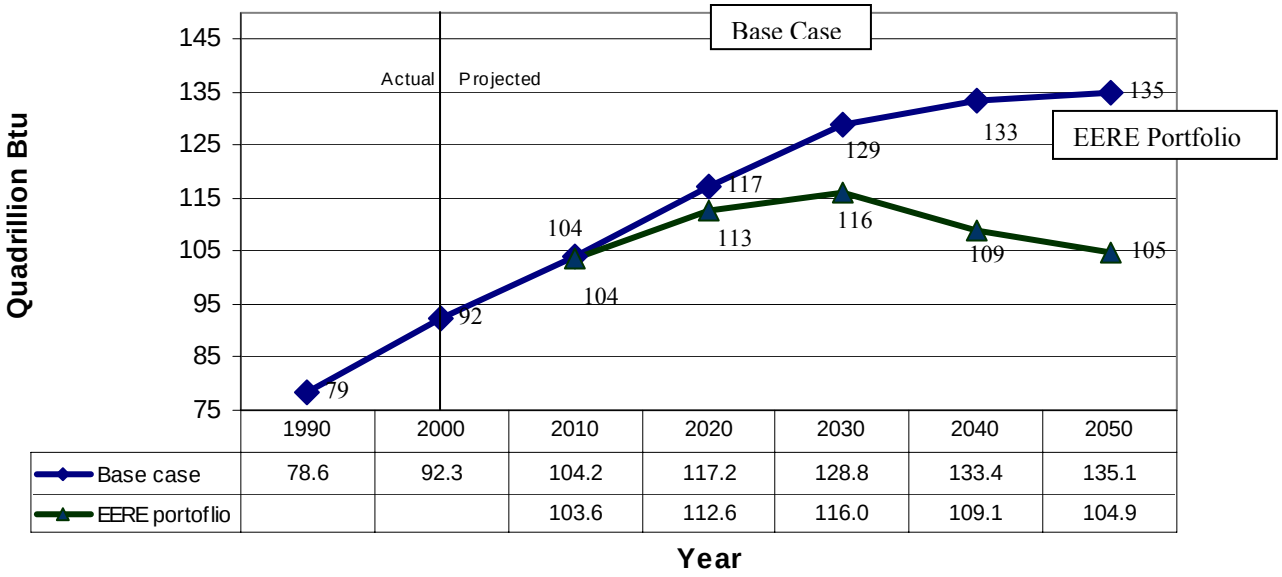
[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

- Price per barrel of oil of about $28 (2003 dollars) in 2003, rising to $35 in 2004, then dropping to $25 in 2010, then rising slowly to $30 in 2025. In nominal dollars, the price of oil in 2025 would be about $52; and
- Price per thousand cubic feet of natural gas of $4.98 (2003 dollars) in 2003, dropping to $3.64 in 2010, then rising slowly to $4.79 by 2025. In nominal dollars, the price of natural gas in 2025 would be about $8.20.

EIA also provides projections under alternative economic assumptions ranging from 2.5 to 3.6 percent annual growth between 2003 and 2025. Across this range, total energy consumption may grow by anywhere from 27 to 44 percent between 2003 and 2025. EIA also offers a range of technology assumptions. Across these cases total energy consumption may grow by anywhere from 42 percent between 2003 and 2025 if technology does not improve at all to 28 percent if technology improves rapidly. Changing assumptions on important variables such as these would likely affect the estimated benefits in this budget.

The results shown in the long term benefits tables are estimates based on modeling of some of the possible program production technologies. While uncertainties are larger for longer term estimates, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits which follow assume that individual technology plans and market assumptions occur. A summary of the methods, assumptions, and models used in developing these benefit estimates are provided at www.eere.energy.gov/office_eere/ba/pba/gpra.html. Final documentation is estimated to be completed and posted by March 31, 2006.

Figure 1. U.S. Nonrenewable Energy Consumption, 1990-2000, and Projections to 2050



	1990	2000	2010	2020	2030	2040	2050
Base case	78.6	92.3	104.2	117.2	128.8	133.4	135.1
EERE portoflio			103.6	112.6	116.0	109.1	104.9

EERE's portfolio includes a mix of efforts intended to produce short-, mid-, and long-term benefits. The size of these benefits depends not only on the success of the EERE program efforts funded in this budget request, but on how future energy markets and policies evolve. EERE estimates a sub-set of these benefits assuming a continuation of current policies and business-as-usual development of energy

markets. These estimates do not include the underlying, basecase improvements in energy efficiency and renewable energy use that could be expected in the absence of continued funding of EERE's programs.[a]

Mid-term Benefits[b]		(calendar year) 2010	2015	2020	2025
Energy Displaced	Primary nonrenewable energy savings (Quads)	0.34	1.45	4.59	7.88
Economic	Energy bill savings (billion 2003$)	2	17	64	100
Environment	Carbon emissions reductions (MMTCE)	8	28	92	168
Security	Oil savings (mbpd)	0.03	0.42	1.06	1.67
	Natural gas savings (Quads)	0.06	0.26	0.94	0.80
	Reduced need for additions to central conventional power (GW)	ns	13	59	119

The table shows, that if successful and the assumptions play out as expected, EERE's programs could provide mid-term benefits in 2025 of $100 billion in annual energy bill savings; a reduction of about 170 million metric tons of annual carbon emissions (MMTCE); a savings of 1.7 million barrels of oil per day; and a reduction of 1.3 Quads of natural gas consumption. A combination of reduced peak demand for electricity and additional renewable and distributed generation capacity eliminated the need for 119 GW of additional conventional central power generation, increasing the flexibility and diversity of our electricity system while reducing the potential for a shortage of new generating capacity.

EERE's portfolio includes a number of efforts to develop fundamental breakthroughs in technologies that promise major changes in how the U.S. will produce and use energy in the decades to come. If these breakthroughs succeed, benefits could continue to grow in the long term. By 2050, benefits may include reductions in the overall annual cost of our energy systems of more than $220 billion; reductions in annual carbon dioxide emissions of more than 600 MMTCE; reductions in oil demand of more than 11 million barrels per day; and annual savings in natural gas demand of nearly 3 Quads.

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible, if all of the program's technical targets are met and are funded at levels consistent with assumptions in the FY 2007 Budget through the program completion year, which varies by program.

[b] Mid-term program benefits, assuming technological success of the entire EERE portfolio, were estimated utilizing the GPRA06-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2004 Reference Case.

Long-Term Benefits[a]		(calendar year) 2030	2040	2050
Energy Displaced	Primary nonrenewable energy savings (Quads)	13	24	31
Economic	Energy system cost savings (billion 2003$)	70	146	217
Environment	Carbon emission reductions (MMTCE)	259	496	626
Security	Oil savings (mbpd)	3.5	7.3	11.0
	Natural gas savings (Quads)	2.1	2.2	2.95

Note: Mid-term energy bill savings only include reductions in consumer energy bills, while long-term energy system cost savings also include the incremental cost of the advanced energy technology purchased by the consumer.

These mid- and long-term estimates are derived utilizing a similar baseline case, but different modeling techniques and, as a result, are not directly comparable. While point estimates are presented, both mid-term and long-term modeling are dependent upon the methodology and assumptions used and could vary substantially around those points. Many of the key variables affecting the benefits estimates are listed as the external factors that could affect expected results in the means and strategy sections of the individual programs, and include variables such as market and policy interactions and the future price of oil, natural gas and electricity generation. Long-term estimates should be considered preliminary as EERE refines its analytical approaches for the 2030-2050 timeframe.

These benefits result from the mix of interrelated investments supported by EERE's budget request. More efficient buildings and factories, for instance, provide the basis for distributed energy resources, such as building integrated solar photovoltaic systems and combined heat and power cogeneration. In addition to these "business-as-usual" benefits, EERE's portfolio would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs. The development of wide-spread sources of wind, solar, geothermal, biomass, and hydropower energy sources; new ways of using energy through hydrogen and distributed power; and technologies that would fundamentally improve the basic efficiency of our homes, businesses, factories, and vehicles could facilitate substantial reductions in our oil use and convert a larger portion of our electricity system to decentralized capacity and renewable energy sources to improve security and reliability.

The following table shows expected benefits by program. The results are not additive, integrated results are shown in the tables above. The estimates are not directly comparable because of some differences in methodology and assumptions. Nevertheless, the table provides relative "order-of-magnitude" estimates while the Department continues to refine and standardize its methodology.

[a] Long-term benefits, assuming technological success of the entire EERE portfolio, were estimated utilizing the GPRA06 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

GPRA 2006 Estimate of Potential Benefits by Program

	Primary Non-Renewable Energy Savings (Quads)		Energy Expenditure Savings (Billion 2003$)	Energy System Net Cost Savings (Billion 2003$)	Carbon Emission Reductions (MMTCE)		Oil Savings (mbpd)	
	2025	2050	2025	2050	2025	2050	2025	2050
Hydrogen Technology Program	0.22	7.73	2	28	6	100	0.28	5.29
Biomass and Biorefinery Systems R&D Program	0.37	0.66	2	2	6	14	0.2	0.21
Solar Energy Program	1.07	5.22	8	10	29	111	ns	ns
Wind Energy Program	3.1	3.85	18	2	69	101	ns	ns
Vehicle Technologies Program	2.32	13.51	49	70	41	260	1.07	6.48
Building Technologies Program	1.99	5.39	17	135	45	124	0.04	0.48
Federal Energy Management Program	0.02	--	0.2	--	0.4	--	ns	--
Weatherization and Intergovernmental Activities[a]	0.2	--	2.3	--	3.8	--	ns	--

Note: EERE's portfolio approach to RD&D affects benefits and the way they are calculated. The total benefits reported for EERE's entire portfolio are usually less that the sum of the individual programs due to competition between these technologies and the resulting tradeoffs. For instance, efficiency improvements reduce the future need for new electricity generating capacity, including the potential size of the renewable electric market. In addition, a research failure in one area will not necessarily reduce the technology's overall benefits, as the lack of market penetration by the failed technology may create a market opportunity elsewhere in the EERE portfolio. An integrated benefit total may be higher than the individual sums because of the additive impact of multiple EERE programs.
ns = Not significant

Facilities Maintenance and Repair

EERE's Facilities Maintenance and Repair activities are tied to its programmatic mission, goals and objectives. Facilities Maintenance and Repair activities funded by this budget are displayed below.

[a] An estimate of renewable electricity generation stimulated by the Renewable Energy Production Incentive is included in the section for Intergovernmental Activities. Because this is not one of the common benefits estimated for all programs, it is not included in this table.

Indirect-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Renewable Energy Laboratory	2,067	2,121	2,543
Total, Indirect-Funded Maintenance and Repair	2,067	2,121	2,543

Direct-Funded Maintenance and Repair

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Renewable Energy Laboratory	2,000	3,790	1,457
Total, Direct-Funded Maintenance and Repair (Energy Supply and Conservation)	2,000	3,790	1,457

Energy Supply and Conservation
Office of Energy Efficiency and Renewable Energy

Funding by Site by Program

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Ames Laboratory			
Vehicle Technologies	450	594	300
Industrial Technologies	216	276	21
Total, Ames Laboratory	666	870	321
Argonne National Laboratory (East)			
Hydrogen Technology	7,896	5,713	8,576
Biomass and Biorefinery Systems R&D	560	450	500
Solar Energy	20	0	0
Wind Energy Systems	20	0	0
Geothermal Technology	15	0	0
Vehicle Technologies	22,640	20,902	19,349
Industrial Technologies	3,188	2,085	1,624
Distributed Energy Resources	775	0	0
Federal Energy Management Program	766	0	0
Weatherization and Intergovernmental Activities	300	300	0
Program Direction	614	0	0
Program Support	1,510	1,089	900
Total, Argonne National Laboratory	38,304	30,539	30,949
Brookhaven National Laboratory			
Hydrogen Technology	680	970	1,573
Biomass and Biorefinery Systems R&D	20	0	0
Solar Energy	420	400	400
Geothermal Technology	362	0	0
Vehicle Technologies	1,065	545	600
Building Technologies	914	454	575

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Federal Energy Management Program	80	0	0
Program Direction	469	0	0
Program Support	510	406	410
Total, Brookhaven National Laboratory	4,520	2,775	3,558
Central Regional Office			
Solar Energy	50	25	0
Wind Energy Systems	701	100	0
Program Direction	3,171	3,255	0
Total, Central Regional Office	3,922	3,380	0
Golden Field Office/Project Management Center			
Solar Energy	300	150	0
Program Direction	13,992	14,695	20,908
Total, Golden Field Office	14,292	14,845	20,908
Idaho National Laboratory			
Biomass and Biorefinery Systems R&D	2,291	1,350	4,500
Wind Energy Systems	125	90	150
Geothermal Technology	2,922	2,000	0
Hydropower	749	100	0
Vehicle Technologies	3,222	3,059	2,935
Industrial Technologies	1,220	573	338
Federal Energy Management Program	301	0	0
Weatherization and Intergovernmental Activities	50	0	0
Program Direction	265	0	0
Total, Idaho National Laboratory	11,145	7,172	7,923
Lawrence Berkeley National Laboratory			
Hydrogen Technology	1,115	1,105	1,123
Solar Energy	36	0	0
Wind Energy Systems	250	200	250

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Geothermal Technology	1,330	1,000	0
Vehicle Technologies	6,497	6,905	5,500
Building Technologies	11,447	8,281	12,119
Industrial Technologies	2,224	1,584	1,407
Distributed Energy Resources	200	0	0
Federal Energy Management Program	2,458	2,007	1,887
Weatherization and Intergovernmental Activities	730	800	200
Program Direction	584	0	0
Program Support	720	515	520
Total, Lawrence Berkeley National Laboratory	27,591	22,397	23,006
Lawrence Livermore National Laboratory			
Hydrogen Technology	1,469	955	839
Geothermal Technology	1,075	500	0
Vehicle Technologies	2,485	3,222	2,962
Industrial Technologies	115	0	0
Federal Energy Management Program	21	0	0
Total, Lawrence Livermore National Laboratory	5,165	4,677	3,801
Los Alamos National Laboratory			
Hydrogen Technology	8,166	7,360	11,284
Biomass and Biorefinery Systems R&D	1,000	50	1,200
Vehicle Technologies	400	248	332
Building Technologies	250	250	250
Industrial Technologies	338	307	50
Total, Los Alamos National Laboratory	10,154	8,215	13,116
Mid-Atlantic Regional Office			
Solar Energy	50	25	0
Wind Energy Systems	105	50	0
Program Direction	2,399	3,039	0
Total, Mid-Atlantic Regional Office	2,554	3,114	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Midwest Regional Office			
Solar Energy	50	25	0
Wind Energy Systems	581	50	0
Program Direction	2,550	2,814	0
Total, Midwest Regional Office	3,181	2,889	0
National Energy Technology Laboratory			
Hydrogen Technology	0	0	56
Solar Energy	1,680	600	600
Geothermal Technology	0	3,000	0
Distributed Energy Resources	1,500	0	0
Federal Energy Management Program	1,687	2,211	2,211
Weatherization and Intergovernmental Activities	820	1,800	0
Program Direction (Project Management Center)	6,960	7,319	12,927
Program Support	100	99	100
Total, National Energy Technology Laboratory	12,747	15,029	15,894
National Nuclear Security Administration (NNSA) Service Center			
Vehicle Technologies	621	644	500
National Renewable Energy Laboratory			
Hydrogen Technology	12,071	9,560	14,272
Biomass and Biorefinery Systems R&D	22,222	14,662	27,500
Solar Energy	57,277	52,175	44,723
Wind Energy Systems	25,406	19,051	34,500
Geothermal Technology	3,147	2,110	0
Hydropower	384	50	0
Vehicle Technologies	17,257	16,278	7,136
Building Technologies	14,772	4,338	5,916
Industrial Technologies	999	786	695
Distributed Energy Resources	1,814	0	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Federal Energy Management Program	3,318	2,817	2,648
Facilities and Infrastructure	10,562	26,052	5,935
Weatherization and Intergovernmental Activities	6,000	3,600	500
Program Direction	1,391	0	0
Program Support	2,940	5,544	2,010
Total, National Renewable Energy Laboratory	179,560	157,023	145,835
Northeast Regional Office			
Solar Energy	50	25	0
Wind Energy Systems	185	50	0
Program Direction	2,675	4,715	0
Total, Northeast Regional Office	2,910	4,790	0
Oak Ridge National Laboratory			
Hydrogen Technology	4,461	1,805	5,302
Biomass and Biorefinery Systems R&D	2,633	746	3,500
Solar Energy	500	220	0
Wind Energy Systems	170	120	150
Hydropower	1,295	150	0
Vehicle Technologies	41,393	41,157	33,990
Building Technologies	6,130	4,409	6,639
Industrial Technologies	10,292	5,231	3,309
Distributed Energy Resources	26,367	0	0
Federal Energy Management Program	2,941	2,456	2,309
Weatherization and Intergovernmental Activities	4,800	4,000	500
Program Direction	4,997	0	0
Program Support	2,165	2,000	2,004
Total, Oak Ridge National Laboratory	108,144	62,294	57,703
Office of Scientific and Technical Information			
Wind Energy Systems	12	15	10
Geothermal Technology	310	10	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Hydropower	11	0	0
Total, Office of Scientific and Technical Information	333	25	10
Pacific Northwest National Laboratory			
Hydrogen Technology	3,814	2,680	4,000
Biomass and Biorefinery Systems R&D	4,367	4,264	6,200
Wind Energy Systems	25	0	0
Geothermal Technology	70	0	0
Hydropower	1,170	150	0
Vehicle Technologies	6,018	6,989	4,855
Building Technologies	5,638	5,377	4,656
Industrial Technologies	1,920	1,462	386
Distributed Energy Resources	200	0	0
Federal Energy Management Program	2,062	1,756	1,651
Weatherization and Intergovernmental Activities	3,700	3,800	0
Program Direction	1,310	0	0
Program Support	1,311	1,189	1,101
Total, Pacific Northwest National Laboratory	31,605	27,667	22,849
Sandia National Laboratories			
Hydrogen Technology	4,863	4,435	5,429
Solar Energy	8,519	10,430	8,830
Wind Energy Systems	5,580	3,695	6,300
Geothermal Technology	4,405	3,500	0
Vehicle Technologies	7,629	7,534	8,443
Industrial Technologies	1,420	1,038	499
Federal Energy Management Program	252	224	211
Weatherization and Intergovernmental Activities	615	700	300
Program Direction	324	0	0
Program Support	600	396	400
Total, Sandia National Laboratories	34,207	31,952	30,412

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Savannah River National Laboratory			
Hydrogen Technology	450	400	855
Federal Energy Management Program	39	0	0
Total, Savannah River National Laboratories	489	400	855
Southeast Regional Office			
Solar Energy	50	25	0
Wind Energy Systems	85	50	0
Program Direction	3,078	3,300	0
Total, Southeast Regional Office	3,213	3,375	0
Washington Headquarters			
Hydrogen Technology	121,787	120,644	142,492
Biomass and Biorefinery Systems R&D	54,378	69,196	106,287
Solar Energy	15,203	18,988	93,819
Wind Energy Systems	7,101	15,221	2,309
Geothermal Technology	11,620	10,946	0
Hydropower	1,271	45	0
Vehicle Technologies	51,649	74,027	79,122
Building Technologies	26,004	46,157	47,174
Industrial Technologies	51,439	43,513	37,234
Distributed Energy Resources	28,213	0	0
Federal Energy Management Program	5,957	7,503	5,989
Facilities and Infrastructure	827	0	0
Weatherization and Intergovernmental Activities	308,437	301,866	223,531
Program Direction	50,852	56,360	57,189
Program Support	6,981	2,083	3,485
Total, Washington Headquarters	741,719	766,549	798,631
Western Area Power Administration			
Wind Energy Systems	125	90	150
Western Regional Office			

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Solar Energy	50	25	0
Wind Energy Systems	160	75	0
Program Direction	2,584	3,032	0
Total, Western Regional Office	2,794	3,132	0
Total, Energy Supply and Conservation	1,239,961	1,173,843	1,176,421

Major Changes or Shifts by Site

Regional Offices (Western Regional Office, Central Regional Office, Midwest Regional Office, Northeast Regional Office, Mid-Atlantic Regional Office, Southeast Regional Office)

Program Direction

- As part of a broader effort to refocus deployment activities, the FY 2007 budget reflects the consolidation and functional shift of realigned deployment activities performed by the six Regional Offices to the two Project Management Centers — the Golden Field Office and the National Energy Technology Laboratory. Beginning with FY 2007, the six Regional Offices will be closed.

Idaho National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, National Energy Technology Laboratory, National Renewable Energy Laboratory, Sandia National Laboratories, and Washington Headquarters

- The Geothermal Program is closing out program activities in FY 2007. Laboratory efforts in FY 2007 will focus on completing the documentation of technology partnerships, transferring research findings to industry, and archiving legacy documents.

Site Description

Ames Laboratory

Ames Laboratory is a multi-discipline laboratory located in Ames, Iowa. Ames provides research for Vehicle Technologies in new materials. Ames conducts basic research on new materials with unique properties. It is a multi-discipline laboratory providing support to Vehicle Technologies and Industrial Technologies.

Vehicle Technologies

Ames Laboratory work for VT includes the development of low-cost powder metallurgy manufacturing methods for particle reinforced aluminum (PRA) composite components. Materials efforts are working to improve powder for permanent magnets.

Industrial Technologies

Ames Laboratory work for ITP includes the development of a new class of materials with extreme resistance to abrasive and erosive wear for use in industrial tools and components.

Argonne National Laboratory East

Introduction

Argonne National Laboratory (ANL) is located in Argonne, Illinois. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Geothermal Program, Vehicle Technologies, Industrial Technologies, Distributed Energy Resources, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Program Direction, and Program Support.

Hydrogen Technology

ANL is conducting research and development of advanced hydrogen storage concepts including modeling of storage systems and life cycle analyses. ANL is the lead laboratory in all facets of the research and development of fuel processor catalysts and fuel cell system analysis. ANL provides technical assistance in the management of DOE cooperative agreements with industry. ANL develops catalysts, materials, and processes for the autothermal reforming of gasoline and other fuels including diesel with CO clean-up, investigates the effect of fuel additives on fuel processor performance, and characterizes the stability and degradation of fuels processing catalysts. ANL is using sulfonated polyarl ether dendrimers (highly branched macromolecules) and inorganic/organic composites to develop membrane electrolytes with high proton conductivity at low relative humidity and temperatures ranging from room temperature to above 100°C. To minimize the cost of fuel cell cathode catalysts, ANL is exploring transition metal carbides/nitrides based materials, especially the mixed transition metal carbides/nitrides (e.g. M_1M_2N, $M_1N_xC_y$, M = transition metal).

Biomass and Biorefinery Systems R&D

ANL conducts research on biomass conversion processes and environmental benefits analysis for several EERE programs, including energy balance and emissions for biofuels in conventional and advanced vehicles with and without fuel cells.

ANL will conduct R&D related to converting biomass to bio-based products with the goal of making the technologies more competitive with petroleum-based alternatives.

Solar Energy

ANL performs technical, market, economic, and other analyses.

Wind Energy Systems

ANL prepared a programmatic environmental impact statement for Wind Energy Systems development on Federal lands.

Geothermal Program

Provided analytical support for major crosscutting issues, such as market and benefit analyses.

Vehicle Technologies

ANL provides simulation, analysis, and develops transient models for hybrid and fuel cell systems. Develops sophisticated software for hardware-in-the loop (HIL) testing. Provides technical support and analysis for heavy hybrids. Conducts research to reduce parasitic loads on heavy vehicles including reductions in idling losses, rolling resistance, aerodynamic drag, and under hood thermal management. Also, works to improve oil filtration, coolants, and regenerative shocks for trucks. Performs high-performance computing with particular focus on computational fluid dynamics (combustion, underhood cooling, HVAC, etc.). Utilizes the Advanced Photon Source facility to characterize fundamental mechanisms of friction, lubrication, and fuel spray from fuel injectors. Develops nano-fluid technology and new designs for higher efficiency heavy vehicle cooling systems. Monitors R&D in industry for underhood electrification for heavy vehicle components and new brake material developments. Provides technical and analytical expertise to the Graduate Automotive Technology Education (GATE) activities. Provides technical support for advanced vehicles student competition. Conducts HEV component and subsystem performance and emissions tests in a state-of-the-art test facility. Validates components and subsystems performance targets for hybrid and fuel cell technology using HIL testing to simulate vehicle operating environment. Develops test procedures for advanced vehicle testing and control strategies to improve overall vehicle efficiency and reduce emissions. Conducts research in energy storage for EVs and HEVs and high performance capacitors. Provides battery technical support, and testing of advanced batteries.

Conducts research and development of in-cylinder emission control techniques for CIDI engines and the evaluation of innovative technologies to reduce emissions and improve fuel efficiencies in heavy-duty diesel engines. Develops wide range of materials (both metals and ceramics), with particular expertise in nondestructive evaluation, rapid prototyping, sensors, and catalysts. Develops economic processes for automotive recycling. Develops permanent magnet materials for high performance motors. Characterizes the effect of micro-dimpling on reduction of surface friction and wear. Develops lower temperature, high strength bonding methods for ceramics and dissimilar materials. Conducts technology analysis (energy, environmental, and economic) as well as vehicle system and subsystem modeling.

Industrial Technologies

ANL performs research and development for the chemical industry R&D area. Argonne provides unique expertise in advanced separations process technologies and new innovative membrane systems. The laboratory also does research on refractory materials for the steel industry. The laboratory also has unique expertise in anode and cathode development for the aluminum industry using technology to analyze the surface effects conditions on the advanced candidate materials.

Distributed Energy Resources

ANL performs research and development including non-destructive evaluation (NDE) of advanced ceramics, high temperature recuperators and coatings and laser ignition research for reciprocating engines. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006.

Federal Energy Management Program

Argonne National Laboratory (ANL) received direct funding from the Departmental Energy Management Program for energy retrofit projects to increase the energy efficiency of its facilities and reduce future utility and maintenance costs. ANL also received funding for a Model Program effort to evaluate expanding the Energy Savings Performance Contract at their site.

Weatherization and Intergovernmental Activities

Funding to ANL supports international activities, primarily in the Asia-Pacific Economic Cooperation (APEC) area by providing technical assistance and support to the program's APEC related projects.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Brookhaven National Laboratory

Introduction

Brookhaven National Laboratory (BNL) is located in Upton, New York. It is a multi-disciplinary research laboratory and is dedicated to basic, non-defense scientific research. BNL provides support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Geothermal Technology, Vehicle Technologies, Building Technologies, Federal Energy Management Program, Program Direction, and Program Support.

Hydrogen Technology

Brookhaven is providing support to Hydrogen Technology; specifically, development of advanced metal hydride hydrogen storage concepts.

BNL conducts research and development of electrocatalysts alloys fuel cell focusing on synthesis and characterization of the materials.

Biomass and Biorefinery Systems R&D

BNL supports EERE analysis of effects and benefits associated with renewable energy and efficiency technologies.

Solar Energy

BNL performs research and development for the Photovoltaic Energy Systems efforts. BNL has the responsibility for environmental, health, and safety (ES&H) impacts associated with photovoltaic energy production, delivery, and use. BNL conducts ES&H audits, safety reviews, and incident investigations and assists industry to identify and examine potential ES&H barriers and hazard control strategies for new photovoltaic materials, processes, and application options before their large-scale commercialization.

Geothermal Technology

BNL supported System Development research activities in advanced drilling and energy conversion research, including drilling materials, high temperature elastomers, and silica recovery from geothermal brines.

Vehicle Technologies

Performs analysis, studies and conducts research in advanced materials to improve the performance and abuse tolerance of lithium battery systems and provides research support for analysis of internal combustion (IC) engine emissions for the FreedomCAR partnership.

Building Technologies

BNL conducts research and development activities for the space heating and cooling technologies for Building Technologies.

Federal Energy Management Program

Brookhaven National Laboratory received direct funding from the Departmental Energy Management Program for an energy retrofit project to increase the energy efficiency of its facility and reduce future utility and maintenance costs.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America

(formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

Provides analytical support for crosscutting issues such as market and benefit analyses.

Central Regional Office

Introduction

The Central Regional Office, located in Golden, Colorado, provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level. It provided support to Solar Energy, Wind Energy Systems, and Program Direction.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Central Regional Office will be transferred to the Golden PMC.

Solar Energy

The Central Regional Office helped to administer Million Solar Roofs.

Wind Energy Systems

The Central Regional Office provided support deployment and outreach programs on a local and regional level.

Program Direction

The Central Regional Office provided support deployment and outreach programs on a local and regional level.

Golden Field Office

Introduction

The Golden Field Office (GO) is located in Golden, Colorado. It provides project management and procurement support for Solar Energy and Program Direction. In FY 2007, the Golden Field Office will also carry out some deployment activities previously handled by the ROs. The Golden Field office provides support to Solar Energy and Program Direction.

Solar Program

Golden Field Office provides project management and procurement support for Solar Energy.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Idaho National Laboratory

Introduction

Idaho National Laboratory (INL) is located in Idaho Falls, Idaho. It is a multi-discipline laboratory providing support to Biomass and Biorefinery Systems R&D, Wind Energy Systems, Vehicle Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, and Program Direction. It also previously supported the Hydropower Program and Geothermal Technology Program.

Biomass and Biorefinery Systems R&D

INL provides biomass-related R&D services and support for the feedstock infrastructure development effort. This work is performed in close collaboration with ORNL and NREL.

Wind Energy Systems

INL provides technical support to the program to enhance government, military applications and Tribal use of wind energy systems, and to address technical and market barriers to wind.

Geothermal Technology

INL served as the lead laboratory for research and development in geosciences and reservoir management. INL conducted research in exploration technologies, Enhanced Geothermal Systems, and advanced heat and power systems.

Hydropower

INL provided engineering and technical support to the Hydropower Program. INL served as the engineering technical monitor for the Advanced Hydro Turbine Technology Subprogram and the Tribal Energy hydropower projects located in Alaska, and conducts hydropower resource and economic assessments. These efforts concluded in FY 2006 when the program was closed out.

Vehicle Technologies

INL develops and assesses advanced oil by-pass filter concepts for heavy vehicles; develops and assesses ultracapacitors for hybrid vehicles. The Laboratory also conducts tests of high-power batteries,

develops battery test procedures, tests and simulates hybrid vehicle performance, and develops energy storage models for electric and hybrid vehicles (SIMPLEV). Additionally, INL develops and demonstrates spray forming process for rapid production on net-shape molds, dies, and related tooling for automotive components; models slurry performing for fiber reinforced composites, non-destructive evaluation of cylinder liners, intelligent welding and spray forming of aluminum, and characterizes metallic structures produced by equal channel angular extrusion process. INL conducts field testing and evaluation of electric, hybrid and hydrogen light duty vehicles and infrastructure, and supports Federal Fleet acquisition reporting as required.

Industrial Technologies

INL provides critical support in project management and analysis for the Forest Products and Steel activities. Work is ongoing for an advanced black liquor spray atomization process for the Forest Products industry, and on the development of controlled thermal-mechanical processing of tubes and pipes for enhanced manufacturing performance and in the development and application of laser-assisted arc welding in the steel industry.

Federal Energy Management Program

Idaho National Laboratory (INL) received direct funding from the Departmental Energy Management Program for an energy retrofit project to increase the energy efficiency of its facility and reduce future utility and maintenance costs. INL also received funding for an audit of their facilities to identify future retrofit projects under Model Programs.

Weatherization and Intergovernmental Activities

Funding to INL supported technical analysis of Inventions and Innovations grant proposals.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Lawrence Berkeley National Laboratory

Introduction

Lawrence Berkeley National Laboratory (LBNL) is located in Berkeley, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Solar Energy, Wind Energy Systems, Geothermal Technology, Vehicle Technologies, Building Technologies, Industrial Technologies,

Distributed Energy Resources, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Program Direction, and Program Support.

Hydrogen Technology

Lawrence Berkeley National Laboratory develops electrocatalysts for membrane electrode assemblies (MEAs) with the goal of increasing understanding of fundamental electrochemical processes.

Solar Energy

LBNL performs technical, market, economic, and other analyses.

Wind Energy Systems

LBNL performs analyses of opportunities for Wind Energy Systems applications in the electricity market.

Geothermal Technology

LBNL performed research on Enhanced Geothermal Systems and exploration technology including studies of reservoir dynamics and seismic, isotopic, and electromagnetic exploration techniques.

Vehicle Technologies

Conducts exploratory research in advanced battery technology, including development of new electrode and electrolyte materials and understanding of fundamental electrochemical phenomena. Develops devices to measure particulate matter from engines. Develops nondestructive testing techniques for evaluation of aluminum and composite structures in manufacturing environments.

Building Technologies

LBNL conducts research and development activities in lighting, windows, appliance standards, analysis tools and design strategies and space heating and cooling.

Industrial Technologies

LBNL supports technology delivery activities of the Best Practices Program including assistance in facilitating Allied Partners with supplier industry organizations (e.g. Hydraulic Institute, Compressed Air and Gas Institute). The laboratory supports the tracking of Best Practices implementation results including the impact of training, software tools and other program delivery mechanisms on manufacturing plants.

Distributed Energy Resources

LBNL will perform analysis tasks to quantify benefits of distributed generation technologies to the customer, the system and the Nation.

Federal Energy Management Program

LBNL facilitates projects, develops guidelines and provides expert advice on the monitoring and verification protocols for energy projects savings, laboratory sustainable design principles, public benefit funds, and lighting.

Weatherization and Intergovernmental Activities

LBNL performs on-going research and technical assistance for the International Renewable Energy Program, including technical assistance for U.S.-China energy cooperation, and support for Collaborative Labeling and Appliance Standards Projects (CLASP).

LBNL also provides technology transfer technical outreach for Rebuild America and ENERGY STAR® In FY 2007 both Rebuild America and ENERGY STAR® subprograms transferred to the Office of Building Technologies.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

LBNL provides analytical support for major crosscutting issues, such as market and benefit analyses.

Lawrence Livermore National Laboratory

Introduction

Lawrence Livermore National Laboratory (LLNL) is located in Livermore, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Geothermal Technology, Vehicle Technologies, Industries Technologies, and Federal Energy Management Program.

Hydrogen Technology

LLNL serves as the lead laboratory in research and development of a high temperature solid oxide electrolyzer and two different systems for pressurized gas storage of hydrogen. LLNL is capable of producing composite storage tanks for environmental testing to verify the advantages of various engineering concepts to increase the storage capacity while reducing the cost of manufacturing.

Geothermal Technology

LLNL conducted research and development in Enhanced Geothermal Systems and exploration technology, including isotope and geochemical studies.

Vehicle Technologies

LLNL provides application of advanced methods of conventional fluid dynamics to aerodynamic drag of heavy vehicle for increased energy efficiency. Performs studies of combustion under diesel and homogeneous charge compression ignition (HCCI) conditions using chemical kinetic modeling and other methods to determine means for increasing fuel efficiency, reducing emissions, and increasing peak output power of advanced internal combustion engines (ICEs). Research is directed at materials development and advanced automotive manufacturing concepts, such as metal treatment using Plasma Surface Ion Implantation (PSII) and development of low-cost aluminum sheet. Develops high-voltage, dielectric ultracapacitors based on nanostructure multilayer oxide materials. Develops aerogel-based NO_x catalysts for CIDI engines. Conducts nondestructive evaluation and develops in-line sensors for the design and product optimization of cast light metals. Applies equal channel angular extrusion to the fabrication of amorphous metallic materials for magnet applications. Chemical kinetic modeling of in-cylinder combustion process of advanced HCCI engine technology as it applies to natural gas engines.

LLNL is constructing and testing hydrogen sensors, both for safety and for fuel stream monitoring in a fuel cell vehicles.

Industrial Technologies

In FY 2005 Lawrence Livermore National Laboratory worked with the Industrial Technologies Program to conduct research on fibrous fillers to manufacture ultra-high ash performance paper and hot rolling scrap reduction through reduction in surface defects.

Federal Energy Management Program

Lawrence Livermore National Laboratory received direct funding from the Departmental Energy Management Program for a survey audit to identify ways to increase the energy efficiency of its facilities and reduce future utility and maintenance costs.

Los Alamos National Laboratory

Introduction

Los Alamos National Laboratory (LANL) is located in Los Alamos, New Mexico. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Vehicle Technologies, Building Technologies, and Industrial Technologies.

Hydrogen Technology

LANL is conducting research and development of advanced hydrogen storage concepts supporting chemical hydrogen storage.

LANL serves as the lead laboratory in research and development of fuel cell components, reduction of precious metal loading while maintaining performance, and characterization of the poisoning of fuel cell catalysts by impurities in air and fuel feeds. To facilitate heat rejection and simplify the fuel cell system, LANL is designing, synthesizing, and characterizing membranes which operate at low relative humidity and high temperatures, 120°C for transportation applications. Other fuel cell related work at LANL includes: development of direct methanol fuel cells at LANL will accelerate high-volume

manufacturing processes for fuel cells; investigating the impact of sub-freezing temperatures on performance and durability of specific fuel cell components; and characterizing the durability of fuel cell stacks operating on hydrogen (targets are 5,000 hours for transportation applications and 40,000 hours for stationary applications), since the durability of fuel cell stacks has not been demonstrated. Additionally, LANL is developing low-cost, high surface area support materials to "replace" precious-metals supports and developing high performance MEAs from alternative ionomer (non-Nation) membrane materials, and is exploring pyrolized macrocycle transition metal catalyst as replacements for the expensive platinum catalysts in fuel cell electrodes.

Biomass and Biorefinery Systems R&D

LANL is supporting the program's technical analysis activity to enhance the probability of achieving cost reduction goals for the biorefinery concept.

Vehicle Technologies

Performs research on combustion in internal combustion engines using simulation and modeling to increase efficiency and reduce NO_x in lean-burn engines and develops microwave regeneration components and design tools for emission controls. Los Alamos is also performing R&D to discover and develop next-generation emission-control catalysts for lean burn engines and to develop technology for onboard generation of chemical reductants from diesel fuel.

Building Technologies

LANL conducts research and development for activities in Windows Technologies.

Industrial Technologies

LANL supports program work for the Chemical industry R&D area. The laboratory provides unique capabilities in theoretical scientific analysis modeling fluid flows and understanding chemical reactions and catalysis phenomena. LANL provided the computer analysis of industrial fluid flows, and the computer technology prepared for use by the civilian sector. LANL also supports the Industrial Materials of the Future activities in the development of new materials for membrane separation systems.

Mid-Atlantic Regional Office

Introduction

The Mid-Atlantic Regional Office provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level. It is located in Philadelphia, Pennsylvania and provided support to Solar Energy, Wind Energy Systems, and Program Direction.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Mid-Atlantic Regional Office will be transferred to the NETL PMC.

Solar Energy

The Mid-Atlantic Regional Office helped to administer the Solar Powers America (formerly Million Solar Roofs).

Wind Energy Systems

The Mid-Atlantic Regional Office provided support deployment and outreach programs on a local and regional level.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Midwest Regional Office

Introduction

The Midwest Regional Office provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level. The Midwest Regional Office is located in Chicago, Illinois. It supported Solar Energy, Wind Energy Systems, and Program Direction.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Midwest Regional Office will be transferred to the Golden PMC.

Solar Energy

The Midwest Regional Office helped to administer the Solar Powers America (formerly Million Solar Roofs).

Wind Energy Systems

The EERE Project Management Center administered financial assistance awards for Distributed Wind Technology industry R&D partnerships, interagency agreements, field verification projects, congressionally-directed projects, and collaborative outreach activities.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

National Energy Technology Laboratory

Introduction

The National Energy Technology Laboratory (NETL) is located in Morgantown, West Virginia. It provides project management and procurement support to Hydrogen Technology, Solar Energy, Geothermal Technology, Distributed Energy Resources, Federal Energy Management Program, the Weatherization and Intergovernmental Activities, Program Direction and Program Support. In FY 2007, the National Energy Technology Laboratory will also carry out some deployment activities previously handled by the ROs.

Hydrogen Technology

In accordance with a Memorandum of Agreement with the Office of Fossil Energy, NETL co-manages hydrogen research and development efforts to improve the efficiency and lower the cost of fossil-based hydrogen production processes. Collaboration also occurs with the Office of Fossil Energy and NETL for producing hydrogen from coal. Specifically, NETL researchers will be developing separation and purification methods critical to producing high quality hydrogen used in fuel cells.

Solar Energy

National Energy Technical Laboratory provides support for various solar deployment activities at the regional, state, and local level.

Geothermal Technology

The State Energy Program Special Project funding for Geothermal formerly went through the Regional Office (RO), and the contracting for the RO was conducted by NETL.

Distributed Energy Resources

NETL manages the university program that supports the advanced reciprocating engine program and performs in-house R&D for that program. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006.

Federal Energy Management Program

Providing technical and financial analyses support for the Biomass Alternate Methane Fuels Technology Specific Super Energy Savings Performance Contract activities.

Weatherization and Intergovernmental Activities

National Energy Technology Laboratory provides technology transfer technical outreach, grants management system development, and tools development for many WIP activities.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

Program Support funds are provided to NETL for the purpose of assisting in utilizing enhanced planning, analytical, and evaluation methodologies and tools; supporting cost/benefits analyses, road maps, data collection, and performance methodologies to support the Government Performance and Results Act (GPRA) as well as OMB's Performance Assessment Rating Tool (PART) and the Research and Development Investment Criteria (RDIC).

National Nuclear Security Administration (NNSA) Service Center

Introduction

The NNSA Service Center is located in Albuquerque, New Mexico. It is a multi-discipline Service Center providing support to Solar Energy and Vehicle Technologies.

Solar Energy

The NNSA Service Center administers the cooperative agreements for the Southeast and Southwest Regional Experiment Stations for Solar Energy.

Vehicle Technologies

Solicits, awards, and administers research and development contracts, cooperative agreements, and grants with industry, academia, and other government organizations. Provides research in full scale aerodynamic stability tests for heavy vehicles.

National Renewable Energy Laboratory

Introduction

The National Renewable Energy Laboratory (NREL) is located in Golden, Colorado. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Vehicle Technologies, Building Technologies, Industrial Technologies, Distributed Energy Resources, Federal Energy Management Program, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, Program Direction, and Program Support. NREL also previously provided support to the Hydropower Program and Geothermal Technology Program.

Hydrogen Technology

NREL serves as the lead laboratory in research and development of technologies using renewable resources that will offer longer-term solutions to the production and storage of hydrogen. NREL is conducting research and development on material systems for the storage of hydrogen using carbon nanotubes and the photoelectrochemical production of hydrogen using semiconductors. NREL also conducts research and development to engineer biological organisms and photoelectrochemical systems to split water into hydrogen and oxygen and the conversion of biomass to hydrogen. Additionally, NREL designs new processes and facilities to produce and use hydrogen through engineering calculations and cost evaluations, and provides key technical expertise for codes and standards development.

National Renewable Energy Laboratory leads the Systems Integration and Analysis function for the program. Models of the technical, economic, and integration aspects of the hydrogen infrastructure and fuel cell vehicle systems provide guidance for the development of hydrogen fuel cell components and materials. In support of ORNL's metallic bipolar plate project, NREL will survey current commercially available alloys to determine the best combination of alloy composition and evaluate nitrided metal samples. NREL will explore pure heteropoly acids (HPAs) and HPA/organic polymer mixtures for high temperature membranes in fuel cells.

Biomass and Biorefinery Systems R&D

NREL is the lead laboratory for biomass R&D. NREL also develops analytical methodologies (chemical and life-cycle) that are used to facilitate industry's commercialization efforts, including economic assessment of technologies. NREL operates two user facilities, the Thermochemical Users Facility (TCUF) for syngas technologies, and the Alternative Fuels Users Facility (AFUF) for bioconversion technologies. Private sector participants may use the facilities after appropriate arrangements are made. NREL contributes to bio-based product tasks.

Solar Energy

NREL serves as the lead laboratory for the Solar Energy Technology Program. NREL conducts fundamental and applied materials research on photovoltaic devices, photovoltaic module reliability and systems development, data collection and evaluation on solar radiation, and implementation of cost-shared government/industry partnerships. Basic research teams investigate a variety of photovoltaic materials, such as amorphous silicon, polycrystalline thin films, high-efficiency materials and concepts,

and high-purity silicon and compound semiconductors. NREL conducts simulated and actual outdoor tests on photovoltaic cells, modules, and arrays. The test results are used in developing standards and performance criteria for industry and to improve reliability.

Wind Energy

NREL is the lead laboratory for national wind R&D, performing research in aerodynamics, structural dynamics, and advanced components and control systems related to wind energy systems. The National Wind Technology Center (NWTC), located at NREL, provides research and testing facilities for fatigue testing of turbine blades, dynamometer testing of wind turbine drive trains and generators, atmospheric testing of turbines, and certification testing which are required for sales and operation in many overseas markets. NWTC staff also conducts the Department's cost-shared R&D industry partnerships for large (> 100kW) wind turbine systems, and provides technical assistance for the Wind Powering America activity.

Geothermal Technology

NREL formerly served as the lead laboratory for Advanced Power System under Systems Development. The laboratory also supports in the Deployment areas of education, outreach and Technical Analysis. In FY 2007, the program will be closed out.

Hydropower

NREL conducted hydropower/renewable energy integration studies and hydropower outreach activities. In FY 2006, the Hydropower Program was closed out.

Vehicle Technologies

NREL provides analysis of performance targets for passenger and commercial vehicles, including developing a Technical Targets Tool for government use. NREL also develops system models and provides analysis and simulation of advanced hybrid and fuel cell configurations using the ADVISOR software developed at the lab, as well as other tools; provides CAD/CAE for optimized vehicle system solutions in support of FreedomCAR partnership goals; and general engineering assessments of HEV and AFV technologies. The laboratory investigates and develops advanced battery thermal management for hybrid and fuel cell vehicles. For heavy duty vehicles, NREL provides analysis, modeling, and technical support for power electronics and electric machines; conducts engine/vehicle integration and platform studies; leads an effort to identify the effects of sulfur levels in diesel fuels on emissions control devices. Leads an effort to determine the lube oil effects on exhaust after treatment devices; and conducts tests of bio-based diesel fuel blending agents to determine their ability to act as reductants in the exhaust stream of diesel engines. NREL also supports EPAct 1992 regulatory programs including Federal Fleet, State and Fuel Provider, Private and Local, and Fuel petitions; and supports the Clean Cities deployment program with technical assistance to regional coalitions and fleet partners, and program analysis and evaluation.

Building Technologies

NREL conducts research and development for the following activities in Building Technologies: Building America, and High Performance Buildings and Windows.

Industrial Technologies

NREL supports the Best Practices Program in communication activities and products. NREL supports overall Industry Program analysis of the logic of individual program activities including the relationship between program goals, milestones and the budget formulation process for several areas including Industrial Materials of the Future, Aluminum and Metal Casting.

Distributed Energy Resources

NREL conducts research and development of novel material, sensor and processing techniques for advanced desiccant systems for humidity control and improved air quality. NREL also performs analysis addressing regulatory and institutional barriers to distributed energy and electricity reliability. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006.

Federal Energy Management Program

NREL facilitates projects, develops guidelines and provides expert advice on sustainable and renewable facility designs, green power procurement, distributed energy resources, and alternative financing.

Facilities and Infrastructure

The Facilities and Infrastructure Program provides funding for plant and capital equipment (PCE) which provides routine upgrades of the laboratory's office, research and user facilities. The program also supports major construction projects, such as the Science Technology Facility that began construction in FY 2004 and is scheduled for completion in FY 2007.

Weatherization and Intergovernmental Activities

NREL provided technical assistance to the transfer of renewable energy and energy efficiency technologies to Native American tribal lands. NREL is also the lead laboratory for the International Renewable Energy Program efforts (e.g., Global Village Energy Partnership (GVEP) and the Climate Energy Technology Export Initiative (CETE) seeking to mobilize private investment in clean energy technologies identified as climate change and development priorities by key developing and transition countries). NREL analyzes the program's communications strategy and develops information outreach products for WIP and specific subprograms. NREL also provides technical assistance in identifying and developing energy policies that will reduce greenhouse gas emissions. In addition, NREL works cooperatively with the private sector.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America

(formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

Provides analytical support for crosscutting issues, such as market and benefit analyses.

Northeast Regional Office

Introduction

The Northeast Regional Office provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level. It is located in Boston, Massachusetts and supported Wind Energy Systems, Solar Energy and Program Direction. The Northeast Regional Office provided support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private and provided direction, guidance, and support deployment and outreach programs on a local and regional level.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Northeast Regional Office will be transferred to the NETL PMC.

Solar Energy

The Northeast Regional Office helped administer the Solar Powers America (formerly Million Solar Roofs).

Wind Energy Systems

The Northeast Regional Office provided support deployment and outreach programs on a local and regional level.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Oak Ridge National Laboratory

Introduction

Oak Ridge National Laboratory (ORNL) is located in Oak Ridge, Tennessee. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management, Weatherization and Intergovernmental Activities, Program Direction, and Program Support. ORNL also previously supported the Hydropower and Distributed Energy Resources Programs.

Hydrogen Technology

ORNL performs research and development activities in photobiology and storage in support of the lead labs, NREL and Sandia National Laboratories. ORNL has collaborated with NREL and UC Berkeley to develop a microalgae system for the production of hydrogen. ORNL is using their expertise to integrate engineered biological systems from NREL and UC Berkeley into a base organism that directly produces hydrogen.

Oak Ridge National Laboratory is the primary National Laboratory for materials R&D aimed at reducing cost and increasing the durability of fuel cell components. ORNL carries out R&D on metal bipolar plates with nitride surface layers and temperature sensors. It characterizes the structure of membranes and membrane electrode assemblies and it develops high-thermal-conductivity graphite fibers for fuel cell thermal management. To reduce sulfur in fuel gas stream, ORNL develops a catalyst to oxidize hydrogen sulfide to elemental sulfur.

Biomass and Biorefinery Systems R&D

ORNL conducts biomass technologies R&D, evaluates harvesting technology for biomass, and conducts environmental research, residue and forests research, and resource and market analysis. These efforts are closely coordinated with INL and NREL.

ORNL provided assistance on biomass technology assessment and information transfer.

Solar Energy

ORNL was the primary laboratory responsible for conducting hybrid solar lighting R&D for the Solar Program. This included research into sunlight transmission through fiber optics; designing and testing systems that collect the sunlight, transferring it into fiber optics, and then distributing the sunlight into rooms; and coordinating industrial partners interested in commercializing the technology. These efforts have been concluded.

Wind Energy Systems

ORNL provides analysis and support to wind integration studies and applications.

Hydropower

ORNL provided biological and environmental analysis and testing support for the DOE Hydropower Program. ORNL had the primary responsibility for environmental mitigation studies and for developing the large hydropower turbine testing protocol. In FY 2006, the Hydropower Program was closed out.

Vehicle Technologies

ORNL develops models to estimate cost of advanced hybrid and fuel cell vehicles to perform trade-off studies, and also develops models to predict emissions from advanced after-treatment devices. ORNL performs research and development on high thermal conductivity carbon foams for high performance truck and automobile radiators, as well as R&D of advanced materials such as carbon fiber, aluminum, titanium, and magnesium. Conducts analysis, technical support, testing and research on power electronic devices and electric machines. Conducts research and provides technical/project management support in propulsion and vehicle system materials. Develops material analytical techniques and material related solutions for automotive and heavy vehicle systems. Conducts research in internal combustion engine technologies, in-cylinder diagnostics (such as application of chaos theory and emission studies), and exhaust after treatment (including catalytic converter research, development, and testing). Develops an understanding of NO_x absorber processes affecting regeneration, desulfation, and degradation under real-world conditions. Provides detailed characterization and speciation of combustion and emission products. Using primarily laboratory reactors and some engine experiments, acquires kinetic data for the development of computer models of after treatment devices. Evaluates the toxicity of unregulated emissions that are present in the exhaust streams of engines operating on advanced fuels. Leads an effort to evaluate the fuel effects on selective catalytic reduction systems on diesel engines. Evaluates the critical fuel properties that effect near term emissions control devices for diesel engines. Determines the effects and the mechanism of lube oil suspended phosphorous on the poisoning of exhaust catalysts in diesel engines. Conducts analysis, technical support, testing and research on power electronic devices (converters and controllers) and electric motors. Gathers heavy truck on-road performance data to improve models. Operates the High Temperature Materials Laboratory, which provides user facilities for materials characterization. Maintains the legislatively-mandated Fuel Economy Guide and its website: www.fueleconomy.gov.

Building Technologies

ORNL is part of a National Laboratory/industry/university consortium conducting research and development for the following activities: Building America; space heating and cooling; envelope and emerging technologies.

Industrial Technologies

In support of the Best Practices effort, ORNL provides support to Plant-Wide Assessments and other technical assistance and also assists in the tracking of program impacts. The lab also helps in the development and delivery of software tools and training. ORNL is the primary laboratory supporting the Industrial Materials of the Future activities to develop advanced materials for industrial use that meet technical requirements identified by industry in the visions and technology roadmaps.

Distributed Energy Resources

ORNL is the primary lab for DER technology development and end-use systems integration. ORNL conducted research and development in advanced materials and sensors for industrial gas turbines and microturbines, advanced reciprocating engines, thermally activated technologies, and combined heat and power (CHP). To conduct this research, ORNL leveraged state-of-the-art, unique resources such as the High Temperature Materials Laboratory (HTML) User Center, the Building Technology User Center, and the CHP Integration User Center. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006

Federal Energy Management Program

ORNL facilitates projects, develops guidelines, and provides expert advice on combine heat and power systems, biomass opportunities, whole building design, and alterative financing.

Weatherization and Intergovernmental Activities

In the International Renewable Energy Program, ORNL provides technical assistance to developing countries in the Asia-Pacific region. This assistance includes training in the use of various models for analyzing various options for mitigating and sequestering greenhouse gas emissions.

Additionally, ORNL assists WIP in the evaluation of state and local grant programs.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Office of Scientific and Technical Information

Introduction

Office of Scientific and Technical Information (OSTI) is located in Oak Ridge, Tennessee. It provides technical support for Wind Energy Systems and Vehicle Technologies. OSTI also previously supported the Hydropower Program and Geothermal Technology Program.

Wind Energy Systems

OSTI distributes technical information for the program, including publishing and maintaining on-line full text of electronic current awareness publications.

Geothermal Technology

OSTI distributed information for the Geothermal Technology Program including publishing, digitizing of legacy documents, and maintaining on-line full text of electronic publications. The Geothermal Program will close out in FY 2007.

Hydropower

OSTI distributed information developed by the Hydropower Program, which closed out in FY 2006, including publishing and maintaining on-line full text of electronic current awareness publications.

Vehicle Technologies

Disseminates heavy vehicle technical reports and literature. Assists in conducting industry/Federal Government workshops in support of Multi-Year Program Planning efforts.

Pacific Northwest National Laboratory

Introduction

Pacific Northwest National Laboratory (PNNL) is located in Richland, Washington. It is a multi-discipline laboratory providing support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Wind Energy, Geothermal Program, Hydropower, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Program Direction, and Program Support. PNNL also previously supported the Hydropower and Distributed Energy Resources Programs.

Hydrogen Technology

PNNL is the lead laboratory in the development of safety materials and systems for various end use applications. PNNL performs research and development tasks such as hydrogen storage and other technical support to address safety issues involved with various technologies, including underground storage, pipeline transmission and hydrogen sensing.

Pacific Northwest National Laboratory develops compact, microchannel fuel reformers. PNNL is developing a model and a controller for solid oxide fuel cells (SOFCs) to be used with APUs. Shock and vibration characteristics applied to SOFC stacks and APU units during operation are being developed in the model. PNNL is identifying candidate filler and cladding alloys for lightweight, low cost, robust metal clad bipolar plates.

Biomass and Biorefinery Systems R&D

PNNL provides thermochemical research and development in support of the syngas platform and related products.

The Pacific Northwest National Laboratory conducts R&D in support of the development of the syngas platform and related products. Major program components include thermocatalysts for fuels and chemicals and wet biomass for syngas production.

Wind Energy

PNNL provided analytical support for major crosscutting issues, such as market and benefit analyses.

Geothermal Program

Provided analytical support for major crosscutting issues, such as market and benefit analyses.

Hydropower

PNNL provided biological, environmental analysis and testing support for the Hydropower Technology Program. PNNL designed and fabricated test equipment to simulate turbine-induced physical stresses on fish, and used this test equipment for assessing the environmental performance of fish-friendly turbines. In FY 2006, the Hydropower Program was closed out.

Vehicle Technologies

Conducts research on predictive cruise control for heavy vehicles to increase energy efficiency. Evaluates advanced energy storage materials. Develops experimental and analytical methods to measure and improve technologies to reduce exhaust emissions and studies materials for lean-burn, high-durability NO_x sensors. Works to facilitate the scale-up process for depositing Si/SiGe super lattices, materials used in the development of thermoelectric devices for recovering waste heat in diesel engines thus improving fuel efficiency. Develops energy efficient production for magnesium, titanium, polymer composite and glass components for advanced automotive and heavy vehicle designs. Studies materials for lean-burn, high-durability spark plugs. Develops environmentally friendly processes for the manufacture of planar thin film ceramic sensors. Develops and tests a lightweight SUV frame prototype with performance equal to conventional steel components. Designs hybrid composite materials for weight critical heavy vehicle structures.

Building Technologies

The Pacific Northwest National Laboratory conducts research and development activities for the following activities: building codes; appliance standards; and emerging technologies.

Industrial Technologies

In support of the Industries of the Future (Specific) and (Crosscutting) activities, Pacific Northwest National Laboratory provides key support to track past program impacts including the over 150 commercial technologies, and their energy and environmental impacts. Other efforts include the evaluation of emerging technologies. The laboratory produces an impacts report summarizing commercial and emerging technologies and past program results and methodologies. The laboratory also performs support to Mining, Aluminum, Sensors and Controls, Glass, Industrial Materials of the Future and Forest Products.

Distributed Energy Resources

Pacific Northwest National Laboratory assisted in carrying out regulatory education and outreach. The lab provided assistance in efforts to remove regulatory barriers to distributed generation. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006.

Federal Energy Management Program

PNNL developed guidelines and provides expert advice on energy efficient buildings maintenance and operations, utility load management, utility restructuring, building commissioning, building diagnostic systems, resource energy management, and analytical support for modeling for the Government Performance Results Act.

Weatherization and Intergovernmental Activities

PNNL performs on-going research and technical assistance for the International Renewable Energy Program (IREP), including technical assistance for international renewable energy activities in Africa, China, and Russia.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

Provide analytical support for major crosscutting issues, such as market and benefit analyses.

Sandia National Laboratories

Introduction

Sandia National Laboratories (SNL) is located in Albuquerque, New Mexico and in Livermore, California. It is a multi-discipline laboratory providing support to Hydrogen Technology, Solar Energy, Wind Energy Systems, Geothermal Program, Vehicle Technologies, Industrial Technologies, Federal Energy Management Program, Weatherization and Intergovernmental Activities, Program Direction, and Program Support.

Hydrogen Technology

SNL in California serves as the lead laboratory in the research and development of metal hydride storage materials and systems for various end use applications. SNL is capable of producing metal hydride materials for use in research and validation projects. SNL also serves as the lead for the design, implementation, and testing of hydrogen systems to verify building codes and equipment standards for many applications.

SNL in Albuquerque is supporting the Hydrogen Technology program by developing alternative polymer electrolyte membranes that can operate at high temperature and low relative humidity to replace Nation in fuel cells.

Solar Energy

SNL supports the Photovoltaic Energy Systems efforts with the principal responsibility for systems and balance-of-systems technology development and reliability. Indoor and outdoor measurement and evaluation facilities provide support to industry for cell, module, and systems measurement, evaluation, and analysis. Systems-level work concentrates on application engineering reliability, database development, and technology transfer. SNL is the lead laboratory for the Concentrating Solar Power activity. SNL's technical responsibilities include power tower R&D, dish R&D, and the management of technical tasks and subcontracts to industry and universities.

Wind Energy

SNL Wind Energy Systems Department staff work closely with counterparts at the National Renewable Energy Laboratory to provide the program and the U.S. wind industry with engineering expertise to further the program's knowledge and goals.

Geothermal Technology

SNL formally served as the lead laboratory for research and development in drilling under Systems Development. SNL conducted research on diagnostics-while-drilling, drilling measurement and control, drilling hardware development, and design and testing of high-temperature wellbore instrumentation. SNL also managed cost-shared exploration with industry partners under Technology Verification and supports outreach activities under Technology Deployment. In FY 2007, this program will be closed out.

Vehicle Technologies

Participates in the modeling and simulation for reduction of heavy vehicle aerodynamic drag. Conducts research on new, rugged high temperature film capacitors for power electronics. Conducts and evaluates electrode materials that would improve abuse tolerance of lithium based battery technologies. Performs abuse tests of various battery technologies. Conducts extensive fundamental research on piston engine combustion processes to reduce emissions formation while maintaining efficiency. Investigates optical and non-optical medium-duty HCCI engines and in an optically accessible light-duty gasoline engine. Develops laser diagnostics to measure diesel particulate matter concentration, size, morphology, and metallic ash content, which are vital to the successful development of robust diesel exhaust after treatment systems. Develops materials R&D to improve the performance of tires, engines, and automotive body structures. Performs analyses and laboratory demonstrations of improved

manufacturing techniques and instrumentation for forging, heat treatment, coating, welding, and other factory processes. Studies the in-cylinder combustion processes of fuel-borne oxygen in diesel fuels using laser-induced incandescence observations.

Industrial Technologies

Sandia's unique capabilities have been applied to the chemical industry R&D activities. These capabilities include research on prototype chemical reactors, research on molecular properties using Sandia's unique computational capabilities, research on industrial separations membranes, and the development of an experimental fluid flow system used to measure properties of chemical reacting flows in greater detail than had previously been achieved. This experimental fluid flow research activity was carried in cooperation with LANL, the PNNL, four U.S. universities, and eight U.S. petroleum and chemical companies.

Distributed Energy Resources

Sandia National Laboratory supported research that was focused on developing a unique combustion strategy that enabled turbine manufactures to build machines that meet or exceed current and future emission requirements. As directed by Congress, this program was transferred to the DOE Office of Electricity Distribution and Energy Reliability in FY 2006.

Federal Energy Management Program

SNL develops guidelines and provides expert advice on renewable technologies for military applications and on distributed generation.

Weatherization and Intergovernmental Activities

SNL provides technical assistance to transfer renewable energy and energy efficiency technologies to Native American tribal lands. Sandia also supports International Renewable Energy activities in Latin America seeking to mobilize private investment in clean energy technologies.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Program Support

SNL provides analytical support for crosscutting issues such as market and benefit analyses.

Savannah River National Laboratory

Introduction

Savannah River National Laboratory is located in Aiken, South Carolina. It is a multidisciplinary research laboratory that provides support to Hydrogen Technology and Federal Energy Management Program. Savannah River is leveraging its history and expertise in understanding the properties of hydrogen and its effects on materials. It is a key element of DOE's metal hydride hydrogen storage research program. Savannah River is capable of producing metal hydride materials for use in research and validation projects.

Hydrogen Technology

Savannah River is leveraging its history and expertise in understanding the properties of hydrogen and its effects on materials. It is a key element of DOE's metal hydride hydrogen storage research program. Savannah River is capable of producing metal hydride materials for use in research and validation projects.

Federal Energy Management Program

Savannah River Site received direct funding from the Departmental Energy Management Program for an energy retrofit project to increase the energy efficiency of its facility and reduce future utility and maintenance costs.

Southeast Regional Office

Introduction

The Southeast Regional Office provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level. It is located in Atlanta, Georgia. It supported Solar Energy, Wind Energy Systems, and Program Direction.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Southeast Regional Office will be transferred to the NETL PMC.

Solar Energy

The Southeast Regional Office helped to administer the Solar Powers America (formerly Million Solar Roofs).

Wind Energy Systems

The Southeast Regional Office supported deployment and outreach programs on a local and regional level.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Washington Headquarters

Introduction

Washington, D.C. is the headquarters for the Office of Energy Efficiency and Renewable Energy operations. The Headquarters operation provides specialized, technical expertise in program planning, formulation, execution, and evaluation, in order to support the responsible guidance and management of the budget. In addition, competitive Program Announcements and solicitations are planned and implemented through Headquarters. It provides support to Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy Systems, Vehicle Technologies, Building Technologies, Industrial Technologies, Federal Energy Management Program, Facilities and Infrastructure, Weatherization and Intergovernmental Activities, Program Direction, and Program Support. It also previously supported the Hydropower, Geothermal Technology and Distributed Energy Resources Programs.

Western Area Power Administration

Wind Energy Systems

Western Area Power Administration (WAPA) is located in Lakewood, Colorado. It is a multi-region power-making agency that is providing support to Wind Energy Systems. WAPA is conducting analysis of integrating wind into its power system, including assessment of opportunities for coordinating operation with its hydropower assets.

Western Regional Office

Introduction

The Western Regional Office is located in Seattle, Washington and provided (1) global analytical support to EERE programs; (2) support to the R&D programs by administering grants and cooperative agreements to regional, State, and local organizations, both public and private; and (3) provided direction, guidance, and support deployment and outreach programs on a local and regional level.

Beginning in FY 2007, EERE will be utilizing a new deployment strategy. This new strategy will, among other things, consolidate all remaining Regional Office activities to the two Project Management Centers. The activities of the Western Regional Office will be transferred to the Golden PMC.

Solar Energy

The Western Regional Office helped to administer the Solar Powers America (formerly Million Solar Roofs).

Wind Energy Systems

The Western Regional Office supported deployment and outreach programs on a local and regional level.

Program Direction

In FY 2007, functions formerly provided by the Regional Offices will be performed at the Project Management Center (PMC).

Program Direction funds the salary, benefits, and travel costs for FTE in order to support: (1) promotion of EERE renewable energy and hydrogen programs at the local and regional levels; (2) administration of grants to, and cooperative agreements with, States and local governments, particularly the Weatherization Assistance Program and State Energy Program grants; and (3) administration and implementation of locally- and regionally-focused deployment activities, such as Solar Powers America (formerly Million Solar Roofs), Wind Powering America, Clean Cities, Rebuild America, and the Federal Energy Management Program (FEMP), etc.

Hydrogen Technology

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Hydrogen Technology					
Hydrogen Production and Delivery R&D	13,303	8,598	-86	8,512	36,844
Hydrogen Storage R&D	22,418	26,868	-268	26,600	34,620
Fuel Cell Stack Component R&D	31,702	31,914	-319	31,595	38,082
Technology Validation[b]	26,098	33,933	-339	33,594	39,566
Transportation Fuel Cell Systems	7,300	1,091	-11	1,080	7,518
Distributed Energy Fuel Cell Systems	6,753	972	-10	962	7,419
Fuel Processor R&D	9,469	623	-6	617	4,056
Safety and Codes and Standards	5,801	4,775	-48	4,727	13,848
Education[c]	0	500	-5	495	1,978
Systems Analysis	3,157	4,975	-50	4,925	9,892
Manufacturing R&D	0	0	0	0	1,978
Technical/Program Management Support	535	0	0	0	0
Congressionally Directed Activities	40,236	42,950	-430	42,520	0
Total, Hydrogen Technology	166,772[d]	157,199	-1,572	155,627	195,801

Public Law Authorizations:

P.L. 93-275, "Federal Energy Administration 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. 94-413, "Electric and Hybrid Vehicle Research, Development and Demonstration Act" (1976)
P.L. 95-91, “Department of Energy Organization Act” (1977)
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)

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[a] Includes a rescission of $1,572,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] The FY 2007 budget request combines Technology Validation and Infrastructure Validation into one key activity.
[c] In the FY 2005 budgets, Education and Cross-Cutting Analysis (now Systems Analysis) were grouped into one key activity. The activities were separated starting in the FY 2006 budget request.
[d] In FY 2005, $2,452,000, which was transferred to the SBIR program, and $292,000 which was transferred to the STTR program.

P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-494, "Alternative Motor Fuels Act" (1988)
P.L. 101-566, “Spark M. Matsunaga, Hydrogen Research, Development, and Demonstration Act of 1990” (1990)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 104-271, “Hydrogen Future Act of 1996” (1996)
P.L. 109-190, “Energy Policy Act” (2005)

Mission

The mission of the Hydrogen Technology Program (HT) in DOE’s Office of Energy Efficiency and Renewable Energy is to research, develop, and validate fuel cell and hydrogen production, delivery, and storage technologies. The program aims to have hydrogen from diverse domestic resources used in a clean, safe, reliable, and affordable manner in fuel cell vehicles and stationary power applications.

Benefits

Hydrogen Technology is a key component of the President’s Hydrogen Fuel Initiative, and with DOE’s FreedomCAR activities is a key part of the Department's technology development strategy to reduce the Nation's long-term dependence on foreign oil. Both FreedomCAR and the Hydrogen Fuel Initiative support the Nation moving forward to achieve the vision of a diverse, secure, and emissions-free energy future. Together, the Hydrogen Fuel Initiative and FreedomCAR will facilitate a decision by industry to commercialize hydrogen-powered fuel cell vehicles in the year 2015. Widespread commercialization of hydrogen-powered vehicles will support our national security interests by significantly reducing our reliance on foreign oil. Hydrogen will be produced from domestic resources in an environmentally sound manner, providing significant reductions in transportation-related criteria pollutants and greenhouse gases. Research undertaken by Hydrogen Technology is targeted to: enable cost-competitive hydrogen production from renewable sources and distributed natural gas; provide storage technology that enables greater than 300 mile driving range for vehicles; and reduce the cost of transportation fuel cell systems by a factor of 5 while increasing efficiency and durability.

In November of 2003, the DOE launched the International Partnership for the Hydrogen Economy (IPHE) that was agreed to by 15 nations and the European Union, in pursuit of hydrogen as a transportation system reality by 2020. In February 2004, the Department released its DOE Hydrogen Posture Plan[a], which outlines the DOE’s and the Department of Transportation’s (DOT) research and development activities and the performance-based milestones used to measure progress. When hydrogen-powered fuel cell vehicles are introduced in substantial numbers, the oil savings and other benefits to the Nation are expected to be significant.

Strategic and Program Goals

The Department’s Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Hydrogen Technology Program supports the following goal:

[a] The Hydrogen Posture Plan can be viewed at http://www.hydrogen.energy.gov/

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Hydrogen Technology Program has one program goal which contributes to General Goal 4 in the "goal cascade:"

Program Goal 04.01.00.00: Hydrogen Technology: Develop fuel cell and hydrogen production, delivery and storage technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. Development of these technologies will also make our clean domestic energy supplies more flexible, dramatically reducing or even ending dependence on foreign oil.

Contribution to Program Goal 04.01.00.00 (Hydrogen Technology)

The key Hydrogen Technology contribution to General Goal 4, Energy Security, is domestic energy supply and energy efficiency through:

- Hydrogen production and delivery R&D for market-based technologies that will reduce the cost of producing hydrogen from renewables (in a distributed system) from $6.20/ gallon of gasoline equivalent (gge) in 2003 to $2.85/gge untaxed, delivered (at 5000 psi) by 2010; and Hydrogen production and delivery R&D for market-based technologies that will reduce the cost of producing hydrogen from natural gas (distributed) from $5.00/gge in FY 2003 to $2.50/gge (at 5,000 psi) in FY 2010 untaxed at the station with high equipment manufacturing volumes (i.e.500 units/year);

- Hydrogen storage R&D to develop and demonstrate commercially-viable hydrogen storage technology that enables greater than 300-mile vehicle driving range, while meeting vehicular packaging, cost and performance requirements. Specifically, develop and demonstrate by 2010 a hydrogen storage technology with capacity of 2.0 kWh/kg (6% by weight), compared to 0.5-1.3 kWh/kg in 2003, and 1.5 kWh/l (kilowatt-hours per liter), compared to 0.5-0.6 kWh/l in 2003;

- Transportation Systems/Fuel Cell Stack Component R&D will improve fuel cell durability and performance while reducing cost. The manufacturing cost of hydrogen-fueled fuel cell power systems will be reduced from $275/kW in 2002 for a 50 kW system to $45/kW in 2010 for an 80 kW system at production levels of 500,000 units per year (projected cost);

- Distributed Energy Systems/Fuel Processor R&D will increase the electrical efficiency of 5-250 kW stationary fuel cell systems operating on natural gas or propane from 29 percent in 2002 to 40 percent in 2011;

- Technology Validation will verify under real world conditions: hydrogen fuel cell vehicle performance and 2,000 hour durability; and hydrogen infrastructure technologies with a cost of $3.00 per gge with 68 percent well-to-pump efficiency in 2009;

- Education activities will increase the understanding of the hydrogen economy and hydrogen technologies among key target audience groups including local and state governments, safety and

code officials, potential end-users, local communities, and students and teachers. By 2011, the program expects to significantly increase the subject knowledge among these target audiences, relative to 2004 baseline survey results, and thereby facilitate the success of near-term hydrogen technology demonstrations as well as accelerate the market adoption of hydrogen technologies over the long-term; and

- Underlying research for safety and codes and standards that will enable preparation of a global technical regulation (GTR) for hydrogen fuel cell vehicles and infrastructure (GTR expected to be submitted in draft in 2008; approval anticipated in 2010). Global consistency in standards will ensure that different technologies need not be developed for each region of the world.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.01.00.00, Hydrogen Technology			
Hydrogen Production and Delivery R&D	13,303	8,512	36,844
Hydrogen Storage R&D	22,418	26,600	34,620
Fuel Cell Stack Component R&D	31,702	31,595	38,082
Technology Validation[a]	26,098	33,594	39,566
Transportation Fuel Cell Systems	7,300	1,080	7,518
Distributed Energy Fuel Cell Systems	6,753	962	7,419
Fuel Processor R&D	9,469	617	4,056
Safety and Codes and Standards	5,801	4,727	13,848
Education[b]	0	495	1,978
Systems Analysis	3,157	4,925	9,892
Manufacturing R&D	0	0	1,978
Technical/Program Management Support	535	0	0
Congressionally Directed Activities	9,920	9,553	0
Subtotal, Program Goal 04.01.00.00, Hydrogen Technology	136,456	122,660	195,801

[a] The FY 2007 budget request combines Technology Validation and Infrastructure Validation into one key activity.
[b] In the FY 2005 budgets, Education and Cross-Cutting Analysis (now Systems Analysis) were grouped into one key activity. The activities were separated starting in the FY 2006 budget request.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
All Other			
Congressionally Directed Activities			
Startech Plasma Hydrogen Production Project	496	0	0
Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems: Gateway Project on Island of Hawaii	992	0	0
Hydrogen Fuel Cell Project Edison Materials Technology	2,976	2,475	0
Florida Hydrogen Partnership/Initiative	1,984	0	0
Fuel Cell Research by the University of South Florida (partially supports goal)[a]	1,488	0	0
Renewable Hydrogen Fueling Station System, University of Nevada at Las Vegas	4,960	0	0
Regional Transportation Commission Of Washoe County Hydrogen Fuel Cell Project	992	2,475	0
Fuel Cell Mine Loader and Prototype Locomotive	1,984	247	0
Hydrogen Regional Infrastructure Program in Pennsylvania	1,984	0	0
Expanding Clean Energy Research and Education Program at the University of South Carolina (partially supports goal)[b]	992	0	0
Hydrogen Storage and Fuel Cells, University of Las Vegas	2,976	0	0
Zero Emission Bus Demo Program	99	0	0
Ohio Distributed Hydrogen Project	1,091	0	0
Bowling Green Fuel Cell, University of Toledo	992	0	0
California Hydrogen Infrastructure (partially supports goal)[b]	2,480	0	0
National Center for Energy Management and Building Technologies (Hydrogen Technology's share)	1,005	0	0
National Center for Manufacturing Science	2,000	0	0
Metal Hydride Hydrogen Storage in California	825	0	0
University of South Carolina Fuel Cell Design Project	0	1,980	0
Center For Intelligent Fuel Cell Materials Design, Multi-State	0	1,485	0
Indigenous Energy Development Center	0	990	0
Delaware State University Center For Hydrogen Storage	0	990	0
Florida International University Center For Energy and Technology Of The Americas	0	990	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
City Of Auburn Energy Production Issues At Wastewater Plant	0	891	0
Purdue Hydrogen Technologies Program	0	990	0
City Of Chicago Ethanol To Hydrogen Project	0	1,980	0
University Of Arkansas At Little Rock Hydrogen Storage Project	0	396	0
University Of Akron Fuel Cell Laboratory	0	495	0
Kettering University Fuel Cell Project	0	495	0
UNLV Research Foundation Solar-Powered Thermochemical Production of Hydrogen (partially supports goal)	0	1,683	0
UNLV Research Foundation Hydrogen Fuel Cell and Storage R&D	0	3,366	0
Montana Palladium Research Center	0	2,475	0
University Of Arkansas Little Rock Nanotechnology Center Production Of Hydrogen	0	495	0
UNLV Research Foundation Renewable Hydrogen Fueling Station System, Including Development Of High Pressure Electrolysis Using Photovoltaics	0	3,366	0
UNLV Research Foundation Development Of Photoelectric Chemical Production Of Hydrogen (partially supports goal)	0	1,238	0
University Of Nevada-Reno Photoelectrochemical Generation Of Hydrogen By Solid Nanoporous Titanium Dioxide Project	0	2,970	0
Southern Nevada Alternative Fuels Demonstration Project	0	495	
Total, Congressionally Directed Activities	30,316	32,967	0
Total, All Other	30,316	32,967	0
Total, General Goal 4 (Hydrogen Technology)	166,772	155,627	195,801

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.01.00.00 (Hydrogen Technology)					
Hydrogen Production and Delivery R&D: Renewable					
		Complete research for biomass syngas reforming catalysts to improve durability and reduce cost towards achieving 5,000 psi hydrogen produced for $5.70/gallon of gasoline equivalent (untaxed, modeled cost) at the station by 2005. [MET]	Model cost of hydrogen produced from renewable sources and assess versus the 2010 target of $2.85/gge, untaxed at the station at 5,000 psi. [MET]	Due to Congressionally Directed Activities, there will be little activity in FY 2006. Target has been delayed into FY 2007.	Complete lab-scale electrolyzer, test to determine whether it achieves 64% energy efficiency and evaluate systems capability to meet $5.50/gge hydrogen cost target, untaxed at the station, and with large equipment production volumes [e.g., 500 units/year].
Hydrogen Production and Delivery R&D: Non-Renewable					
Complete construction of a prototype hydrogen generator with ceramic membrane for production and purification of hydrogen from natural gas.		Complete research for natural gas-to-hydrogen production and dispensing component development and fabrication towards achieving 5,000 psi hydrogen for $3.00/gge (untaxed and without co-production of electricity) at the station in 2006. [MET]	Complete the research for a distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge (untaxed and without co-producing electricity) at the station in 2006. [MET]	Complete the development of a laboratory scale distributed natural gas-to-hydrogen production and dispensing system that can produce 5,000 psi hydrogen for $3.00/gge.	Complete preliminary lab scale tests to identify technologies that produce 5,000 psi hydrogen from natural gas for $2.50/gge, untaxed at the station and with large equipment production volumes [e.g., 500 units/year].
Hydrogen Storage R&D: Materials-based					
		Complete draft of standard test protocol and construction of test facility for solid-state hydrogen storage materials in support of the targets of 1.2 kWh/l and 4.5 wt. percent and the 2010 targets of 2.0kWh/kg (6 wt. percent), 1.5 kWh/l at $4/kWh. [MET]	Identify materials with the potential to meet 2010 targets of 2.0 kWh/kg (6 wt percent), 1.5 kWh/l, at $4/kWh. [MET]	Complete fabrication and testing of a sub-scale prototype materials-based storage system to demonstrate projected system capacity of 2.5 wt.% (0.8 kWh/kg); evaluate progress toward the 2007 target of 4.5 wt.% (1.5 kWh/kg).	Complete baseline on-board storage systems analyses, down select materials, and evaluate against 2007 targets of 1.5 kWh/kg (4.5% by weight) and 1.2 kWh/L.
Hydrogen Storage R&D: Tanks					
	Complete design of the 5,000 psi cryogenic-gas tank and 10,000 psi compressed gas tank to achieve 1.3 kWh/kg and 0.6 kWh/l. [MET]	Complete development of 5,000 psi cryo-gas tank and 10,000 psi compressed gas tank achieving 1.3 kWh/kg and 0.8 kWh/l. [MET]	Complete testing of 10,000 psi hydrogen storage tanks evaluating against the hydrogen storage system target of 1.5 kWh/kg (4.5% by weight), and identify approaches to meet the cost target of $6/kWh. [MET]		

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Technology Validation					
	Verify low electricity and hydrogen production cost (<$.08/kWh and <$3.60/gal equivalent untaxed when produced in quantity) through cost shared operation of a 50kWe stationary fuel cell and hydrogen co-production facility for six months. [MET]	Identify and complete feasibility and system design of an isothermal compressor to be incorporated in hydrogen refueling stations to produce hydrogen at $3.00/gge by 2009. [MET]	Complete validation of an energy station that can produce 5,000 psi hydrogen from natural gas for $3.60 per gallon of gasoline equivalent (including co-production of electricity) untaxed at the station with mature equipment production volumes (e.g., 100 units/year). [PARTIALLY MET]	Complete installation and 1,000 hours of testing of a refueling station; determine system performance, fuel quality and availability; and demonstrate the ability to produce 5,000 psi hydrogen from natural gas for a projected cost of $3.00 per gallon of gasoline equivalent, untaxed at the station, assuming commercial deployment with large equipment production volumes (e.g., 100 units/year) by 2009.	Validate achievement of a refueling time of 5 minutes or less for 5 kg of hydrogen at 5,000 psi through the use of advanced sensor, control, and interface technologies.
	Plan technology validation activity. [MET]	Industry contracts are awarded and initial vehicles delivered that support the 1,000 hour durability target. [MET	Fuel Cell demonstration vehicles' durability can be projected to 1,000 hours based on voltage measurements. [PARTIALLY MET]	Operate fuel cell vehicle fleets to determine if 1,000 hour vehicle fuel cell durability, using fuel cell degradation data, was achieved by industry.	
Transportation Fuel Cell Systems and Fuel Cell Stack Component R&D					
	Achieve $225/kW for a hydrogen-fueled 50kW fuel cell power system. [MET]	Achieve $200/kW for a hydrogen-fueled 50 kW fuel cell power system. [MET]	DOE-sponsored research will reduce technology cost to $125/kW for a hydrogen-fueled 50kW fuel cell power system. [MET]	DOE-sponsored laboratory scale research will reduce the modeled technology cost to $110/kW for a hydrogen-fueled 80 kW fuel cell power system.	DOE-sponsored laboratory scale research will reduce the modeled technology cost to $90/kW for a hydrogen-fueled 80kW fuel cell power system.
Distributed Energy Fuel Cell Systems and Fuel Processor R&D					
	Achieve 30 percent efficiency at full power for a natural gas or propane fueled 50 kW stationary fuel cell system. [MET]	Achieve 31 percent efficiency at full power for a natural gas or propane fueled 50-250 kW stationary fuel cell system. [MET]	Achieve 32 percent efficiency at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell system. [MET]	Due to Congressionally Directed Activities, there will be no activity in this area in FY 2006.	DOE-sponsored research will improve electrical efficiency to 34 percent at full power for a natural gas or propane fueled 5-250 kW stationary fuel cell power system verified by a prototype (5-50 kW system).
Education					
		Determine the baseline level of knowledge and develop a plan for educating target audiences (students and teachers, state and local governments, and large-scale end-users nationwide). [MET]			

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Safety and Codes and Standards					
		Complete the harmonized technical standard for high pressure vehicle storage that can be incorporated into a regulation (i.e. incorporating the various standards of different countries into a single regulation) for hydrogen storage. Complete the draft technical standard for vehicular safety. [MET]			
Systems Analysis					
		Define requirements for system analysis and integration to link the program's technical objectives to cost and schedule. [MET]			
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the Hydrogen/Fuel Cell Program FY 2004 end of year adjusted uncosted baseline ($29,283K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.[a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

Hydrogen Technology will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches to implement the President's Hydrogen Fuel Initiative and carry out the program in accordance with the Energy Policy Act of 2005. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

Hydrogen Technology will implement the program through the following means:

- Develop hydrogen production, delivery and storage technologies to achieve cost, efficiency, and other required targets to meet program goals;
- Conduct long-term research, development, and technology validation activities, which are aimed at reducing oil consumption across a range of energy applications and sectors of the economy;
- Conduct infrastructure validation activities in partnership with industry to develop and validate the feasibility of hydrogen generation stations that derive hydrogen from both renewable and fossil fuels for stationary and transportation fuel cell systems;
- Conduct research, development, and technology validation to address the key technical barriers of performance, cost and durability of fuel cell systems for transportation, stationary, auxiliary power units (APUs), and portable power applications;
- For transportation applications, focus R&D on critical requirements to support an industry decision in 2015 to enter into commercialization, primarily focusing on lowering the high-volume system cost of fuel cells to $30/kW. Other significant criteria for transportation fuel cell systems include the need to have fuel cell technologies developed and validated that enable: (1) full performance over 5,000 hours of life; (2) 60 percent efficiency (hydrogen-fueled) at peak power; and (3) operation in vehicles with comparable performance, safety, and reliability to the gasoline internal combustion engine;
- For stationary applications, work towards removing technical barriers to facilitate the near-term introduction of fuel cells in a variety of applications that include energy generation for buildings, uninterruptible power systems, and portable power devices such as consumer electronics;
- Support the introduction of fuel cell vehicles and stationary fuel cell systems to controlled user-groups such as utilities or military installations through real world demonstrations. These demonstrations validate technology performance, provide experience to both manufacturers and end-users supporting the successful introduction of commercial products, and help build early public awareness;
- Develop systems models and make trade-off analyses to direct effective technology decisions;
- Conduct cross-cutting analyses and focus on life cycle cost, emissions, and efficiency of transportation and stationary fuel cell systems in the near (2015), mid (2030), and long term (post 2050);

- Conduct research, development and demonstration activities through competitive, cost-shared grants with industry and universities;
- Conduct research for safety and codes and standards, focused on ensuring the safety aspects of hydrogen technologies and enabling widely accepted codes and standards. Enabling effective codes and standards requires a substantial and verified database of scientific information on hydrogen properties. DOE will coordinate with and assist DOT and other code developing entities by providing this experimental database from research projects and the DOE "learning" demonstration project; and
- Develop and distribute educational materials and training to facilitate the transition to a hydrogen economy.

Hydrogen Technology will implement the program through the following strategies:

- Implement the Hydrogen Posture Plan (which outlines the research and development needed), the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-year Research, Development and Demonstration Plan (which establishes technical targets and schedules to address key technology barriers) and the National Hydrogen Energy Roadmap (which lays out research and development pathways to guide hydrogen and fuel cell R&D);
- Perform formal merit reviews across the Department's portfolio of Hydrogen activities (this process includes the merit review of EERE, Nuclear Energy, Science and Technology (NE), Fossil Energy (FE) and Science (SC) hydrogen and related technologies). The Merit Review evaluation incorporates the principles of the Administration's R&D investment criteria and is conducted in compliance with the Department's Merit Review Guidelines. Additionally, field project managers and technology development managers evaluate progress formally on a quarterly basis;
- Conduct meetings of the Hydrogen and Fuel Cell Technical Advisory Committee (per the Energy Policy Act of 2005 (EPAct)) to advise the Energy Secretary regarding the Department's hydrogen activities;
- Participate in the development of research data to enable uniform codes and standards at the international level to ensure that the U.S. industry can compete globally;
- Use Centers of Excellence for R&D on chemical hydrides, metal hydrides and carbon-based materials to support the storage goal for materials-based systems;
- Conduct cross-cutting analyses and focus on life cycle cost, emissions, and efficiency of a broad array of options for hydrogen infrastructure in the near (2015), mid (2030), and long term (post 2050);
- Conduct research, development and demonstration activities through competitive, cost-shared grants with industry and universities; and
- Begin a Manufacturing R&D effort that will enable the mass production of both supply and end-use technologies for the hydrogen economy, and will foster a strong domestic supplier capability.

These means and strategies will result in improving energy security by increasing the generation of reliable, affordable, and environmentally sound hydrogen, adding to the diversity and security of the Nation's energy supply - thus putting the taxpayers' dollars to more productive use.

The following external factors could affect Hydrogen Technology's ability to achieve its strategic goal:

- Congressionally Directed projects that do not contribute to the program's goals;
- Price, performance and availability of alternative technologies and conventional fuels that will compete with hydrogen fueled vehicles will affect the market;
- Decisions on the nature and timing of supporting policy instruments to help stimulate end-use markets; and
- Public acceptance and concerns regarding the safe use of hydrogen.

In carrying out the program's mission, Hydrogen Technology performs the following collaborative activities:

- Coordinate across four Departmental elements, EERE (Biomass, Solar, Buildings, Wind, and Vehicles), NE, FE and SC and the Department of Transportation (DOT) to update the DOE Hydrogen Posture Plan periodically to support and coordinate the Department's Hydrogen Fuel Initiative budget request. EERE is the Departmental lead and coordinates research, development and demonstration planning, budget formulation and budget execution activities under the Hydrogen Fuel Initiative.

	(dollars in thousands)
Hydrogen Fuel Initiative	FY 2007 Request
Energy Efficiency and Renewable Energy (EERE)	195,801
Nuclear Energy (NE)	18,665
Fossil Energy (FE)	23,611
Office of Science (SC)	50,000
Subtotal, Department of Energy	288,077
Department of Transportation (DOT)	1,420
Total Hydrogen Fuel Initiative	289,497

- Participate in the Interagency Hydrogen and Fuel Cell Technical Task Force, in accordance with the Energy Policy Act of 2005, to leverage and coordinate Federal resources. The Task Force involves Federal agencies that have hydrogen and fuel cell related activities to leverage and coordinate Federal resources;
- Participate in the International Partnership for a Hydrogen Economy to leverage R&D capabilities globally;

- Work with the DOT, the Environmental Protection Agency (EPA) and the National Institute for Standards and Technology (NIST) on research for safety and codes and standards. Develop an annual coordination plan with DOT that outlines cooperative activities and establishes roles and responsibilities;
- Collaborate with EERE's Building Technologies Program, the Office of Electricity Delivery and Energy Reliability's Distributed Energy Resources Program and the Office of Fossil Energy's solid oxide fuel cell research and development effort on fuel cell technology activities; and
- For activities that support transportation applications, cooperate with the EERE Office of FreedomCAR and Vehicle Technologies. The President's Hydrogen Fuel Initiative and activities in the FreedomCAR budget crosscut are implemented through technical teams, which provide a mechanism for developing requirements and industry consensus (see Technology goals below), evaluating R&D activities, and providing recommendations for program direction. These technical teams are composed of government and industry experts that meet regularly. The interdependency is depicted in the table that follows.

2010 Hydrogen Fuel Initiative and FreedomCAR Coordinated Technology Goals

The Office of FreedomCAR and Vehicle Technologies has responsibility for these goals:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kW peak.
- Internal Combustion Engine Powertrain Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards.
- Electric Drive train Energy Storage with 15-year life at 300 Wh with discharge power of 25 kW for 18 seconds and $20/kW.
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(Shared responsibility with the Hydrogen Technology Program.)*

The Office of Hydrogen, Fuel Cells, and Infrastructure Technologies has responsibility for these goals:

- 60 percent peak energy-efficient, durable fuel cell power systems (including hydrogen storage) with 325 W/kg specific power and 220 W/l power density operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.
- Demonstrate hydrogen refueling with developed commercial codes and standards and diverse renewable and non-renewable energy sources. Goal: cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $2.00-3.00 per gallon

gasoline equivalent produced and delivered to the consumer independent of pathway by 2015.

- On-board Hydrogen Storage Systems demonstrating specific energy of 2.0 kWh/kg (6% by weight hydrogen) and energy density of 1.5 kWh/l at a cost of $4/kWh by 2010 and specific energy of 3.0 kWh/kg (9% by weight hydrogen), 2.7 kWh/l, and $2.00/kWh by 2015.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(Shared responsibility with the Vehicle Technologies Program.)*

Validation and Verification

To validate and verify program performance, Hydrogen, Fuel Cells and Infrastructure Technologies will conduct internal and external reviews and audits. Programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. Specific milestones, go/no-go decision points, and technical progress are systematically reviewed through the program's merit review process. The table below summarizes validation and verification activities.

Data Sources: Merit Review and Peer Evaluation of R&D, and Program Peer Reviews are conducted. Engineering models and quarterly reports are used to validate technical targets. Summary program plans are used to evaluate progress towards technical targets.

Baselines: The following are the key baselines used in Hydrogen Technology:

- renewable hydrogen production (delivered) (2003): $6.20/gge
- non-renewable production (delivered) (2003): $5.00/gge
- electrolysis production efficiency (2003): 62 percent
- compressed hydrogen tank-only storage (2003): 1.3 kWh/kg (3.9% by weight) and 0.6 kWh/l system capacity
- solid state materials for storage systems (2003): 1% by weight system capacity and 0.5 kWh/l
- transportation systems/stack component R&D (2002): $275/kW fuel cell cost
- distributed energy systems/fuel processor R&D (2002): 29 percent electrical efficiency
- technology validation (2003, laboratory): 1,000 hours durability of fuel cell

[a] A 2004 Baseline Knowledge Assessment was completed to measure the knowledge and awareness of hydrogen energy systems among key target audiences. Out-year surveys will be used to evaluate changes in knowledge over time.

vehicle systems

- validated production (delivered) (2004): $3.60/gge (beginning of life testing)
- education (2004): Survey[a]

Frequency: GPRA Benefits are estimated annually, Merit Review and Peer Evaluation of R&D projects are carried out annually, and Program Peer Review is conducted biennially. Quarterly reports are submitted to DOE Technology Development Managers. Summary program plans are submitted annually.

Data Storage: EERE Corporate Planning System

Evaluation: In carrying out the program's mission, the HT Program uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the HT Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based on Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputations of potential benefits for the Government Performance and Results Act (GPRA).

The National Academies (National Research Council and National Academy of Engineering) have performed an extensive review of the Hydrogen Program and has published a 2004 report titled: "Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs." The committee's report indicated the four most fundamental technological and economic challenges are: 1) to develop and introduce cost-effective, durable, safe and environmentally desirable fuel cell systems and hydrogen storage systems; 2) to develop the infrastructure to provide hydrogen for the light-duty vehicle user; 3) to reduce sharply the costs of hydrogen production from renewable energy sources over a time frame of decades; and 4) to capture and store the carbon dioxide byproduct of hydrogen production from coal.

Preliminary analysis of the baseline survey results has been completed, but FY 2005 funding for this activity was not provided, so detailed analysis of the survey has been put on hold.

Additionally, in 2005, the National Academies performed a review of the FreedomCAR and Fuel Partnership and published a report titled: "Review of the Research Program of the FreedomCAR and Fuel Partnership".[a] The committee's report finds that DOE's three-year-old FreedomCAR and Fuel Partnership "has already made an excellent start." The report notes that the partnership faces significant technical challenges, including hydrogen storage in vehicles, commercially viable fuel cells, and the need to build an infrastructure for hydrogen fueling. The report recommends that DOE pay special attention to the challenges of shifting from petroleum to hydrogen as a transportation fuel, including hydrogen safety issues and any environmental impacts of large-scale hydrogen production and use. It also recommends an overall program evaluation to help decide among trade-offs and determine priorities. Finally, the report notes that Congress has appropriated significant portions of the funding for specific projects that are not focused on the partnership's goals, and notes that the partnership will be unable to meet its milestones if the practice continues.

- Merit Reviews and peer evaluations conducted by energy, hydrogen, and fuel cell experts from outside of the U.S. Department of Energy are held to evaluate the research, development and demonstration projects to ensure that they address the priorities and key technology barriers identified in the HT planning documents.
- The HT Program develops and implements planning documents and supports the development of technology roadmaps with industry.[b] These efforts are used to focus the program's investments on activities that are within the Federal Government's role and that address top priority needs. The technical advisory committee will also be used to independently review the program.
- For new applied research activities, the program plans to compete both the National Laboratories and the private sector side by side. Industry and universities already receive funding through a competitive process that leads to cost-shared grants. Hydrogen and fuel cell industry experts review each university, laboratory and industry project at the annual Merit Review and Peer Evaluation. Consistent with the principles of the Administration's R&D Investment Criteria, project peer reviews include: 1) Relevance to overall DOE and Hydrogen Fuel Initiative objectives; 2) Approach to performing the research and development; 3) Technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed

[a] Report can be found at http://www.nap.edu/books/030909730/html.

[b] See the following documents: Fuel Cell Report to Congress, Feb. 2003; A National Vision of America's Transition to a Hydrogen Economy, March 2002; National Hydrogen Energy Roadmap, November 2002; FreedomCAR Fuel Cell Technical Roadmap; EERE Hydrogen Program Multi-Year Research, Development and Demonstration Plan ; Hydrogen Posture Plan; The National Academies' Report, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs" 2004; and the National Academies' Report, "Review of the Research Program of the FreedomCAR and Fuel Partnership, First Report, August 2005.

future research. The panel also evaluates the strengths and weaknesses of each project, and recommends additions to or deletions from the scope of work.

- Some projects are also evaluated by the FreedomCAR joint technical teams each year. The program facilitates supplier-customer relationships to ensure that R&D results from National Laboratories and universities are transferred to industry suppliers and that industry supplier developments are made available to automakers, energy industry and stationary power producers.
- Reviews are conducted by the Hydrogen Safety Panel to monitor the safety of procedures and facilities throughout the Hydrogen Technology Program.

Verification: Quarterly reports from DOE-funded industry, university and National Laboratory partners document the status of quarterly targets and milestones. An Annual Report is used to evaluate progress towards meeting program goals and technical targets. Data from Technology Validation projects will be used to assess technology status. Independent Systems Integration function will evaluate research results.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Hydrogen Technology Program has incorporated feedback from OMB into the FY 2007 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The Hydrogen Technology Program was rated "moderately effective" on their latest PART rating in 2003 (Purpose: 80%, Planning: 80%, Management: 100%). Most PART recommendations within program control have been addressed and results-based planning continues to improve. The 2002 PART review of Hydrogen Technology contained a recommendation to establish a partnership with the energy industry to complement the DOE's FreedomCAR budget. To fulfill this recommendation, FreedomCAR (the partnership between DOE and USCAR) was expanded to include energy industry partners and the expanded partnership was launched to coordinate hydrogen research activities with both automotive and energy industry partners. Many activities funded through the President's Hydrogen Fuel Initiative and FreedomCAR are now implemented through the government-industry FreedomCAR and Fuel Partnership.

The 2002 PART recommendation to expand high-risk R&D on hydrogen production from renewable resources and on hydrogen storage technologies was addressed with two solicitations for proposals that led to grants with universities and industry, and work agreements with National Laboratories to develop high-risk hydrogen production from renewable resources and hydrogen storage technologies. EERE and the DOE Office of Science (SC) coordinated extensively in developing a FY 2004 solicitation for basic research to support hydrogen production, storage and use.

Another 2002 PART recommendation suggested the development of adequate annual performance measures. Annual performance measures that correlate with multi-year program plan technical targets

have been included in budget requests. These improvements in planning and accountability were reflected in the Hydrogen Program's improved 2003 PART score in those areas, resulting in an overall score improvement and a "moderately effective" rating, the second highest rating possible.

The 2003 PART also found that the program has coordinated well with other DOE programs (i.e., in developing the DOE Hydrogen Posture Plan) and with industry (i.e., in developing technology roadmaps) in establishing a plan to achieve the goals of the President's Hydrogen Fuel Initiative. The PART noted that a significant level of congressionally directed activities in FY 2004 − nearly half of the program's budget − jeopardizes progress on the President's initiative by reducing program funding available to address the most important barriers to the hydrogen economy.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to development of the FY 2007 budget. The program has provided input the Department needs to improve consistency in the methods and assumptions used to estimate potential benefits. The Department is employing the data in its effort to produce comparable estimates within its energy R&D programs to inform budget decision makers. EERE is working with OMB, the other applied R&D programs, and the PMA Budget and Performance Integration principals in the Department to establish an increasingly integrated and consistent framework to inform the budget process.

Expected Program Outcomes

Hydrogen Technology pursues its mission through integrated activities designed to improve the energy efficiency, flexibility, and productivity of our energy economy. We expect these improvements to reduce susceptibility to energy price fluctuations; reduce greenhouse gas emissions; reduce EPA criteria and other pollutants; and enhance energy security by increasing the production and diversity of domestic fuel supplies. Realization of the Hydrogen Technology goals would provide the technical potential to reduce conventional energy use.

Estimates for energy savings, energy expenditure savings, carbon emission reductions, oil savings, and natural gas savings that result from the realization of the HT Program goals are shown in the tables below through 2050, reflecting the increasing availability of commercial fuel cells and hydrogen sources. When hydrogen-powered fuel cell vehicles are introduced in substantial numbers and fuel cells reach the mass consumer market for electronics and other stationary applications, the oil savings and other benefits to the Nation are expected to be significant. If hydrogen technology reaches its full potential under the aggressive market penetration scenario envisioned in the Presidential Initiative, up to 11 million barrels per day (mbpd) of oil could be displaced in 2040. This displacement includes contributions from the DOE Nuclear Energy, Science, and Fossil Energy activities in the Hydrogen Initiative, and also from the EERE Vehicle Technologies Program's emerging work on hydrogen-fueled internal combustion engines.

Estimates are based on the assumptions and methodologies used in each subsystem model, which are under continuous development, and can have a significant impact on the estimated benefits. The results could also vary significantly if external factors, such as future energy prices, differ from the "baseline case" assumed for this analysis.

EERE's Hydrogen Technology Program baseline case (which assumes a modest market-based technology penetration) results in mid-term oil savings of nearly 0.3 mbpd in 2025 as the program technologies begin to enter the market (based on the GPRA07-NEMS model) and in the long term ramp up to savings of more than 5 mbpd in 2050 (based on estimates using the GPRA07–MARKAL model). EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors identified in the Means and Strategies section above, such as unexpected changes in competing technology costs, could also affect the program's ability to achieve its goals.

The results shown in the long term benefits tables estimates based on modeling of some of the possible program production technologies. They provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits that follow assume that individual technology plans are followed and current market assumptions apply. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at: http://www.eere.energy.gov/ba/pba/gpra.html.

The full long-term potential for renewable-based hydrogen is not reflected in this FY 2007 benefits analysis. Further improvements in the analysis for renewable-based hydrogen technology are underway. In addition, these estimates do not include an assessment of the role of policy measures in facilitating the development of the infrastructure necessary to provide hydrogen at refueling stations nationwide, or in stimulating consumer demand for hydrogen fuel cell vehicles.

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

FY 2007 GPRA Benefits Estimates for Hydrogen Technology Program[a]

Mid-term benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	ns	ns	0.02	0.22
Energy expenditure savings (Billion 2003$)	ns	ns	ns	2
Carbon emission reductions (MMTCE)	ns	ns	ns	6
Oil savings (mbpd)	ns	ns	0.03	0.28
Natural gas savings (Quads)[d]	ns	ns	-0.03	-0.33

Long-term benefits[e]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	0.43	2.63	7.73
Energy system net cost savings (Billion 2003$)	0	4	28
Carbon emission reductions (MMTCE)	5	29	100
Oil savings (mbpd)	0.32	1.77	5.29
Natural gas savings (Quads)	-0.03	-0.28	-0.61

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are met and funding continues at levels consistent with assumptions in the FY 2007 Budget.
[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.
[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.
[d] Although these results show a small negative impact on natural gas demand in the short and mid-term, an analysis by the Office of Energy Efficiency and Renewable Energy (EERE) of its entire research and deployment portfolio indicates that by 2020 the industrial, buildings, and other portions of this EERE portfolio will be freeing up significant natural gas demand to more than offset the estimated small impacts on natural gas of the HT Program during the early phases of the transition to a hydrogen economy. In the long term, the program is targeting more renewable-based hydrogen.
[e] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Hydrogen Production and Delivery R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Hydrogen Production and Delivery R&D	13,303	8,273	35,798
SBIR/STTR	--	239	1,046
Total, Hydrogen Production and Delivery R&D	13,303	8,512	36,844

Description

Hydrogen Production and Delivery R&D encompasses both distributed natural gas and a diversity of renewable energy sources (including biomass, wind, solar, etc.). Work involving coal- and nuclear-based hydrogen is funded by the DOE Fossil Energy and Nuclear Energy offices, respectively. Areas of collaboration with other offices include an array of production processes and techniques such as reforming, separating, purifying, compressing, and delivering hydrogen.

Benefits

Production and Delivery R&D supports the mission of the HT Program by developing new and advanced technologies to produce hydrogen from diverse domestic resources. The benefits of the R&D support the achievement of fuel costs on a cents/mile basis which are less than or equivalent to gasoline or gasoline hybrid vehicles.[a] The research will enable the projected cost of hydrogen produced in large quantities by renewable and non-renewable fuel sources to be reduced as indicated.

Hydrogen Production Costs (modeled)[b]: Renewable delivered at 5000 psi

		($/gge)							
		2003	2004	2005	2006	2007	2008	2009	2010
Hydrogen from renewables	Target	6.20	6.00			5.50		4.50	2.85
	Actual	6.20	5.45	5.88[c]					

[a] A new hydrogen cost goal range of $2.00 to $3.00 per gasoline gallon equivalent (gge) by 2015 has been determined independent of technologies used to produce and deliver hydrogen, based on National Academies' fuel efficiency improvement factors for gasoline and gasoline hybrid vehicles and the Energy Information Administration's "High A Case" 2015 gasoline price projection. This methodology will make hydrogen fuel less than or equivalent to gasoline on a cents-per-mile basis.

[b] Hydrogen production cost estimates use laboratory data and assume high equipment manufacturing volumes, i.e., 500 units/year.

[c] The increase of the actual value of modeled cost of hydrogen produced from renewables is due to two factors: (a) increase in the assumed industrial electricity price from 5¢/kWh to 5.5¢/kWh from the EIA Annual Energy Outlook and (b) increase of capital cost estimate of electrolyzer.

Hydrogen Production Costs (modeled)[a]: Non-renewable delivered at 5000 psi, untaxed, based on natural gas at $ 5.25/MBtu.

($/gge)

		2003	2004	2005	2006	2007	2008	2009	2010
Hydrogen from natural gas (distributed)	Target	5.00			3.00				2.50
	Actual	5.00		3.10					

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Production and Delivery R&D	**13,303**	**8,273**	**35,798**

The Production and Delivery R&D subprogram funds multiple pathways for hydrogen production including: water electrolysis; reforming of natural gas and biomass-derived liquids; photoelectrochemical; photobiological; and solar high temperature water-splitting. The majority of the funding is directed toward technologies from renewable energy sources.

The program will conduct research on advanced distributed natural gas reforming systems and select technologies with the potential to produce hydrogen at 5,000 psi for $2.50/gge (untaxed at the station) by 2010.

The program will also conduct research on advanced electrolyzer systems (pilot scale) toward achieving a delivered hydrogen cost of $4.50 per gasoline gallon equivalent (gge) at 5000 psi by 2009 when modeled in a 1500/gge/day refueling station using renewable integrated grid electricity.[b] Research on reforming of biomass and biomass derived liquids to reduce capital costs and improve efficiencies will be targeted to achieve a delivered hydrogen cost target of $3.60/gge by 2011. Gasification technology research will be coordinated with the EERE Biomass Program and DOE's Fossil Energy Program. Separation technologies to reduce energy use and capital costs associated with purifying hydrogen streams from renewable sources such as biomass will be developed in coordination with DOE's Office of Fossil Energy.

In photoelectrochemical water splitting production, begin development of standard test protocols to validate and compare the efficiencies and durabilities of materials and devices under development by universities, industry, and National Laboratories. In collaboration with the Office of Science, complete development of photoelectrochemical material that achieves a projected 8 percent solar-to-

[a] Hydrogen production cost estimates use laboratory data and assume high equipment manufacturing volumes, i.e., 500 units/year.
[b] Distributed grid connected electrolysis with electricity generation mix that includes approximately 30 percent from renewable sources.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

hydrogen system efficiency with 1,000-hour durability by the end of 2011. Conduct research for advanced photoelectrochemical materials to achieve 10 percent solar-to-hydrogen system efficiency and 5,000-hour durability by 2016. In collaboration with the Office of Science, research biological micro-organism systems to improve hydrogen production efficiency. Conduct research of biological technology that achieves 2 percent incident light energy-to-hydrogen efficiency with 30 minute duration of continuous photoproduction by 2011 and 5 percent efficiency with 4 hour duration by 2016. Additionally, conduct research in solar based high temperature water splitting chemical cycles using solar concentrators aimed at demonstrating the feasibility of $6.00 per gasoline gallon equivalent at the plant gate by 2012.

Conduct research to reduce capital costs and increase energy efficiency of delivery systems from central production facilities and within refueling stations. This research includes improving materials for hydrogen pipelines to resolve embrittlement and reduce capital costs, reducing hydrogen compression technology costs, reducing the cost and footprint size of bulk hydrogen storage, increasing the energy efficiency of liquefaction technology, and reducing the cost of solid and liquid carrier systems.

Continue production and delivery research cooperative agreement projects selected in 2004. Down-select to the projects on track toward achieving the 2010 research targets.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Based on technologies researched in FY 2006, issues such as reforming and water-gas-shift reactor designs for distributed natural gas reforming will need to be addressed to achieve the overall system targets in 2015.

SBIR/STTR	**--**	**239**	**1,046**

In FY 2005, $223,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Hydrogen Production and Delivery R&D	**13,303**	**8,512**	**36,844**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Hydrogen Production and Delivery R&D	
This increase is partially to restore shortfall resulting from funds redirected by Congressionally Directed activities and lower than requested appropriations. Specifically, 46 projects would be restarted: 16 delivery technology projects with industry and National Laboratories, 3 high temperature solid oxide electrolysis projects with industry, 2 central biomass reforming of gasified stream projects with industry, 2 central solar thermochemical water splitting projects with industry, 7 photobiological projects with industry and National Laboratories, 7 photoelectrochemical projects with industry and National Laboratories, 5 hydrogen separation and purification projects with industry and National Laboratories, and 4 distributed reforming from liquid renewables projects with industry and National Laboratories. Restoring these projects is consistent with the RDIC: it incorporates industry involvement; uses competitive awards and peer review; and supports the DOE Hydrogen Posture Plan and the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan. **(**$24 million)	
The additional funding also would invest in new process technologies and related materials to contribute towards achieving technology targets. New research and development projects with industry and National Laboratories in of process technologies including natural gas and renewable liquid reforming, and water electrolyzing from renewable electricity sources, biomass reforming, solar high temperature thermochemical cycling, and will be started. ($3.5 million).....	+27,525
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+807
Total Funding Change, Hydrogen Production and Delivery R&D	**+28,332**

Hydrogen Storage R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Hydrogen Storage R&D	22,418	25,855	33,651
SBIR/STTR	--	745	969
Total, Hydrogen Storage R&D	22,418	26,600	34,620

Description

Hydrogen Storage R&D will focus primarily on the research and development of on-board vehicular storage systems that allow for a driving range of greater than 300 miles within the constraints of weight, volume, durability, refueling time, efficiency, and total cost, to meet consumer expectations. Hydrogen Storage R&D will develop and demonstrate solid and liquid storage media and explore conformable tank technologies for hydrogen storage systems to meet 2010 and 2015 on-board system performance targets.

Benefits

Hydrogen storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies for transportation, stationary power, and portable power applications. Current hydrogen storage systems for vehicles are inadequate to meet customer driving range expectations without intrusion into vehicle cargo or passenger space. The Hydrogen Storage R&D activity supports the mission of the HT Program by focusing on the development of safe, compact, light-weight, low-cost, durable, and efficient storage systems to achieve a driving range of greater than 300 miles.

The research will enable the system volumetric (kWh/l) and gravimetric (kWh/kg or % by weight) storage capacities (while meeting cost targets) to be improved as indicated below.

Hydrogen Storage Performance Metrics

Materials-Based		2003[a]	2004[b]	2005	2006	2007	2008	2009	2010
Volumetric (kWh/1)	Target					1.2			1.5
	Actual	0.5	0.6	0.65					
Gravimetric (% by weight)	Target	1	1.7		2.5	4.5			6.0
	Actual	1	1.7	1.9					

[a] 2 kWh/kg = 6% by weight. A 6% by weight hydrogen storage system contains 6 kg of hydrogen in a system weighing 100 kg. 1 kg of hydrogen contains 33.3kWh (on a lower heating value basis), so 6 kg contains approximately 200kWh. A 200 kWh hydrogen/100 kg system = 2kWh/kg.
[b] The program plans in effect in FY 2003 and 2004 did not include quantitative performance targets for these years.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Hydrogen Storage R&D	**22,418**	**25,855**	**33,651**

To address the critical challenge of hydrogen storage, the program will conduct research and development through the framework of the "*National Hydrogen Storage Project,*" consisting of Centers of Excellence as well as independent projects aimed at meeting the following technical goals by 2010: storage density of 2.0 kWh/kg (6% by weight hydrogen), 1.5 kWh/l, and $4/kWh. This work is based in part on awards initiated in FY 2005 from the "Grand Challenge" solicitation issued in FY 2003; FY 2007 would be the third year of the effort.

Hydrogen storage materials-based research and development will also continue utilizing an annual competitive solicitation initiated in FY 2006 that provides DOE increased flexibility to fund new material and process concepts not awarded in the FY 2003 Grand Challenge solicitation. Using this flexible approach, hydrogen storage efforts will focus on innovative chemistries and novel materials in collaboration with the DOE Office of Science - through university, National Laboratory, and industry R&D. Advanced concepts include high-capacity metal hydrides, solid and liquid chemical hydrogen carriers, boron-based materials, novel carbon nanostructures, metal-organic framework materials, clathrates, conducting polymers, and novel material treatment processes. Overall technical progress for hydrogen storage in FY 2007 will be based upon achieving the interim system target of 4.5% by weight hydrogen.

In FY 2007, the program will conduct hydrogen storage research and development at Centers of Excellence established in FY 2005 that include teams of university, industry and National Laboratory partners, with a focus on metal hydrides, chemical hydrogen storage, and carbon-based materials. Building on the research conducted in FY 2005 through the end of FY 2007, each center will recommend to DOE a down-select or focusing of its R&D portfolio on the most promising material technologies to meet the DOE 2010 system targets. This down-select process is part of the planned process by focusing on key technologies to achieve the program goals.

Chemical hydrogen storage research will focus on identifying improved materials and to improve the life cycle cost and energy efficiency of their use in a storage system to meet 2010 system targets and pathways to meet the 2015 targets. The program's FY 2007 milestone for chemical hydrogen storage is a down-select of chemical hydrogen carrier regeneration processes.

Metal hydride research will focus on designing and developing high-capacity metal hydride materials that have the potential to meet the 2010 system targets and offer pathways to meet the 2015 system targets. The FY 2007 milestone for the program's metal hydride research is a down-select of on-board reversible metal hydride materials to meet the 2010 system targets.

Research on carbon-based materials and sorbents will continue to focus on innovative ways to store hydrogen with lower binding energies as compared to metal hydrides and chemical hydrides. The

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

carbon research portfolio in FY 2007 will also take into consideration the outcome of a go/no-go decision in the 4th quarter of FY 2006 on continuation of carbon nanotube R&D. Based on the criterion of reproducibly demonstrating 6% by weight hydrogen storage capacity (on a material basis) in single wall carbon nanotubes, the go/no-go decision would dictate an emphasis either on single wall nanotubes or on other sorbent materials such as hybrid metal containing-carbon systems.

System Analysis activities will focus on advanced storage options and develop a database to compare life cycle energy efficiencies, cost and environmental impact. The Storage System Analysis Working Group initiated in FY 2005 will continue to leverage analysis activities occurring in the Centers of Excellence as well as in the independent projects.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**745**	**969**

In FY 2005, $480,500 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Hydrogen Storage R&D	**22,418**	**26,600**	**34,620**

Explanation of Funding Changes

FY 2007 vs. FY 2006 ($000)

Hydrogen Storage R&D

The majority of the requested increase will support competitive, merit-reviewed, cost-shared R&D on materials-based hydrogen storage technologies by industry, universities and Federal Laboratories (including DOE National Laboratories and others), focused on the three key areas of metal hydrides, chemical hydrogen storage, and carbon-based materials ($5.8 million). This additional funding also invests in applied and engineering sciences necessary to meet the 2007 (previously 2005) technical performance targets (1.5 kWh/kg and 1.2 kWh/l). The target date for these performance levels was delayed from 2005 due to congressionally directed activities that reduced the number of competitive, merit-reviewed projects that support the DOE Hydrogen Posture Plan and the Hydrogen Program Multi-Year Research, Development and Demonstration Plan.

The increased funding will also support new awards from the solicitation for new materials and concepts. These new projects, planned to start in FY 2007, will

	FY 2007 vs. FY 2006 ($000)
complement the work being done at existing materials-based Centers of Excellence and existing independent projects ($2.0 million).	
The increase in R&D of materials-based hydrogen storage technologies is consistent with the National Academies' recommendations in their *Hydrogen Economy* report and is supported by multiple RDIC factors: it is a Presidential priority; it addresses market barriers (e.g., no current market) and provides a public benefit; it builds on existing technology and complements current R&D; it incorporates industry involvement in planning, industry cost-sharing, performance indicators, and "off ramps;" and it is competitively awarded based on merit reviews	+7,796
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+224
Total Funding Change, Hydrogen Storage R&D	**+8,020**

Fuel Cell Stack Component R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Fuel Cell Stack Component R&D	31,702	30,710	37,016
SBIR/STTR	--	885	1,066
Total, Fuel Cell Stack Component R&D	31,702	31,595	38,082

Description

Fuel cell stack component costs dominate the cost structure and lifetime of the fuel cell system. The National Academies recognize the importance of stack component R&D in their 2004 recommendation to focus the research on breakthroughs in fuel cell costs and materials for durability. Collaborative research and development efforts with industry, National Laboratories and academia focus on the most critical technical barriers for polymer electrolyte membrane (PEM) fuel cell stack components for both transportation and stationary applications. Critical technical barriers include cost, durability, efficiency and overall performance of components such as the polymer electrolyte membranes, oxygen reduction electrodes, advanced catalysts, bipolar plates, etc. The 2005 National Academies' Report recommends an expanded activity and raised priority on membranes R&D, new catalyst systems and electrode design (in collaboration with DOE's Office of Basic Energy Sciences (BES)). In particular, National Laboratories and other appropriate scientific centers should focus on failure mechanisms, including a better understanding of the chemistry, physics and materials involved. The success of these research and development efforts will assist the industry in making its decision regarding commercialization of fuel cells. Technical targets established at the component level support the technology goals for fuel cell vehicles.

Benefits

Stack Component R&D supports the HT Program's mission by focusing on overcoming critical technical barriers at the *component level* to improve overall fuel cell performance and durability, while lowering cost. Addressing these barriers at the component level supports technology transfer and the industrial effort to integrate the fuel cell system and develop full-scale fuel cell stacks. R&D that reduces the inherent cost of producing and operating fuel cells while maintaining performance and durability comparable to or better than conventional technology will ultimately help get fuel cells into the marketplace so that national energy and environmental benefits can be realized.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Fuel Cell Stack Component R&D	**31,702**	**30,710**	**37,016**

Membranes that operate at low relative humidity and higher temperature reduce the complexity of the fuel cell system by eliminating the need for external humidification and simplifying water and thermal management. In FY 2007, the program will develop proton-conducting materials that operate at low relative humidity (25-50% RH) over a range of vehicular operating conditions from -20°C to 120°C. The program will also develop membranes that are low-cost and durable in the aggressive environment of the fuel cell, and have good mechanical and chemical stability under highly oxidizing conditions. The results from Basic Energy Science (BES) research projects will be used to research, develop, and demonstrate membranes that address and mitigate the failure mechanisms. Membrane development activities will be coordinated internationally through an International Partnership for the Hydrogen Economy (IPHE) project.

Electrocatalysts are a significant contributor to the high cost of fuel cell systems. Reducing the amount of precious metal in electrocatalysts while maintaining performance and lifetime is a key technical challenge. Research will be conducted to elucidate mechanisms of loss of electrocatalyst material and performance. Technologies to meet the design lifetime requirement (40,000 hours operation for stationary, 5,000 hr under cyclic operation for transportation, with <5% degradation in performance) will be developed. Research and development will be conducted of low-cost cathode catalysts containing little or no precious metals and whose use in stacks leads to performance at least as good as stacks with conventional precious metal catalysts over a range of vehicular operating conditions from -20°C to 120°C. The program will develop a method for cleaning sulfur-poisoned platinum catalyst layers in stacks, with minimum interruption of fuel cell operation. Precious metal reclamation processes will be evaluated to determine whether or not scale-up will take place.

Water is produced during the operation of a fuel cell. A detailed understanding of the water properties and location within the stack across the operating conditions and during start up and shut down is required to optimize fuel cell performance and durability. In FY 2007 the program will: evaluate the effects of freeze/thaw cycles on PEM fuel cell components, cells, and stacks; develop in-situ/ex-situ tools to characterize water transport within the different cell components; identify water transport mechanisms and controlling parameters that govern water removal; develop materials and components that enhance water transport, and decrease flooding and dehumidification; and initiate the development of engineering solutions that mitigate freeze/thaw damage and improve subfreezing operation.

As fuel cell systems approach the target lifetimes, fuel cell developers have determined that current seal materials fail before the target lifetime. To address this issue the program will research and develop PEM fuel cell seal materials and structures that possess chemical and structural integrity, and

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

are non-conductive, gas impermeable, and low cost. Seal materials must be durable and compatible with the membrane and other cell components

The size, weight and cost of bipolar plates must be reduced to meet specific power, power density and cost targets. Therefore, the program will: continue testing of coated stamped metal bipolar plates and initiate development of bipolar plates that can demonstrate in-stack performance that is at least 95 percent of the performance of an equivalent stack using machined graphite plates, while costing significantly less than graphite plates and potentially offering greater durability. Reduced cost and improved durability are both elements of the program's 2010 goal for stack components.

A 2,000-hour durability test of advanced membrane-electrode assemblies for stationary fuel cell application will be completed in the program.

Participation in the European Commission's Fuel Cell Testing, Safety and Quality Assurance Program to develop generic tools for fuel cell systems modeling, testing, safety and quality assurance will continue as part of an IPHE project.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR.....	**--**	**885**	**1,066**

In FY 2005, $789,000 and $50,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are the estimated requirements for the continuation of the SBIR and STTR program.

Total, Fuel Cell Stack Component R&D	**31,702**	**31,595**	**38,082**

Explanation of Funding Changes

FY 2007 vs. FY 2006 ($000)

Fuel Cell Stack Component R&D

The requested increase will support competitive, merit-reviewed, cost-shared R&D on polymer electrolyte fuel cell stack component technologies by industry, universities and National Laboratories resulting from a solicitation and laboratory call for proposals. The R&D will be focused on the critical path fuel cell technologies including electrocatalysts, catalyst supports, membranes, membrane electrode

	FY 2007 vs. FY 2006 ($000)
assemblies, bipolar plates, seals, water transport, innovative approaches and the impact of hydrogen quality on fuel cell performance and durability. Technical progress will be evaluated against the 2010 fuel cell component technical targets and the fuel cell system cost target of $45/kW.	
The increase in R&D of fuel cell stack component technologies is consistent with the RDIC: it incorporates industry involvement; uses competitive awards and peer review; and builds on and complements existing R&D in support of the DOE Hydrogen Posture Plan	+6,306
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+181
Total Funding Change, Fuel Cell Stack Component R&D.....	**+6,487**

Technology Validation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Validation	26,098	33,452	39,400
SBIR/STTR	--	142	166
Total, Technology Validation	26,098	33,594	39,566

Description

Technology Validation includes both Fuel Cell Technology Validation and Hydrogen Infrastructure Validation. This activity funds the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project, which has the dual objective of being a "Learning Demonstration" to re-focus the hydrogen and fuel cell component and materials research while also validating the technology against time-phased performance-based targets. This project is a 50/50 cost-shared effort between the government and industry, including automobile manufacturers, energy companies, suppliers, universities, and state governments. The project involves the major stakeholders that will have the responsibility for implementing the development of hydrogen vehicles and infrastructure. The fuel cell technology validation effort will be an important opportunity to validate vehicle fuel cell components and storage systems under real-world operating conditions and gain experience in the safety of hydrogen fueled vehicles. By operating these vehicles in a controlled manner, all participating parties will be able to provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell vehicles. Extensive data will be collected both while the vehicles are operated on-road and during dynamometer testing. Validation of the hydrogen infrastructure includes using full-scale demonstrations to verify hydrogen production cost, fast fill times and operation of stations in a safe manner.

Benefits

Technology Validation will provide the most accurate assessment of technology readiness and the risk of continued government and industry investment. In order for the automotive, energy and utility industries to make commercialization decisions by 2015, integrated vehicle and infrastructure systems need to be validated and individual component targets need to be met under real-world operating conditions. This activity supports HT's mission by providing critical statistical data that fuel cell vehicles can meet the 2015 targets of 5,000-hour fuel cell durability, 300+ mile range hydrogen storage, and hydrogen fuel costs between $2.00 and $3.00 per gallon gasoline equivalent (gge). Specifically, the program validates the performance and vehicle interfaces of hydrogen fuel cell vehicles to demonstrate an increase in durability from approximately 1,000 hours in 2003 (laboratory) to 2,000 hours by 2009 in a vehicle fleet (2000 hours is equal to approximately 50,000 vehicle miles) and 250 mile range by 2009. Technology Validation also provides information in support of codes and standards development and for the development of best practices regarding safety.

Specifically, the research will enable commercial scale validation of the parameters indicated in the table below.

Technology Validation Performance Metrics

		2004[a]	2005	2006	2007	2008	2009
Durability (hours)	Target		1,000 (Projected)[b]	1,000			2,000
Range (miles).....							
Cost of hydrogen production[c] ($/gge untaxed).....	Target		3.60				3.00
Fill Time (minutes).....	Actual						

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Validation.....	**26,098**	**33,452**	**39,400**

Five automobile manufacturers and energy company partnerships were selected in April, 2004 to design and construct hydrogen fuel cell vehicles to support "learning demonstrations" in the Controlled Hydrogen Fleet and Infrastructure Technology Demonstration and Validation Project. The primary goals are to validate reaching the 2009 target of 2,000 hours fuel cell durability and 250+ mile range. The fuel cell vehicle technology validation effort will quantify the performance, reliability, durability, maintenance requirements and environmental benefits of fuel cell vehicles under real world conditions and provide valuable information to researchers to help refine and direct future R&D activities related to fuel cell vehicles.

In FY 2007, the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

[a] The program plan in effect in 2004 did not include quantitative targets for that year. The $3.60/gge includes co-production of electricity and hydrogen fuel, and is only for limited testing.
[b] FY 2005 durability target was changed to 1000 hours "projected" due to the delay in selecting projects from the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Solicitation. The 1000 hours durability will be validated in FY 2006.
[c] The validation activity validates the 2006 laboratory data for estimated hydrogen production costs for non-renewable in real world conditions. Hydrogen production cost estimates use real world data and assume high equipment manufacturing volumes, e.g., hundreds of units/year.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

will complete the third year of data collection on first generation vehicles, including chassis dynamometer tests. This data collection will facilitate a better understanding of vehicle and infrastructure interface issues of hydrogen fueled vehicles. An initial composite system efficiency assessment and an interim evaluation of data that were collected from first-generation hydrogen-fueled vehicles will be completed. Second generation vehicles will begin to be tested with more advanced fuel cell and storage systems that will ultimately validate the 2,000 hour fuel cell system durability and 250+ mile range.

To support fueling of the fuel cell vehicles, the partnerships will design and construct hydrogen refueling stations and associated infrastructure of new hydrogen production technology to validate reaching the 2009 target of $3.00/gge (untaxed) with 68 percent natural-gas based well-to-pump efficiency.

The infrastructure efforts through FY 2007 will include installing and operating stations in Northern and Southern California, Michigan, Washington, D.C., and Florida. Hydrogen production concepts being demonstrated will explore options that will span viable candidates for the early transition period (i.e., 2018 to 2025) as well as later transition candidates (i.e., 2026 to 2035). Additional stations for low-cost hydrogen production will be deployed by FY 2007 that will explore the use of local distributed natural gas reformation plants, renewable systems, and mid-size natural gas reformation plants with pipelines and mobile refueling systems to local distribution stations. High-efficiency energy stations that co-produce hydrogen fuel for vehicles and electric generation will be deployed as potential low cost fuel providers and early infrastructure options. Data relevant to key vehicle and refueling interface issues such as refueling times, hydrogen purity impacts, energy efficiency of the hydrogen generation plant, and plant availability and reliability will be produced and published to provide a data base for system modelers.

Two distributed natural gas reformation systems were operated through 2006 to demonstrate the ability to produce hydrogen for $3.00/gallon gasoline equivalent (untaxed) at 5000 psi hydrogen (with high capital equipment manufacturing volumes, e.g., hundreds of units/year). If possible, these units will be incorporated into the Learning Demonstration in 2007 and operate under real world operating systems. The Energy Station at Las Vegas, Nevada, will continue to be operated as part the Controlled Fleet and Infrastructure Demonstration Project.

A competitive solicitation was issued (as part of the FY 2002 State Energy Special Projects Program) for 50/50 cost-share projects with utilities to demonstrate integrated renewable and fossil fuel distributed generation systems with hydrogen storage (power parks). Three power park projects were awarded funds for the integration of renewable energy systems into distributed electric generation systems in September, 2002. One project was completed in FY 2006 and the other two will be completed in FY 2007. The power park projects to be operated and maintained in FY 2007 will demonstrate the ability to use both distributed electric generation from natural gas and renewable energy in a synergistic and efficient manner.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

(In past budgets this funding was requested as two budget items: validation of fuel-cell vehicles and validation of hydrogen infrastructure, although the work was performed as an integrated project. In FY 2005, the funding split was $17.660 million for fuel-cell vehicles and $8.438 million for hydrogen infrastructure. In FY 2006 the split is $23.067 million for fuel-cell vehicles and $10.527 million for infrastructure. In FY 2007 funding is requested as a single budget item, but the anticipated comparable split is $24.729 million for fuel-cell vehicles and $14.837 million for infrastructure.)

Activities will also include participation in the California Fuel Cell Partnership, through which field evaluations of hydrogen fuel cell buses and vehicle systems under real world conditions will continue to validate system durability and performance. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**142**	**166**

In FY 2005, $300,000 and $51,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Technology Validation	**26,098**	**33,594**	**39,566**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Technology Validation	
In the "Learning Demonstration" project, the increased funds will be used for data collection of the first generation demonstration vehicles and the first year of testing of second generation vehicles. These are necessary steps toward verifying the achievement of program goals. The increase is consistent with the RDIC: it will support competitive, merit-reviewed, cost shared R&D with industry, and it was planned with industry participation	+5,948
SBIR/STTR	
No significant change	+24
Total Funding Change, Technology Validation	**+5,972**

Transportation Fuel Cell Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Transportation Fuel Cell Systems	7,300	1,050	7,307
SBIR/STTR	--	30	211
Total, Transportation Fuel Cell Systems	7,300	1,080	7,518

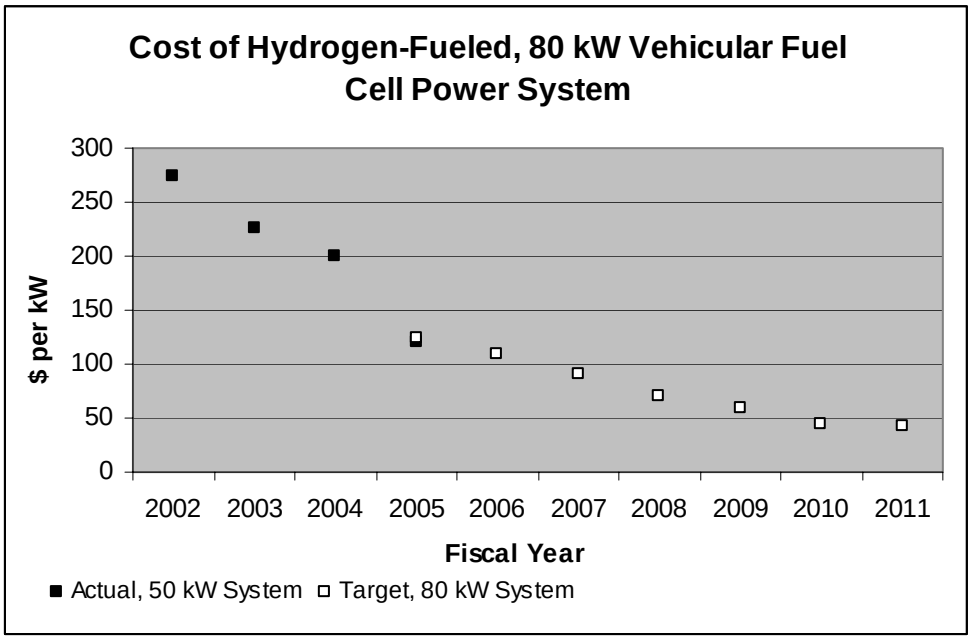
Description

Transportation Fuel Cell Systems R&D conducts analyses that address key barriers to fuel cell systems for transportation. Key systems-level barriers include lack of compressor/expanders, sensors, and heat exchangers that meet automotive packaging and cost requirements of the fuel cell system. Because of the increased ability of industry to develop complete systems, Transportation Fuel Cell Systems R&D does not develop complete, integrated systems for transportation applications. Instead, Transportation Fuel Cell Systems R&D supports the development of individual component technologies critical to systems integration as well as systems-level modeling activities that serve to guide R&D, benchmark systems progress, and explore alternate systems configurations on a cost-effective basis. Other activities include studies that appraise the status of critical metrics (such as cost) and evaluate water and thermal management strategies. Transportation Fuel Cell Systems R&D also supports limited development of fuel cells for vehicle Auxiliary Power Units (APUs) for automotive or heavy vehicle applications and fuel cell for portable power applications. Fuel cell issues such as vibration and dust and/or contaminants which could have a deleterious effect on stack performance and life are also addressed in Transportation Fuel Cell Systems R&D. Systems components developed include compressor/expanders, sensors, heat exchangers and water management devices. Transportation Fuel Cell Systems R&D includes competitively selected projects that include significant industry cost share.

Benefits

Transportation Fuel Cell Systems R&D supports the HT Program's mission by improving performance and durability, while lowering the cost of components and materials, and optimizing operating strategies that enable the widespread use of fuel cells. The improvements will help to accelerate commercialization of fuel cells by making them competitive with conventional technologies so that the potential benefits of energy security and environmental quality can then be realized.

Research activities for transportation applications (including transportation systems and stack component R&D) will reduce the cost of the hydrogen-fueled, 80 kW vehicle fuel cell power systems as indicated below.[a]



Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Transportation Fuel Cell Systems	**7,300**	**1,050**	**7,307**

In FY 2007, fuel cell system cost and trade-off analyses will be conducted to support the 2015 commercialization decision and transition scenarios. Scenarios for operating fuel cell systems at low relative humidity and under sub-freezing conditions will be evaluated.

The status of air, thermal and water management technologies will be assessed. Based on the results of the evaluation, a decision will be made on whether or not to continue development. In FY 2007, testing and evaluation of prototype turbo compressors towards established targets in a full scale fuel cell system will be completed.

[a] Cost of 80 kW vehicle fuel cell power systems estimated for production rate of 500,000 units yearly and includes fuel cell stack, balance of plant, and hydrogen storage.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

Fuel cell systems for auxiliary power in heavy duty trucks are being developed as alternate power supplies to avoid idling the diesel engine to provide overnight power to the cab. Fuel cell Auxiliary Power Units (APU) would operate off hydrogen from reformed diesel. The development of APUs supports the 21st Century Truck initiative. Solid Oxide fuel cell technology is being considered for APU applications. APU development is conducted in coordination with the Office of Fossil Energy's Solid Oxide Fuel Cell R&D effort. APU fuel cell stack and reformer assembly will be completed and an APU system will begin to be built. Continue development of a system to protect the fuel cell from air contaminated with particulates and chemical aerosols typically found in off-road use.

Fuel cell systems for portable power are being developed as an early market application where the market accepts a higher cost per kilowatt and a shorter lifetime. Commercialization of fuel cells for portable power will develop the manufacturing base for fuel cell systems. For portable power applications, develop polymer electrolyte fuel cells (PEMFC) such that there is a manufacturing pathway to $5 per Watt (in high volume production).

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR.....	**--**	**30**	**211**

In FY 2005, $165,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are the estimated requirements for the continuation of the SBIR and STTR program.

Total, Transportation Fuel Cell Systems.....	**7,300**	**1,080**	**7,518**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Transportation Fuel Cell Systems	
This increase is to restore this activity to funding levels essential to continue the research and development efforts that were delayed in FY 2006 due to reduced funding and Congressionally directed activities. Transportation system cost and performance trade-off analyses; air, thermal, and water management technologies; and auxiliary power, portable power and off-road systems research and development activities would be restored. Specifically, 12 projects would be restarted: 2 sensor projects at National Laboratories, 1 compressor project with industry would be completed, 2 water and thermal management projects (1 with industry and 1 at a National Laboratory), 4 APU projects (2 with industry and 2 with National Laboratories), 2 portable power projects with industry, 1 off-road project with industry and 1 analysis project with a National Laboratory. Restoring these projects is consistent with the RDIC: it incorporates industry involvement; uses competitive awards and peer review; and supports of the DOE Hydrogen Posture Plan and the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-year Research, Development and Demonstration Plan	+6,257
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+181
Total Funding Change, Transportation Fuel Cell Systems	**+6,438**

Distributed Energy Fuel Cell Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Distributed Energy Fuel Cell Systems	6,753	939	7,242
SBIR/STTR	--	23	177
Total, Distributed Energy Fuel Cell Systems	6,753	962	7,419

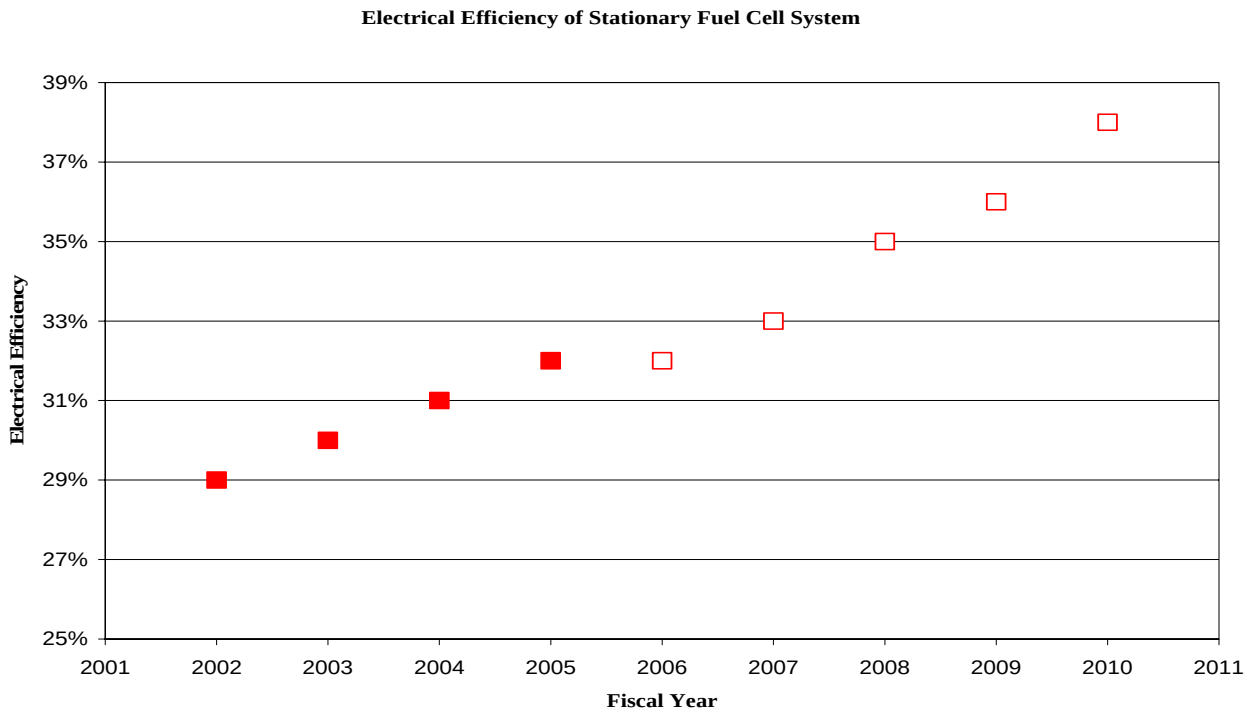
Description

Distributed Energy Systems develops high-efficiency Polymer Electrolyte Membrane (PEM) fuel cell power systems as alternative power sources to grid-based electricity for buildings and other stationary applications. Distributed Energy Systems focuses on overcoming the barriers to stationary fuel cell systems, including cost, durability, heat utilization, start-up time, and managing power transients and load-following requirements. Improved heat usage and recovery are addressed for combined heat and power generation to maximize overall efficiency of (thermal and electrical) systems. This activity will also take advantage of the synergy between transportation systems and distributed energy systems, particularly in the areas of developing improved materials for high temperature membranes, and improving fuel cell component durability. In response to the National Academies recommendation that the DOE discontinue the PEM applied R&D program for stationary systems, DOE has established a go/no-go milestone for the distributed energy systems activity for 2011.

Benefits

Distributed Energy Systems R&D supports the HT Program's mission by focusing on overcoming barriers to stationary fuel cell systems, including improving durability and performance, while lowering cost to enable the widespread use of fuel cells in distributed energy and other small stationary applications. The improvements will help to accelerate commercialization of fuel cells by achieving an ultimate durability requirement of 40,000 hours and cost range of $400-$750 per kW, making fuel cells competitive with conventional technologies.

Research activities will improve the electrical efficiency of 5-250kW stationary fuel cell systems fueled by natural gas, liquefied petroleum gas (LPG), or biomass-derived fuels. Specifically, stationary fuel cell R&D activities will increase the electrical efficiency of these systems as indicated in the performance indicator graph below.



Target and Actual are the same for FY 2002-2005.[a]

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Distributed Energy Fuel Cell Systems	**6,753**	**939**	**7,242**

In FY 2007, the development of a prototype 50 kW stationary fuel cell power system will be completed and demonstrated in a commercial application. Research and development to increase the durability of a 5-250kW stationary fuel cell system will be conducted. Advanced high temperature membranes will be developed to improve Polymer Electrolyte Membrane (PEM) fuel cell stack durability towards the 2011 durability target of 40,000 hours. Stationary fuel cell system test will operate for 15,000 hours. PEM stack components and power plant design concepts will be evaluated in field evaluations. The development of critical balance of plant components for stationary fuel cells will continue. An international or intergovernmental stationary fuel cell project will be initiated in support of the IPHE and the Interagency Hydrogen and Fuel Cell Technical Task Force.

[a] No change in 2006: virtually all work is deferred due to Congressionally directed funding and reduced total funding.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR.....	**--**	**23**	**177**

In FY 2005, $119,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are the estimated requirements for the continuation of the SBIR and STTR program.

Total, Distributed Energy Fuel Cell Systems	**6,753**	**962**	**7,419**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Distributed Energy Fuel Cell Systems	
This increase is to restore funding essential to continue distributed energy fuel cell systems activities that were delayed in FY 2006 due to reduced funding and Congressionally directed activities. Specifically 2 projects with industry to develop prototype stationary fuel cell systems and 1 National Laboratory analysis project will be restored. (Approximately $5 million) An international or intergovernmental stationary fuel cell project will be initiated in support of the IPHE and the Hydrogen Interagency Task Force. (Approximately $1.3 million) Restoring these projects and starting a new project is consistent with the RDIC: it incorporates industry involvement; uses competitive awards and peer review; and supports of the DOE Hydrogen Posture Plan and the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-year Research, Development and Demonstration Plan.....	+6,303
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+154
Total Funding Change, Distributed Energy Fuel Cell Systems.....	**+6,457**

Fuel Processor R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Fuel Processor R&D	9,469	600	3,942
SBIR/STTR	--	17	114
Total, Fuel Processor R&D	9,469	617	4,056

Description

Fuel Processor R&D develops fuel processors for integrated stationary applications and fundamental catalysts suitable for a variety of fuel processing applications. Fuel processing technology can be fuel-flexible – capable of processing multiple fuels – such as methanol, ethanol, biomass derived liquids, natural gas, propane or diesel – into hydrogen.

Benefits

Fuel Processor R&D supports the HT Program's mission by developing the subsystem that aids the widespread use of fuel cell power technology in stationary applications. Processing fuels such as natural gas, propane, methanol, ethanol, biomass derived liquids, or diesel, will enable environmental and efficiency advantages of hydrogen fuel cell technologies to be realized in an integrated fuel cell system. The option of using a diversity of fuels to produce hydrogen to power fuel cells will be a significant contributor to energy independence. Synergies exist between distributed hydrogen production and integrated fuel flexible stationary fuel cell systems.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Fuel Processor R&D	**9,469**	**600**	**3,942**

Development of fuel processors for light duty transportation applications was closed out in FY 2005, based on a decision in 2004 by DOE (which was supported by the members of the FreedomCAR and Fuel Partnership) to focus on direct hydrogen fuel-cell vehicles. In FY 2007, Fuel Processor R&D activities will focus on fuel processing for stationary power systems to increase the efficiency of conversion, lower the cost and improve the performance and durability of catalysts.

Advanced fuel processing catalysts that meet performance requirements for distributed generation

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

applications will be developed. Operating parameters (e.g., O_2 to fuel and steam to fuel ratios, temperature, gas-hourly space velocity) will be defined to optimize catalyst performance and lifetime. Research will be conducted to improve the understanding of reforming reaction mechanisms, catalyst deactivation, and sulfur poisoning. The construction of an advanced reforming module for stationary applications that produces 1,000 standard cubic feet of reformate per hour (scfh) with low product life-cycle cost will be completed. Technology that allows the output of the reformer to scale from 500 to 2,000 scfh will be developed. Accelerated aging processes will be employed to assess the lifetime.

Increase fundamental understanding of reaction mechanisms to increase catalytic activity and improve sulfur tolerance of catalysts in stationary power systems. Decrease precious metal loading while improving catalyst stability. Develop advanced fuel processing and water-gas shift catalysts suitable for a variety of fuel processing applications. Evaluate novel reactor designs with optimized heat integration. Evaluate sulfur removal strategies. Develop computer simulation models to evaluate advanced fuel processing concepts to predict and optimize performance.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**17**	**114**

In FY 2005, $222,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are the estimated requirements for the continuation of the SBIR and STTR program.

Total, Fuel Processor R&D	**9,469**	**617**	**4,056**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Fuel Processor R&D	
The increase in funding restores the original plan for Fuel Processing activities as described below:	
The increased funding in FY 2007 restores some of the activities that were deferred in FY 2006 as a result of Congressionally directed activities and reduced overall appropriations. This R&D is needed to achieve the program's 2011 stationary fuel cell goals of 40 percent system efficiency and a system cost of $400-750 per kW. Activities to be restarted include optimization of reformer operating parameters; basic understanding of catalyst reaction mechanisms and sulfur-poisoning processes leading to improvement in the cost, performance, and durability of catalysts; prototype construction; and development of scale-up technology.....	+3,342
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+97
Total Funding Change, Fuel Processor R&D.....	**+3,439**

Safety and Codes and Standards

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Safety and Codes and Standards	5,801	4,595	13,460
SBIR/STTR	--	132	388
Total, Safety and Codes and Standards	5,801	4,727	13,848

Description

Safety and Codes and Standards include fundamental studies to determine the flammability, explosive, reactive, and dispersion properties of hydrogen. Components, subsystems, and systems will be subjected to environmental conditions that could result in failure in order to verify design practice and failure-mode prediction analysis. Once the identification of critical failure modes and safety issues for hydrogen and fuel cell technologies are developed, this technical data will be provided to the appropriate codes and standards developing organizations (i.e., International Code Council, National Fire Protection Association) to write and publish applicable codes and standards for hydrogen production and delivery processes as well as for hydrogen storage and fuel cell systems for both transportation and stationary applications. The DOE will not be involved directly in writing codes and standards, but instead will facilitate the development of these standards through R&D and support for appropriate technical representation in working groups. Dissemination of safety related information will include development of a hydrogen incident and safety database, publication and presentation of activity results and investigation of hydrogen related incidents. Activities also include the development of passive and active safety systems based on new sensor technologies, and comprehensive safety analysis of hydrogen components and systems. DOE and DOT will closely coordinate hydrogen safety and codes/standards development activities.

Benefits

In order for industry to make commercialization decisions, the technologies must meet safety standards. This requires a comprehensive and defensible database on component reliability and safety to enable publishing of performance-based domestic standards and international standards or regulations that will allow the technologies to compete in a global market. This activity supports the Hydrogen Technology Program's mission by providing the critical data needed to write and adopt standards, the safety criteria and systems that meet or exceed current technologies and will eventually lead to new Federal Motor Vehicle Safety Standards for fuel cell vehicles by the Department of Transportation.

Activities under Safety and Codes and Standards will facilitate and provide data to support the establishment of a global technical regulation for hydrogen and fuel cell vehicles and infrastructure.

	2006	2007	2008	2009	2010
Facilitate global technical regulation	Characterize large-leak releases of hydrogen and develop model to validate experiments to within 25 % of expected value.		Provide preliminary data for draft U.S. technical standards for preparation of draft regulation.		Data and testing completed to finalize U.S. technical standards for preparation of a Global Technical Regulation.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Safety and Codes and Standards	**5,801**	**4,595**	**13,460**

Assist the drafting and adoption of hydrogen codes and standards through the development of hydrogen characterization and behavior data and through limited direct support of Standards Development Organizations (SDOs) and Codes Development Organizations (CDOs). Hydrogen release data and incident scenario analysis will support codes and standards development activities focused on the 2015 FreedomCAR and Fuel Partnership commercialization decision milestone. Collaborate with DOT, EPA, NIST and other government agencies to ensure hydrogen codes and standards development proceeds in agreement with existing regulatory authority and by maximizing available resources and expertise in areas such as hydrogen dispensing measurement (NIST) vehicle safety (DOT National Highway Traffic Safety Administration) and international standards development (DOT, EPA).

Begin drafting a handbook on Best Management Practices for Safety, which will provide guidance for ensuring the safe use of hydrogen to be published in 2008. This will be a living document that compiles “lessons learned” from safety reviews and incident analysis. The handbook will also compile hydrogen safety information available from other resources such as state and international hydrogen programs.

Compile and update a hydrogen incident database. Continue monitoring the safety of DOE hydrogen projects through the Hydrogen Safety Panel. The Panel will conduct site visits, interviews and safety plan reviews of DOE projects.

Design and build safety training devices that enable firefighters and first responders to conduct “hands on” training of likely hydrogen fuel safety incidents. Training devices, also known as “props,” will be located at the Volpentest HAMMER Training and Education Center and will be designed to simulate devices such as hydrogen bulk storage, fuel dispensing and piping systems. Training devices will be used as part of a comprehensive training program developed in collaboration with the Education activity. Training will target fire marshals, code officials, first responders and other stakeholders.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

Conduct an analysis of potential accident scenarios which identifies potential hydrogen systems weaknesses and required R&D to improve systems safety. The scenarios report will also help guide the risk analysis effort which uses Probabilistic Risk Analysis (PRA) and Failure Modes Effects Analysis (FMEA) methods to quantitatively estimate hydrogen systems risk. Risk assessment activities provide information to guide the codes and standards development process as well as key industry stakeholders such as fuel providers and the insurers.

Initiate investigation of hydrogen safety sensor technology which can meet technical targets for response time and accuracy within the required measurement range of 0.1% to 10%. Perform verification tests of systems components (i.e., valves, regulators) to determine the performance relative to appropriate component standards and highlight areas of required change to existing standards or equipment to meet those standards.

R&D which supports a hydrogen quality standard will quantify the effects of hydrogen contaminants on system components, as well as the development of analytical methods to allow verification of hydrogen purity on a cost effective basis. Hydrogen metering technologies will also be supported to allow accurate measurement of delivered hydrogen.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**132**	**388**

In FY 2005, $70,000 and $30,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Safety and Codes and Standards	**5,801**	**4,727**	**13,848**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Safety and Codes and Standards	
The increase supports the development of risk analysis methodologies which support the codes and standards process and which focus on emerging hydrogen production, storage and conversion technologies. Probabilistic Risk Assessment methods will focus on component standards, while Failure Modes Effects Analysis supports the code development process. Testing of component technologies versus draft standards will verify and guide the existing standards development process. Work will be initiated to determine hydrogen quality standards, measurement, and metering. Hydrogen quality is a critical issue that affects all aspects of hydrogen technology. Hydrogen safety sensor R&D will be restarted to allow development of sensors which detect hydrogen leakage. Development of new storage monitoring technologies will measure degradation of high pressure storage systems	+8,865
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+256
Total Funding Change, Safety and Codes and Standards	**+9,121**

Education

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Education	0	481	1,923
SBIR/STTR	0	14	55
Total, Education	0	495	1,978

Description

Education activities are designed to increase the understanding of the benefits and challenges to achieving a hydrogen economy, the facts about hydrogen safety, and the role that certain key target audiences can play in the transition to a hydrogen economy. Target audiences, identified by key government and industry stakeholders in the National Hydrogen Energy Roadmap, include state and local government representatives, safety and code officials, potential end-users, and the public. Over the long term, education of teachers and students will also be required. The education activity responds to the President's National Energy Policy recommendation to the Secretary of Energy to develop an education campaign that communicates the benefits of alternative energy, including hydrogen. The Energy Policy Act of 2005 also calls for enhanced education relating to hydrogen and fuel cells, including activities in conjunction with hydrogen demonstrations to raise awareness among the public, information exchange to facilitate the development and adoption of codes and standards, and support for institutes of higher education.

Benefits

Education aids in overcoming institutional barriers to a hydrogen economy. The 2004 Hydrogen Education Survey measured the technical knowledge and opinions of hydrogen among key target audiences, including the public. This national, statistically-valid survey was developed to help guide hydrogen education activities and provide a baseline from which to measure changes over time. Preliminary analysis of the results shows a direct correlation between technical understanding and opinions about the safe use of hydrogen – respondents who scored lower on technical knowledge questions about hydrogen fuel cell technology also expressed the greatest fear about the use of hydrogen as an energy carrier. With an emphasis on hydrogen safety, near-term education activities will enable not only the successful implementation of early hydrogen demonstration projects, but also longer-term market adoption and acceptance, which are required to realize the benefits of a hydrogen economy.

State and local governments lay the foundation for long-term change and, with safety and code officials, facilitate the adoption of appropriate codes and approve hydrogen project installations. As they are with other commonly-used fuels, safety officials and emergency responders must be trained to handle potential hydrogen incidents. Public misunderstanding and false perceptions about the safe use of

hydrogen threaten the implementation of near-term hydrogen fueling station demonstrations, as well as the success of a future hydrogen economy. Education can overcome these significant challenges and build public confidence in hydrogen and the safe use of hydrogen as an energy carrier. In addition, hydrogen education at universities will ensure the availability of scientists and engineers needed for critical near-term research in government, industry, and academia, as well as foster development of a trained workforce required to maintain hydrogen fuel cell equipment in the future. Over the long term, hydrogen education can engage younger students in the study of science and technology and enable an informed first-generation of hydrogen technology users.

Hydrogen Education Survey Targets[a]

	2004	2005	2006	2007	2008[b]	2009	2011[b]
State and local government representatives	66%				73% (10% increase)		80% (20% increase)
General public	33%				38% (15% increase)		43% (30% increase) [b]
End users[c]	44%				50% (15% increase) [b]		57% (30% increase)
Students	32%				35% (10 % increase) [b]		38% (20% increase)

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Education	**0**	**481**	**1,923**

In collaboration with Safety, Codes and Standards, expand the development and availability of hydrogen safety training to fire marshals, first-responders, city planners, code officials, and users in order to facilitate the approval and implementation of hydrogen demonstration projects. Activities will leverage training resources available at the Volpentest HAMMER Training and Education Center.

[a] The Hydrogen Baseline Knowledge Assessment conducted in 2004 assessed four target audiences' understanding of a hydrogen economy. The results provide a baseline from which to evaluate future increases in knowledge. Modified targets reflect preliminary analysis of the results; target dates have been shifted because Education activities were not funded as originally expected. The baseline and outyear targets are a population's average score on 11 technical knowledge questions. Target increases refer to an increase in the average number of correct answers relative to the 2004 baseline.
[b] The target increases for state and local government officials were determined according to a higher baseline (average score on technical questions). The target increases for students reflect near-term program priorities and interest in educating this target audience over the long-term.
[c] Survey for this target audience includes safety and code officials.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

Develop multi-tiered hydrogen safety training modules and make them available to a national audience through distance learning. Initiate development of training for hazardous materials technicians that will incorporate the use of hands-on "props" developed through the Safety and Codes and Standards activity.

Work in partnership with state hydrogen and fuel cell initiative leaders and state energy offices to expand education opportunities for state and local government officials. Training will include "Hydrogen 101" overview workshops, as well as more intensive "hydrogen energy institute" seminars to help ensure an understanding of hydrogen technologies, hydrogen safety issues, and opportunities to facilitate the transition to a new energy economy.

In cooperation with automotive and energy industry partners involved in hydrogen infrastructure validation projects, conduct activities to educate the public and key target audiences in communities where new hydrogen fueling stations will be implemented. Develop and conduct training seminars and targeted outreach to raise awareness of the hydrogen economy and build public familiarity and confidence with the safe use of hydrogen as an energy carrier.

Implement new and expanded undergraduate and graduate-level hydrogen courses at universities. Expand teacher professional development opportunities to middle school and high school teachers nationwide. Based on initial pilot and trial sessions, initiate full-scale national field testing of hydrogen technology education lesson plans and curriculum.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**14**	**55**

The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Education	**0**	**495**	**1,978**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Education	
The requested increase will build on efforts initiated in FY 2006 and support additional specialized hydrogen training for safety and code officials as well as expanded public education in areas where technology validation projects are planned. Additional funds will also restart efforts that have been delayed since FY 2004, including training for state and local government officials, the expansion of hydrogen and fuel cell courses at universities, and two projects to introduce hydrogen and fuel cell technologies to secondary school teachers and students.	
The requested increase will support education targets. As evidenced by the 2004 Hydrogen Baseline Knowledge Assessment, on which hydrogen education targets are based, there is a correlation between technical knowledge of hydrogen and opinions about the safe use of hydrogen as an energy carrier. Focused education activities, with an emphasis on hydrogen safety, will facilitate the local approval, implementation, and success of near-term hydrogen demonstrations. The requested increase is also consistent with provisions in the Energy Policy Act of 2005 for supporting education efforts related to hydrogen safety, codes and standards development; raising public awareness of hydrogen technology; and enhancing hydrogen and fuel cell related activities at institutes of higher education	+1,442
SBIR/STTR	
No significant change	+41
Total Funding Change, Education	**+1,483**

Systems Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Systems Analysis	3,157	4,787	9,615
SBIR/STTR	--	138	277
Total, Systems Analysis	3,157	4,925	9,892

Description

Systems Analysis includes development of independent systems analysis and independent evaluation functions consistent with the recommendations of the National Academies. One of the findings of the Academies' report on hydrogen states, "The effective management of the Department of Energy Hydrogen Program will be far more challenging than any activity previously undertaken on the civilian energy side of the DOE." The Academies also recommend that a systems analysis capability be established to identify the impacts of various hydrogen technology pathways, assess associated cost elements and drivers, identify key costs and technological gaps, evaluate the significance of actual research results, and assist in the prioritization of research and development directions. Systems Analysis provides the analytical and technical basis for understanding the hydrogen economy and supports informed decision-making with regard to research and development direction and prioritization.

Benefits

Systems Analysis is one of the keys to the Hydrogen Program in terms of understanding and assessing the technology needs and progress, the potential environmental impacts, and the energy-related economic benefits of the various hydrogen supply and demand pathways. This analysis is done to directly support program decision-making, planning and budgeting, and interactions with other energy domains. In addition, the results support the annual updates to key planning documents, including the Hydrogen Posture Plan, which describes the current direction and the planned milestones for the DOE Hydrogen Program.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Systems Analysis	**3,157**	**4,787**	**9,615**

Systems Analysis provides the analytical and technical basis for understanding the hydrogen economy and supports informed decision-making with regard to research and development direction and prioritization. One of the key issues is to understand possible ways for a "hydrogen economy" to emerge from our current fossil-fuel economy. To address this, the program is currently developing five "transition scenarios" of how a hydrogen economy might emerge. In FY 2007, we will complete the analysis of 5 transition scenarios with the new transition analytical models and tools developed in FY 2005 and 2006. Combine the new transition models with existing systems analysis models to determine resource limitations, production options for hydrogen supply, the hydrogen supply evolution, delivery restrictions and the potential environmental impacts of wide scale commercialization. Building on efforts initiated in FY 2005 and 2006 to develop the Macro System Model to provide overarching and hierarchal economic analysis for the program, further develop linkages to the Macro System Model to provide transition analytical capabilities for higher level economic analysis. This transition analysis supports the National Academies' recommendation (in The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs, February 2004) of evaluating a transition plan consistent with developing the infrastructure and hydrogen resources.

In order to develop that transition plan and in collaboration with Technical Validation and Production and Delivery, Systems Analysis will:

- Validate the models utilized for program analysis with emerging cost, performance, yield and environmental information from demonstration programs.
- Develop and update models for new renewable production and delivery technologies based on the results of technology research and development.
- Conduct environmental impact analyses for hydrogen commercialization and ensure regulatory compliance. Environmental well-to-wheels evaluations will be completed for emerging pathways and technologies and research and development projects. Analytical models will be updated with the most recent environmental data to insure accurate well-to-wheels emissions projections.
- Coordinate the relationship of hydrogen purity changes and the impact on production cost among all key program elements of Production and Delivery, Storage, Fuel Cells and Safety, Codes and Standards. Evaluate the purity/cost relationship for various pathways and technologies and the impact on fuel cell performance.
- Provide system analysis support and input for all the program elements such as go/no-go decisions. Building on the Integrated Baseline developed in FY 2005, continue to update well-to-wheels analyses of baseline performance of current technologies and targets to track program progress and to help identify most critical R&D needs.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

- Update and maintain the Analysis Portfolio, the prioritized analysis list, and the Hydrogen Analysis Resource Center, which were developed in FY 2005 to insure analysis consistency and transparency. Update the Systems Analysis Plan, Technical Requirements Document and the Posture Plan.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**138**	**277**

In FY 2005, $83,000 and $11,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Systems Analysis	**3,157**	**4,925**	**9,892**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Systems Analysis	
The majority of the requested increase will support competitive, merit-reviewed, cost-shared R&D in key areas of crosscutting analysis and model development by universities, industry and Federal laboratories. This additional funding would invest in new models and analysis projects to contribute towards achieving the 2007 target (the completion of 5 transitional scenarios). Research and development of the transitional models and analysis are in support of the 2015 targets and commercialization decision of the DOE Hydrogen Posture Plan and the Hydrogen Program Multi-Year Research Development and Demonstration Plan.	
The increase in R&D of analysis and analysis projects is consistent with the National Academies' recommendations in their Hydrogen Economy report and is supported by the RDIC: it funds a Presidential priority; addresses market barriers – e.g., no current market; provides a public benefit; builds on existing technology and complements current R&D; and incorporates industry involvement in planning, industry cost-sharing, performance indicators, "off ramps", and competitive awards based on merit reviews	+4,828

	FY 2007 vs. FY 2006 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+139
Total Funding Change, Systems Analysis	**+4,967**

Manufacturing R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Manufacturing R&D	0	0	1,923
SBIR/STTR	0	0	55
Total, Manufacturing R&D	0	0	1,978

Description

The Manufacturing R&D subprogram will support the development of manufacturing processes in parallel with technology development critical for hydrogen and fuel cell components and systems. Activities will address the challenges of moving today's laboratory produced technologies to high-volume, pre-commercial manufacturing thereby driving down the cost of hydrogen and fuel cell systems. Research will be conducted in coordination with the Department of Commerce and the White House Office of Science and Technology Policy's Interagency Working Group on Manufacturing R&D. Technology areas include an array of fabrication and process techniques amenable to high volume production of fuel cells, hydrogen production, delivery, and storage components and systems. A research and development technology roadmap has been developed with industry to identify critical technology development needs for high volume manufacturing of fuel cell and hydrogen systems. Manufacturing processes and techniques that are synergistic in terms of cross-cutting applications such as, for example, high volume membrane fabrication techniques for both fuel cell stacks and electrolyzers will be the initial focus.

Benefits

Manufacturing R&D supports the mission of the Hydrogen Program by developing advanced fabrication and process technologies to meet the cost targets of critical hydrogen and fuel cell technologies. These activities foster the achievement of fuel cell system and hydrogen fuel costs that are equivalent to internal combustion engine and gasoline costs. The manufacturing technology research will focus on enabling a positive industry commercialization decision by 2015 — the goal of the President's Hydrogen Fuel Initiative.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Manufacturing R&D	**0**	**0**	**1,923**

Initiate research and development of low cost, high volume manufacturing processes for hydrogen and fuel cell technologies. Collaborative research efforts involving university, industry, and National Laboratories will focus on development of fabrication processes amenable to low cost, high volume production. Near-term activities will encompass research and development of technologies critical to the initial transition to the hydrogen economy: 1) membrane-electrode assemblies and bipolar plates for fuel cells, 2) distributed reforming and electrolysis systems and components for producing hydrogen, and 3) vessels, valves, and regulators for hydrogen storage and dispensing. Specific manufacturing research and development projects will be identified as technology road maps are updated.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**0**	**0**	**55**

The FY 2007 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Manufacturing R&D	**0**	**0**	**1,978**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Manufacturing R&D	
The increase would support research and development of low cost, high volume manufacturing processes for hydrogen and fuel cell technologies. Collaborative research efforts involving university, industry, and National Laboratories will focus on development of fabrication processes and technologies amenable to high volume production. Activities will address manufacturability and cost reduction in critical technology areas, i.e., hydrogen production and delivery, hydrogen storage, and fuel cells. This increase is consistent with the RDIC: it incorporates industry involvement and uses competitive awards and peer review	+1,923

	FY 2007 vs. FY 2006 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+55
Total Funding Change, Manufacturing R&D	**+1,978**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	535	0	0
Total, Technical/Program Management Support	535	0	0

Description

In the past, consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation Programs provided funding for Technical/Program Management Support. This included activities such as research and development (R&D) feasibility studies; R&D option development and trade-off analyses; and technical, economic, and market evaluations of research. These activities provide important benefits directly to the HT Program described above and are therefore an integral part of the R&D program. Consistent with Energy and Water committee standard practice, those functions are built into the individual program budgets starting in FY 2007.

Benefits

The analysis and technology assessment and planning necessary for good management of the R&D programs will be funded within the programs themselves, since it is an integral part of the Federal role in managing the R&D programs described above.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	**535**	**0**	**0**

Technical management activities, including strategic and technical planning; project and performance tracking; program reviews and evaluations, including R&D feasibility studies and trade-off analyses; peer reviews; data collection and publication; and market, economic, and other analyses are all part of the sound management of any R&D or technology deployment program. Consistent with Energy and Water committee standard practice, funding for those activities will be provided from within the requested budgets for the Hydrogen Technology Program starting in FY 2007.

Total, Technical/Program Management Support	**535**	**0**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funding requested in FY 2006 or FY 2007	0
Total Funding Change, Technical/Program Management Support	**0**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	40,236	42,520	0
Total, Congressionally Directed Activities	40,236	42,520	0

Description

In general, such activities do not support program goals because they are not well-aligned with established research pathways or focused on overcoming the technical barriers as identified in the program's detailed planning documents.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2006, there were 28 Congressionally Directed activities funded out of the Hydrogen Technology Program. The program does not request any funds to continue these projects as they do not further the achievement of DOE's goals. The following projects were directed by Congress to be included in this program:

Competitive Solicitation for Solid Oxide Fuel Cells	**4,960**	**0**	**0**

A solicitation was issued and awards have been made to Ion America and Materials and Systems Research for an integrated fuel cell/electrolysis system.

Startech Plasma Hydrogen Production Project	**496**	**0**	**0**

This project is examining the merits of plasma driven gasification with hydrogen membrane separation technology to process medical wastes, municipal solid waste, scrap plastic and coal. Pilot scale equipment will be utilized.

Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems: Gateway Project on Island of Hawaii	**992**	**0**	**0**

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

Funding supports the preparation of a business case for biomass and wind systems for the Gateway Project.

Hydrogen Fuel Cell Project Edison Materials Technology	**2,976**	**2,475**	**0**

A solicitation was issued and eight projects are being negotiated that include a range of topics from hydrogen sensor development to photoelectrochemical hydrogen production. A second round of project selection is underway.

Florida Hydrogen Partnership/Initiative	**1,984**	**0**	**0**

This project is funding hydrogen research, demonstration, development and outreach projects in Florida. A solicitation has been issued for developing hydrogen infrastructure.

Fuel Cell Research by the University of South Florida	**2,976**	**0**	**0**

The project objectives are to explore materials and concepts that may be applicable to fuel cells and hydrogen storage.

Hydrogen Fuel Cell Project Washoe County, Nevada	**992**	**2,475**	**0**

This project plans to develop and deploy a geothermal/electrolysis hydrogen production refueling station and provide for the conversion of county buses to operate on hydrogen and hydrogen mixture fuels.

Fuel Cell Mine Loader and Prototype Locomotive	**1,984**	**247**	**0**

Plans include the development and the deployment of a mine front-end loader and mine locomotive at operating mines for tests.

Renewable Hydrogen Fueling Station System, University of Nevada at Las Vegas	**4,960**	**3,366**	**0**

Plans include the construction and deployment of a photovoltaic/electrolysis refueling station in Las Vegas and research tasks on photoelectrochemical conversion from water to hydrogen.

Hydrogen Regional Infrastructure Program in Pennsylvania	**1,984**	**990**	**0**

This project will conduct R&D in the areas of: materials evaluation, materials modeling for lifecycle durability prediction, and sensors for hydrogen pipeline delivery and off-board storage.

Expanding Clean Energy Research and Education Program at the University of South Carolina	**1,984**	**1,980**	**0**

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

This project is researching production of hydrogen by electrolysis of anhydrous gaseous HCl, HBr and SO_2; hydrogen storage in complex metal and chemical hydrides; and fuel cell design and development.

Hydrogen Storage and Fuel Cells, University of Las Vegas	**2,976**	**3,366**	**0**

This project plans to create the basis for an academic research center that will combine theory and experiment to address specific aspects of hydrogen storage and utilization. It will emphasize a fundamental understanding of the interactions of atomic and molecular hydrogen with materials pertinent to hydrogen storage and utilization.

Zero Emission Bus Demo Program	**99**	**0**	**0**

This project is anticipated to include activities related to a zero emissions bus demonstration.

Ohio Distributed Hydrogen Project	**1,091**	**0**	**0**

This project is anticipated to include activities in Ohio related to distributed hydrogen technologies.

Bowling Green Fuel Cell, University of Toledo	**992**	**0**	**0**

This project will develop renewable hydrogen production technologies and will use that hydrogen to fuel a fuel cell vehicle.

California Hydrogen Infrastructure, Storage and Systems	**4,960**	**1,386**	**0**

This project will develop several technological approaches to deploy refueling stations that will include mobile platforms, stations at pipelines, alternative delivery systems, and electrolysis systems. In FY 2006, it is anticipated that Air Products and Chemicals, Inc. will design and develop a chemical hydride storage system and advanced infrastructure and delivery systems in support of the Technology Validation activity.

National Center for Energy Management and Building Technologies (Hydrogen Technology's share)	**1,005**	**0**	**0**

Activities funded under this project are to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Center for Manufacturing Science	**2,000**	**0**	**0**

Activities funded under this project are to identify and develop critical manufacturing technology assessments vital to the affordable manufacturing of hydrogen-powered systems. NCMS will leverage technologies from other industrial sectors and work with the DOE's extensive industrial membership to do feasibility projects on those manufacturing technologies identified as key to reducing the cost of targeted hydrogen-powered systems. (Earmark added in FY 2005 Supplemental Appropriations (H.R. 1268))

Metal Hydride Hydrogen Storage in California	**825**	**0**	**0**

FuelSell Technologies, Incorporated, will adapt hydrogen storage technologies for hydrogen compressor applications. (Earmark added in FY 2005 Supplemental Appropriations (H.R. 1268)).

Fuel Cell Freeze/Cold Start Program.....	**0**	**990**	**0**

This project is anticipated to investigate thermal management, system design and components to be able to operate fuel cells under cold climate conditions.

Center for Intelligent Fuel Cell Materials Design.....	**0**	**1,485**	**0**

The Center for Intelligent Fuel Cell Materials Design is a multi-state collaboration, headed by Chemsultants International, to design fuel cells for manufacturability.

Delaware State University Center for Hydrogen Storage.....	**0**	**990**	**0**

This project will research and develop novel materials that can store and release large quantities of hydrogen gas at moderate temperatures and pressures.

Florida International University Center for Energy and Technology of the Americas.....	**0**	**990**	**0**

The Florida International University Center for Energy and Technology of the Americas (CETA) works to increase reliable energy supplies, improve energy efficiency, and promote cooperation in policy and technology transfer in the western hemisphere.

City of Auburn Energy Production Issues at Wastewater Plant	**0**	**891**	**0**

This project seeks to incorporate hydrogen technologies into the wastewater plant in Auburn.

Hydrogen Fleet Infrastructure Demonstration Project	**0**	**1,980**	**0**

This project will support BP's infrastructure research and development efforts under DOE's Hydrogen Fleet and Infrastructure Demonstration program.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Purdue Hydrogen Technologies Program	**0**	**990**	**0**

This project is anticipated to research the various aspects of hydrogen generation, storage, and utilization.

Detroit Commuter Hydrogen Project	**0**	**1,287**	**0**

Ford Motor Company and the Southeast Michigan Council of Governments (SEMCOG) will use this project to support Ford's vehicle research and development efforts under DOE's Hydrogen Fleet Infrastructure Demonstration program.

City of Chicago Ethanol to Hydrogen Project.....	**0**	**1,980**	**0**

This project plans to build a refueling station in the city of Chicago that will convert renewable liquid ethanol into hydrogen gas.

University of Arkansas at Little Rock Hydrogen Storage Project	**0**	**396**	**0**

The program funds research and development of hydrogen storage technologies.

University of Akron Fuel Cell Laboratory	**0**	**495**	**0**

This project is anticipated to develop a coal-based fuel cell for power generation.

Kettering University Fuel Cell Project.....	**0**	**495**	**0**

The project seeks to accelerate the development and commercialization of fuel cells for stationary and mobile applications through engineering research, testing and evaluation.

Hydrogen Optical Fiber Sensors	**0**	**495**	**0**

This project seeks to develop advanced optical fiber sensors for detecting hydrogen leaks and ensuring the safety for fuel cell vehicles.

UNLV Research Foundation Solar-Powered Thermochemical Production of Hydrogen	**0**	**3,366**	**0**

This project will develop a pilot plant design and implementation plan for a solar-powered hydrogen production system based on thermochemical cycles.

Montana Palladium Research Center	**0**	**2,475**	**0**

This project seeks to develop palladium-based materials for use in hydrogen production and end-use technologies.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
University of Arkansas Little Rock Nanotechnology Center Production of Hydrogen	**0**	**495**	**0**
This program will include hydrogen production research at UALR's new nanotechnology laboratory, which will house both production and application research laboratories.			
UNLV Research Foundation Development Of Photoelectric Chemical Production Of Hydrogen	**0**	**2,475**	**0**
This project will develop and characterize state-of-the-art photovoltaic components coupled to durable photoactive oxide films immersed in suitable electrolytes for the purpose of direct water splitting.			
University of Southern Mississippi's School of Polymers and High Performance Materials Improved Materials for Fuel Cell Membranes Program	**0**	**495**	**0**
This project seeks to develop advanced, durable, low-cost membranes for polymer electrolyte membrane (PEM) fuel cells.			
University Of Nevada-Reno Photoelectrochemical Generation Of Hydrogen By Solid Nanoporous Titanium Dioxide Project	**0**	**2,970**	**0**
This project seeks to develop direct water-splitting technology for hydrogen generation based by improving the efficiency and durability of solid nanoporous titanium dioxide semi-conducting materials.			
Southern Nevada Alternative Fuels Demonstration Project	**0**	**495**	**0**
This project seeks to speed the transition to alternative transportation fuels that are cleaner, domestically produced, and less expensive.			
Total, Congressionally Directed Activities	**40,236**	**42,520**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal	-42,520
Total Funding Change, Congressionally Directed Activities	**-42,520**

Biomass and Biorefinery Systems R&D

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Biomass and Biorefinery Systems R&D					
Feedstock Infrastructure	1,984	484	-5	479	9,967
Platforms Research and Development	29,288	15,293	-153	15,140	50,530
Utilization of Platform Outputs R&D	20,473	23,557	-235	23,322	89,190
Congressionally Directed Activities	35,332	52,300	-523	51,777	0
Technical/Program Management Support	394	0	0	0	0
Total, Biomass and Biorefinery Systems R&D	87,471[b]	91,634	-916	90,718	149,687

Public Law Authorizations:

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. 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, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-12, “National Appliance Energy Conservation Act" (1987)
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. 101-549, “Clean Air Act Amendments" (1990)
P.L. 101-575, “Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 106-224, “Biomass Research and Development Act" (2000)
P.L. 107-171, “Farm Security and Rural Investment Act” (2002)
P.L. 108-148, “Healthy Forest Restoration Act” (2003)
P.L. 109-190, “Energy Policy Act” (2005)

[a] Includes a rescission of $916,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $1,146,000 was transferred to the SBIR program and $137,000 was transferred to the STTR program.

Mission

The mission of the Biomass and Biorefinery Systems R&D Program ("Biomass Program") is to reduce our dependence on imported oil by funding research and development on advanced technologies that will convert our Nation's biomass[a] resources into affordable industrial products (including energy and higher value chemicals and materials) through the development of multi-product, high efficiency, high through-put, biorefineries.[b] An analogy to this approach is the petroleum refinery that refines crude oil into a broad range of industrial products.

Benefits

The program's research focus is to develop technology to support the successful deployment of biorefineries that will use more biomass resources to accelerate the growth of the bioindustry, increase and diversify domestic energy supply, increase energy security, emit less carbon, and reduce petroleum consumption and the use of other fossil resources. This request includes a new Biofuels Intiative that reflects the Administration's continuing efforts to dramatically reduce our dependency imported oil and to address the security of our liquid transportations fuels production. The goal of the Biofuels Initiative is to enable U.S. industry to produce biofuels equivalent to 30 percent of current gasoline demand -- about 60 billion gallons of biofuels produced each year -- by 2030. Biorefineries, like oil refineries, can convert their feedstock to a number of products based on market demand. The added advantages for biorefineries is that they will be more dispersed (increased security) and can use domestic biomass resources instead of an increasing fraction of oil imports. Additionally, the growth of the biorefinery industry will benefit rural economies.

Examples of existing biorefineries include wet and dry mill corn-ethanol plants and pulp and paper mills. The program partners with these industries as well as the chemical industry to develop the next generation of biorefineries that will produce value-added chemicals and materials together with fuels and/or power from non-conventional, lower cost feedstocks such as agricultural residues. Fuels from biomass have great potential to displace petroleum because ethanol and biodiesel are compatible with today's major transportation fuels (i.e., gasoline and diesel) and show promise as transition fuels to the future hydrogen economy. Although some of the projects with industry partners are currently focused on the development of chemicals, the configuration and integration of biobased products technologies into a biorefinery will enable the cost effective and efficient production of fuels, chemicals and materials for a sustainable future. The goal of the biorefinery development efforts is to help industry create a new domestic vertical industry, from agricultural production to products end-use that displaces petroleum imports and allows renewable carbon resources to be recycled via photosynthesis. If the industry develops and displaces oil use, greenhouse gas emissions could be significantly reduced.

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[a] Biomass means any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood wastes and residues, plants, grasses, residues, fibers and animal wastes, municipal solid wastes, and other waste materials.

[b] Biorefineries are processing facilities that extract carbohydrates, oils, lignin, and other materials from biomass, convert them into multiple products such as transportation fuels, power, and products.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Biomass Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Biomass Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.08.00.00: Biomass. Develop biorefinery-related technologies associated with the different biomass resource pathways to the point that they can compete in terms of cost and performance and are used by the Nation's transportation, energy, chemical, agriculture, forestry, and power industries to meet their respective market objectives. This helps the Nation expand its clean, sustainable energy supplies, improve its energy infrastructure, and reduce its greenhouse gases emissions, fossil energy consumption and dependence on foreign oil.

Contribution to Program Goal 04.08.00.00 (Biomass)

The program directly supports General Goal 4, Energy Security principally by increasing the production of biomass-based substitutes for petroleum-derived fuels, chemicals, materials, and heat and power, and thereby diversifying and expanding energy supply. It also addresses the goals and recommendations of the Biomass R&D Act of 2000, the Farm Security and Rural Investment Act of 2002, and the Energy Policy Act of 2005.

In order to increase the probability of success, the program funds key technology pathways that contribute to the achievement of this goal:

Feedstock Infrastructure contribution:

- Reduce biomass harvesting and storage costs so that the delivered cost will be reduced from $53 per dry ton in 2003 to $45 per dry ton by 2012. Indicators of progress toward that goal include developing a conceptual, novel harvesting system and testing a wet storage system by 2009.

Platforms Research and Development contribution:

- The program will continue to focus biochemical conversion R&D towards reducing the cost of producing mixed, dilute sugars to enable biorefinery pathways. The overarching barrier in the biochemical conversion platform is the recalcitrance of biomass (i.e., when compared to starch, cellulose is not easily broken down into sugars). The program will accelerate reductions in the cost of mixed sugars by integrating its enzyme cost reduction accomplishments with advances in other process steps. The program will orient

thermochemical R&D towards developing technologies for biorefinery pathways that convert process residues in biochemical biorefineries, forest resources, and pulping liquors into clean syngas and bio-oils for further synthesis into fuels and chemicals. The mid- and long-term goals are the use of the maximum variety of feedstocks to produce fuels, power, and chemicals in stand alone facilities or incorporated with other conversion technologies into biorefineries.

- The Biochemical Platform R&D effort is targeted to reduce the estimated cost for production of a mixed, dilute sugar stream suitable for fermentation to ethanol from agricultural residues, forestry residues, and perennial crop pathways. For agricultural residues, with a base of 15 cents/lb in FY 2003 (corresponding to $2.75 per gallon of ethanol at $53 per dry ton of corn stover), the goal is to reduce costs to 9.6 cents/lb by FY 2012 (corresponding to $1.50 per gallon of ethanol at $45 per dry ton of corn stover). Indicators of progress will be bench-scale data (FY 2007) and economic and technological validation (FY 2012) to support and enable the commercialization of the technologies. The continued progress will not only enable additional pathways to be developed but will also drive the economics to the ultimate goal of Greenfield lignocellulosic conversion facilities.
- The Thermochemical Platform R&D will initially focus on the utilization of non-fermentable process residues in biorefineries (off-spec feedstock, low quality biomass, and lignin-rich residues) to provide clean syngas. With a base of $7.25 per million Btus in FY 2005 (corresponding to 6.86 cents per kWh of electricity), the goal is to reduce syngas cost to $5.25 per million Btus (corresponding to 6.18 cents per kWh of electricity) in FY 2011.

Utilization of Platform Outputs R&D contribution:

- In view of the integrated biorefinery emphasis, the current budget request focuses on the conversion of sugars and syngas, the biorefinery intermediate products, into transportation fuels (including ethanol from residual starch and cellulose), heat, power, and various chemicals. For the near term biorefinery pathways (wet mills, dry mills, and oilseeds), validation will be pursued through the industrial-scale projects scheduled to be initiated in FY 2007. Products development work consists of cost shared development and demonstration of high value chemicals and materials from biomass, including corn starch and agricultural residues. Additional, accelerated efforts in fermentation microorganism development through public/private partnerships will be conducted.

An indicator of progress toward achieving those benefits include:

- In FY 2007, complete a preliminary engineering design package, market analysis, and financial projections for at least 2 industrial-scale projects for near term agricultural pathways (corn wet mill, corn dry mill, oilseed) to produce a minimum of 5 million gallons of biofuels per year using advanced production techniques, cellulosic feedstock conversion, and/or featuring the production of co-products in addition to biofuels. The intent is to provide proof that the resultant industrial scale biorefineries could produce and market biofuels at prices competitive (on an integrated systems basis) with petroleum fuels produced from $50 per barrel oil.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.08.00.00, Biomass and Biorefinery Systems R&D			
Feedstock Infrastructure	1,984	479	9,967
Platforms Research and Development	29,288	15,140	50,530
Utilization of Platform Outputs R&D	20,473	23,322	89,190
Technical/Program Management Support	394	0	0
Subtotal, Program Goal 04.08.00.00, Biomass and Biorefinery Systems R&D	52,139	38,941	149,687
All Other			
Congressionally Directed Activities			
Biomass Restoration by Eastern Nevada Landscape Coalition	248	0	0
Center for Biomass Utilization at University of North Dakota	992	0	0
Mississippi State Biodiesel Production Project	1,489	0	0
Regional Biomass Energy Program	3,969	0	0
Thermo-Energy Project at University of Nevada - Reno	496	0	0
Vermont Biofuels Initiative	496	0	0
Recycling for Energy Conservation in Wells, Nevada	248	0	0
Alternative Fuels Plant in Livingston Parish	496	0	0
Alaska Wood Biomass Project	198	0	0
Mississippi Technology Alliance – Alternative Energy Enterprise	2,977	0	0
Kentucky Rural Energy Supply	1,984	0	0
South-Eastern and North-Central Regional Sun Grant Centers	1,488	0	0
Purdue-Midwest Consortium for Sustainable Biofuels	496	0	0
SUNY-Morrisville Anaerobic Digester Project	198	0	0
NREL Demonstration for Small-Scale Biomass (BioMax)	2,976	0	0
Anaerobic Digestion – Ohio Agricultural Research Development Center	992	1,485	0
Alabama Alternative Fuel Source Study	496	0	0
Georgia Biorefinery and Hydrogen Fuel Cell Research	1,488	0	0
National Center for Energy Management and Building Technologies	708	0	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Biofuel Energy Laboratory	1,984	1,980	0
Texas A&M – Renewable Energy from Animal Biowaste	992	990	0
Ag-Based Industrial Lubricants - University of Northern Iowa	496	990	0
Sugar-Based Ethanol Biorefinery at Louisiana State University	1,984	495	0
Biotech-to-Ethanol Project	1,488	990	0
Research Triangle Biomass, North Carolina	992	1,238	0
Iowa Switchgrass Project - Chariton Valley	496	742	0
Oxygenated Diesel Emissions Testing in California and Nevada, AAE Technologies	496	495	0
Biorefinery at Louisiana State University	496	495	0
Vermont Biomass Energy Center	496	495	0
Consortium for Plant Biotechnology Research	2,977	3,465	0
University of Georgia Biomass Pyrolysis Biorefinery Project	0	1,238	0
Wood Debris Bioenergy Project	0	990	0
Clarkson University Dairy Waste Partnership	0	248	0
Madison County Landfill Gas-to-Energy	0	990	0
Asphalt Roofing Shingles into Energy, Xenia	0	990	0
Ohio State University 4-H Green Building	0	990	0
Solid Waste Authority Pyramid Resource Center	0	1,980	0
City of Stamford Waste-to-Energy Project	0	1,485	0
Iowa State University Biomass Energy Conversion Project	0	495	0
Iroquois Bioenergy Consortium Ethanol Project	0	3,465	0
New York Biomass/Methane Gas Power Fuel Cell	0	1,980	0
Western Massachusetts Biomass Project	0	495	0
Greenville Composite Biomass Project	0	742	0
Laurentian Bioenergy Project	0	1,238	0
Kona Carbon Biomass Project	0	990	0
Sustainable Energy Center at Mississippi State University	0	10,889	0
Missouri Biodiesel Demonstration Project	0	990	0
Auburn Alternative Fuel Source Study of Cement Kilns	0	990	0
Canola-Based Automotive Oil Research	0	990	0
Center for Advanced Bio-based Binders	0	792	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Development of Applied Membrane Technology	0	495	0
Michigan Biotechnology Institute	0	990	0
Washington State Ferries Biodiesel Demonstration	0	495	0
UNLV Research Foundation for Developing Biofuels	0	2,970	0
Total, Congressionally Directed Activities	35,332	51,777	0
Total, All Other	35,332	51,777	0
Total, General Goal 4 (Biomass and Biorefinery Systems R&D)	87,471	90,718	149,687

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.08.00.00 (Biomass and Biorefinery Systems R&D)					
Feedstock Infrastructure					
					Complete a core R&D engineering design and techno-economic assessment of an integrated wet storage - biomass field pre-processing assembly system with a pretreatment process that could potentially be scaled up to produce feedstocks to achieve a reduction to $45 per ton by 2012 from $53 per ton as of 2003.
Platforms Research and Development					
DOE waited for responses associated with the biomass solicitation issued in FY 2002, and delayed to 2004 the development of prototype yeasts capable of fermenting multiple biomass-derived sugars to meet cost goals for the ethanol/gasoline blend markets.	Completed the thermochemical options analysis to assess various process pathways to fuels (e.g., F-T, gasoline, diesel, alcohols). [MET] Developed an improved enzyme preparation for reducing the cost of producing ethanol from biomass. Evaluate its impact on production costs using an updated computer model of the production process. [MET]		Completed a technical and economic evaluation of integrated biomass to fuels systems to validate the sugar cost of $0.135 per pound and syngas cost of $6.13 per million Btu. [MET]	Complete laboratory and economic assessment of 2 different feedstocks, identifying operating conditions that link pretreatment with enzymes that could be scaled-up and have the potential of achieving the goal of $0.125 per pound sugar by 2007.	Complete integrated tests of pretreatment and enzymatic hydrolysis in conjunction with existing fermentation organisms at bench-scale on com stover that validate $0.125 per pound sugars on the pathway to achieving $0.096 per pound in 2012. Demonstrate conversion of 50% of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007 (equivalent electricity cost of 6.83 cents/KWh).
Utilization of Platform Outputs R&D					
	Established testing program at three existing gasifiers at partners' sites for the development and application of technology components (e.g. gas clean-up, gas engines, fuel cells, etc.) that needed to be integrated with the gasification components to produce power, fuels, and chemicals. [MET: Greater than 80 percent but less	Demonstrated clean syngas production in three thermochemical conversion systems. [MET] Completed testing of ethanol production from corn fiber in partnership with industry in order to achieve a 3 percent increase in ethanol production from each corn ethanol plant that successfully implements the			Complete a preliminary engineering design package, market analysis, and financial projections for at least 2 industrial-scale projects for near term agricultural pathways (corn wet mill, corn dry mill, oilseed) to produce a minimum of 5 million gallons of biofuels per year.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
	than 100 percent – Completion was delayed by 5 months.]	technology without requiring additional corn feedstock. [MET]			
Utilization of Platform Outputs R&D/Products Development					
Cargill Dow LLC started up the first full-scale PLA plastic manufacturing facility (300 million lbs. /yr.) based on corn sugar as the feedstock.	In partnership with industry, completed pilot-scale demonstration of two new biobased product technologies for economic, technical, and product performance. [MET] A 2-cycle engine oil derived from soy oil was commercialized for the emerging bioproducts industry. [NOT MET: 2-cycle engine oil commercialized in FY 2004]	Completed validation of one new biobased product technology, with long-term potential of greater than 2 billion lbs. /yr. sales, at the pilot-scale for economic, technical, and product viability in partnership with industry. [MET] With industry partners, a new biobased product technology advanced to scale-up partners' intention to commercialize in a new industrial biorefinery by FY 2008. The biorefinery will be at pilot-scale. [MET]	Established the technical and market potential of a new biobased product. [MET]	Identify at least one sugar-derived or biomass oil-derived bio-based chemical or material (among those being evaluated) that possesses sufficient potential to enter into the scaled-up developmental phase of R&D from the previous bench-scale phase.	
		Contributed proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds]	Contributed proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the Biomass & Biomass Refinery Systems Program FY 2004 end of year adjusted uncosted baseline ($62,235K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

Fuels from biomass have great potential because ethanol and biodiesel are compatible with today's major transportation fuels, gasoline and diesel, and show promise as transition fuels on the way to the future hydrogen economy. The Biomass Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals.

The Biomass Program will implement the following means in order to improve the cost-competitiveness of biomass technologies:

- R&D through competitive solicitations for industrial partnerships with appropriate cost sharing to attract innovation and ensure investment value for industry and university contracts;
- Management of R&D by a series of objectives and milestones; tracked by the Project Management Center[a] and verified with reviews from industry and university experts;
- Industrial-scale validation of integrated biorefineries through competitive solicitations to validate their economic and technical validity in order to help facilitate commercialization; and
- Input from peer reviews.[b] Peer reviews of program plans and activities are aimed at obtaining expert, independent opinion on the program's goals and objectives; feasibility of reaching the goals; appropriateness of technical barriers being addressed; appropriateness of the Federal role, and whether the level of Federal funding for projects is commensurate with technical objectives.

The Biomass Program will implement the following strategies:

- The Biofuels Initiative will take advantage of R&D platforms and technology development strategies already in place. Accelerating these R&D strategies will make significant inroads into achieving the goals of the Initiative. DOE has aggressive strategies in the basic sciences as well as feedstock, conversion and biorefinery technology advancement that map directly to Initiative goals. The Initiative will leverage extensive technical expertise available throughout the Federal sector, industry, academia and laboratories. Partnerships are already in place with the DOE Office of Science, the U.S. Department of Agriculture and other Federal agencies. The basic approach to implementing the Initiative will include developing and employing a mix of basic and applied sciences related to biomass feedstocks and conversion technologies as well as efforts to help bridge the gap from technology validation to deployment.
- For each feedstock targeted, Initiative research will aggressively develop handling and conversion technologies specific to feedstock properties and validate the technical performance and projected economics at industrial scale.

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[a] EERE implemented the Project Management Center approach at the Golden Field Office and the National Energy Technology Laboratory to enhance the management of projects.
[b] In November 2005, a program review was held. The last one took place in November 2003.

- The Initiative will further basic research in the areas of feedstock development, overcoming the recalcitrance of certain biomass feedstocks, and optimizing collection, storage, transportation and conversion processes. For example, the Biomass Program will collaborate with the DOE Office of Science to target and conduct research on the development of new organisms and techniques that are able to process the various sugars in biomass collectively. This will consolidate several steps in bioprocessing and lead to a significant reduction in tanks and associated equipment currently needed to convert biomass feedstocks into ethanol. This will result in a large reduction in plant costs.
- The Initiative will establish Regional Energy Crop Development Partnerships, thus leveraging the local resources through partnerships with agriculture producers, universities, and industry who understand the regional opportunities and challenges. They will enable development of new feedstocks tailored to industrial applications for conversion to specific fuels and applications. This will allow biomass fuels and chemicals to continue to grow beyond the limitations of present commodity crop and forest resources.
- The Initiative will focus aggressive R&D on high-opportunity, high-impact technologies for converting biomass feedstocks to ethanol. R&D will focus on developing process integration methodologies, identifying effective pretreatment catalysts effective on multiple biomass feedstocks, and targeting efficient enzymes. Moreover, as biorefinery plants mature, advanced thermochemical technologies, i.e., pyrolysis oils, will be pursued to increase biofuels production and value.
- Guidance by the Biomass Technical Advisory Committee and the Biomass R&D Board established under the Biomass R&D Act of 2000. The Biomass R&D Board will be instrumental in integrating R&D across agencies, particularly in the feedstock development area where leveraging of resources and expertise is vital to ensuring that the potentially vast resource base identified in the Billion Ton Study becomes economic and sustainable. Evaluation and analysis results are also input to the decision process as required by the Government Performance & Results Act (GPRA) and the President's Management Agenda (PMA).
- The Administration's R&D Investment Criteria and DOE's internal assessment modeled after the Administration's Program Assessment Rating Tool (PART). These are overlaid on the various inputs provided by external and internal entities so that program decisions will result in the highest possible return on Federal investments.

The following external factors could affect the program's ability to achieve its strategic goal:

- Cost and availability of conventional fossil energy sources and infrastructure adjustments;
- Federal and State farm policies and grower's actual adoption rate for new crops;
- Widespread adoption of sustainable crop management practices;
- Consumer acceptance;
- Cost of competing technologies; and
- The market penetration rate of bio-based technologies, which is a function of technical breakthroughs, incentives; price trends of coal, oil and natural gas; and policy factors.

Collaborations are integral to achieving the planned investments, means and strategies, and to addressing external factors. In carrying out its mission, the program performs the following collaborative activities:

- Partnering with DOE's Office of Science on feedstock development and consolidated bioprocessing (technology aimed at reducing the number of unit operations needed in a biorefinery);
- Coordination with the Hydrogen Program to evaluate biomass as a feedstock for hydrogen production, and coordination with the Vehicle Technologies Program's efforts to increase the use of biofuels in vehicle fleets;
- Annual USDA/DOE solicitation for biomass technologies R&D and other coordination under the Biomass Research and Development Act of 2000;
- Partnerships with existing biorefineries to develop technologies resulting in more cost-effective use of current feedstock and/or utilization of additional, new feedstock such as cellulosic residues; and
- Collaboration on advanced conversion processes and techniques with the DOE Office of Science will help define the future of advanced biorefineries.

Validation and Verification

To validate and verify program performance, the Biomass Program will conduct internal and external reviews and audits. For example, during program peer reviews the programmatic activities are reviewed by experts from universities, state agencies, industry, and the U.S. Department of Agriculture. The table below summarizes validation and verification activities.

Data Sources:	The Renewable Fuels Association's production statistics; the National Renewable Energy Laboratory's Renewable Electric Plant Information System (REPIS); the Energy Information Administration's (EIA) Annual Energy Review, Renewable Energy Annual and Annual Energy Outlook; the Gas Technology Institute Survey of Distributed Resources; EIA Form 860 data analyzed by the Resource Dynamics Corporation. Individual projects develop production cost and quantity estimates for sugar, syngas, ethanol, and other fuels and chemicals (these are reviewed and monitored by managers).
Baselines:	The following are the key baselines used in the Biomass Program: ▪ Biomass delivered cost (2003): $53 per dry ton for wheat straw and corn stover ▪ Mixed, dilute, unfermented sugars produced in a Greenfield facility (2003): 15 cents per pound (equivalent to $2.75 per gallon of ethanol) ▪ Cost of cleaned and reformed biomass-derived synthesis gas from a mature gasification plant (2005): $7.25 per million Btus (equivalent to 6.86 cents per kWh)

- Industrial-scale projects validating the cost of producing fuels, chemicals, and power utilizing biomass feedstocks: 2005 baseline = 0

Evaluation: In carrying out the program's mission, the Biomass Program uses several forms of evaluation to assess progress and to promote program improvement.

- Stagegate review, technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Biennial Technical Program Review of the Biomass Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning; and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and updated analysis of potential benefits for the Government Performance and Results Act (GPRA).

The National Laboratories receive direct funds for technology research and development, based on their capabilities and performance. Advisory panels consisting of non-Federal and industry experts review each laboratory and industry project at scheduled stage-gate reviews and peer evaluation of R&D. Projects are evaluated based on the following criteria: 1) Relevance to overall DOE objectives; 2) Approach to performing the research and development; 3) Technical accomplishments and progress toward project and DOE goals; 4) Technology transfer/collaborations with industry/universities/laboratories; and 5) Approach and relevance of proposed future research. The panels also evaluate the strengths and weaknesses of each project, and recommend additions to or deletions from the scope of work. The program organization facilitates relationships to ensure that Federal R&D results are transferred to industry.

Frequency: Potential benefits are estimated annually. Independent evaluation of R&D projects are performed according to schedule per the "stage-gate" process for moving each project through an independent review "gate", from a less costly stage (such as preliminary paper studies) to a more costly stage (such as bench-scale experiments). Program Peer Reviews are conducted annually.

Data Storage:	EERE Benefits website, Corporate Planning System, and other computer-based data systems.
Verification:	DOE technology managers verify the achievement of targets through project reviews, including reviews of cost and performance modeling results. Project leaders in the field must provide to the technology managers documentation of experimental and/or analytic results as evidence of success. The evidence is listed in material supporting the DOE Joule performance tracking system. Various trade associations review the data and the modeling processes (e.g. REPIS renewable), and the EIA verifies the REPIS database. Peer reviews are independently conducted by personnel from industry, academia and governmental agencies other than the U.S. Department of Energy.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Biomass Program received its first OMB PART review in 2005. The 2005 PART review included ratings of 80% for program purpose, 90% for planning, 73% for management and 42% for program results and accountability with an overall rating of Adequate. The program will periodically re-evaluate its mid-term targets based on technical progress made in major technology development and validation projects. These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles. The program recognizes the need to improve consistency in its use of performance measures, a major cause for the program's lower scores on results and accountability. Congressionally directed projects have accounted for approximately 40 to 57 percent of the program's budget in recent years, slowing program progress and reducing the management score because directed projects are not competitively selected and sometimes result in high uncosted balances.

Expected Program Outcomes

The Biomass Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources and contribute towards improved energy productivity of our economy. The program's success will reduce national susceptibility to energy price fluctuations and potentially lower energy bills; reduce several EPA-criteria pollutants and other pollutants; enhance energy security and reliability by increasing the production and diversity of domestic fuel supplies; and strengthen our domestic energy resource infrastructure.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, oil savings, and natural gas savings that result from the realization of Biomass Program goals are shown in the table below through 2050. The level of cellulosic ethanol production expected as a result of realizing the program goals is also reported.

These estimates do not include other benefits such as local air quality improvements and represent a conservative effort at assessing the benefits of the Biomass Program activities. This year's benefits are noticeably higher than in most prior years based upon lower ethanol costs projected for the mid- to long-term. The lower costs are associated with increased investment in integrated biorefinery R&D.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals. Also note that the modeling of long term benefits assumes that funding levels will be consistent with the President's commitment and assumptions in the FY 2007 Budget, and that funding will be applied to the core program. Congressionally directed projects, by reducing resources available for the program's planned activities, frequently limit the choice of technology development pathways that are important to future technical success. This can lead to a reduction in estimated future benefits.

The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html. The benefits shown below are incremental benefits, i.e., differences between the program case and the baseline (program phased-out) case.

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

FY 2007 GPRA Benefits Estimates for Biomass Program[a b]

Mid-Term Benefits[c,d]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	ns	0.25	0.43	0.37
Energy expenditure savings (Billion 2003$)[e]	ns	ns	5	2
Carbon emission reductions (mmtce)	ns	5	8	6
Oil savings (MBPD)	ns	0.19	0.26	0.20

Long-Term Benefits[f]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	0.86	0.47	0.66
Energy system net cost savings (Billion 2003$)	1.0	2.0	2.0
Carbon emission reductions (MMTCE)	17	10	14
Oil savings (MBPD)	0.35	0.19	0.21

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the base program's technical targets are met and funding continues at levels consistent with base program assumptions in the FY 2007 Budget.

[b] The program is assessing alternative Biofuels Initiative pathways and integrating its program goals and market impacts using new modeling tools and methods. We expect those efforts to more effectively capture new integrated vertical technology and market scenarios. The preliminary results of these new analyses suggest a much greater potential impact for biomass than is currently reflected in GPRA benefits. Updated benefits reflecting this new analysis are planned as an addendum when the final GPRA FY 2007 benefits report is posted in March 2006.

[c] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.

[d] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.

[e] Only gasoline savings are included.

[f] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Feedstock Infrastructure

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Feedstock Infrastructure	1,984	466	9,722
SBIR/STTR	0	13	245
Total, Feedstock Infrastructure	1,984	479	9,967

Description

Biomass is bulkier than fossil resources such as coal and oil, resulting in higher costs for transport and storage when compared to fossil fuels. The goal of this work is to develop novel harvesting equipment designs and storage and logistics systems for agricultural residues. The requested level of support also provides funds to conduct systems level design studies such as analysis of biomass feedstock systems (including sustainability requirements) and regional and national cost/supply relationships. The increase in funding also allows the establishment of regional feedstock development partnerships, which are critically important to the Biofuels Initiative identifying the regional biomass supply, growth, and opportunities for new energy crops and conversion technologies that help unlock the potential biomass resource base (as identified in *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply (Billion Ton Study)*, a joint publication by USDA and DOE).

Benefits

Feedstock costs account for up to 30 percent the production costs of bio-based fuels and products. These activities will reduce biomass harvesting and storage costs for agricultural residues such as wheat straw and corn stover in order to facilitate the growth of the biomass industry. Indicators of progress toward that goal include developing a conceptual, novel harvesting system and testing a wet storage system by FY 2009. In addition, it is also anticipated that regional feedstock development partnerships will enable the potential billion-ton resource base.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Feedstock Infrastructure.....	**1,984**	**466**	**9,722**

In FY 2007, feedstock infrastructure systems work will be accelerated for single-pass harvester development for wheat straw and corn stover collection, and storage and transportation options to minimize costs for delivering these agricultural feedstock residues to a conversion plant. Analysis of infrastructure systems and supply curves will be accelerated in order to integrate economic and environmental considerations. Also in FY 2007, a framework for regional feedstock development partnerships will be developed, based on the resource potential identified in the *Billion Ton Study,* and the program will pilot at least one partnership (including initiation of R&D). The establishment of partnerships will be pursued in close collaboration with USDA's Agricultural Research Service, Forest Service, other USDA agencies, land grant universities, and regional consortia. It is anticipated that funds will be leveraged with USDA through the Biofuels Initiative. Goals for the feedstock development regional efforts will likely include, but are not limited to: R&D, such as replicated field trials across regions to determine the impact of residue removal on grain yield in subsequent years, and genetic evaluation and field trials to develop pedigreed energy crops to be planted within a geographical region; resource assessments to determine regional feedstock supply curves; and economic studies that identify candidate site conditions and general locations for biorefinery deployment within a region. In addition, sustainability and environmental issues will be explored at a reasonable scale within the region. It is anticipated that these feedstock partnerships may also be able to function as information repositories and serve as liaisons to growers, biorefinery developers, and other interested parties such as State officials. The program will also partner with the genomics research activity within the DOE Office of Science and at USDA to further the goals of the feedstock efforts.

SBIR/STTR.....	**--**	**13**	**245**

The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Feedstock Infrastructure.....	**1,984**	**479**	**9,967**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Feedstock Infrastructure	
Increase funding for Feedstock Infrastructure to overcome important cost barriers using the R&D Investment Criteria dealing with market relevance based on industry's input and maximizing public benefits. Increase R&D on residues harvesting and storage systems and analysis of infrastructure, supply, and sustainability (+$4,756,000). Initiate effort to work with USDA and university research partners to develop regional feedstock development partnerships, resulting in at least one pilot partnership from which others -- representing the full scope of the feedstocks and potential agricultural regions outlined in the *Billion Ton Study* -- could be modeled. (+$4,500,000)	+9,256
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+232
Total Funding Change, Feedstock Infrastructure	**+9,488**

Platforms Research and Development

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Platforms Research and Development			
Thermochemical Platform R&D	18,153	4,377	16,455
Biochemical Platform R&D	11,135	10,365	32,832
SBIR/STTR	--	398	1,243
Total, Platforms Research and Development	29,288	15,140	50,530

Description

Platform R&D will focus on developing technologies needed to make fuels, power, and products from biorefineries economically competitive with their petroleum-based counterparts, thus supporting the goals of petroleum displacement and energy independence. The funding increase accelerates the research needed to lower the conversion cost of the wide variety of biomass feedstocks required to reach the goal of the Biofuels Initiative of 60 billion gallons of biofuels by 2030. Specifically, Platform R&D is focused on Thermochemical Platform R&D and Biochemical Platform R&D. Conversion of biomass via thermochemical and/or biochemical processes is viewed as the best choice for the production of significant quantities of fuels, power, chemicals, and/or materials. The process intermediates are synthesis gas (syngas), pyrolysis oils, and sugars. One of the key goals of Thermochemical Platform R&D is to complete the development of gas cleanup technologies in order for syngas from biomass feedstocks to be converted to clean products that meet the stringent gas quality specifications for advanced systems to produce fuels and chemicals.

The most promising pathways will be selected for aggressive development in a FY 2007 solicitation focusing on integrated biorefineries. The near-term goal is the integration of these pathway technologies and validation on an industrial scale along the nearer term pathways. With DOE support, the projects will result in technological risk reduction, thereby enhancing the probability of successful commercialization.

Benefits

Integration and optimization of these processes will be necessary in order to:

- Reduce the estimated cost for production of a mixed, dilute sugar stream suitable for fermentation to ethanol, from a baseline of 15 cents/lb in 2003 (corresponding to $2.75 per gallon of ethanol at $53 per dry ton of corn stover) to 9.6 cents/lb by 2012 (corresponding to $1.50 per gallon of ethanol at $45 per dry ton of corn stover). Indicators of progress will be bench-scale (2007) and economic and technological validation (2012) to support commercialization.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Thermochemical Platform R&D	**18,153**	**4,377**	**16,455**

The Thermochemical Platform R&D Activity conducts research, testing, integration, and feasibility studies on thermochemical conversion of biomass to provide the technology for advanced and integrated biorefinery systems. The program will orient Thermochemical Platform R&D towards developing technologies that convert process residues in biochemical biorefineries, forest resources, and pulping liquors into clean syngas and bio-oils for further synthesis into fuels and chemicals. The Thermochemical Platform R&D effort will initially focus on residues (off-spec feedstock, low quality biomass, and lignin-rich residues) from biochemical biorefineries to provide clean syngas. Subsequently, it will expand to forest and pulp mill residues. In FY 2007, the program will also support pyrolysis research for the production of bio-based diesel at oil refineries.

In FY 2007, the program will continue to develop technologies for the production, cleanup and conditioning of biomass syngas or bio-oils suitable for fuels and chemicals synthesis. This will be done in collaboration with competitively selected industrial partners from the biofuels and petroleum industries. Cleanup and conditioning efforts will focus on the syngas and pyrolysis streams for the removal of particulates and other inorganic materials, on the conversion of tars, improving syngas yields, and upgrading pyrolysis oils. The increase in funding allows needed R&D in pyrolysis conversion technology that, with gasification technology, would allow another option for the conversion of a large portion of the current potential biomass feedstock to fuels.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Biochemical Platform R&D	**11,135**	**10,365**	**32,832**

The Biochemical Platform is defined by the work to convert the complex cellulosic carbohydrates of biomass to simple sugars and focuses on three major elements, (a) advanced pretreatment, (b) enzymatic hydrolysis, and (c) process integration. The Biochemical Platform also supports integration activities with Utilization of Platform Outputs because the output of the Biochemical Platform includes sugars which are the intermediate feedstocks that can be utilized through conversion to products in a biorefinery.

The program's focus has been on the agricultural residue from corn harvesting (stover) and its conversion to ethanol. Funding this year allows the acceleration of research into the conversion of other residues needed to achieve the aggressive goal of the Biofuels Initiative. Sugar cost reductions will reflect the results of independent work in the areas of feedstock development, pretreatment, conversion of cellulosic components of biomass to simple sugars, and integration of the individual processes. Specific targets include: (a) reducing the severity (harshness) of thermochemical pretreatment while

(dollars in thousands)

FY 2005	FY 2006	FY 2007

optimizing the digestibility of the pretreated material by selection of optimal pretreatment chemistry along with improving the overall effectiveness of the pretreatment process; (b) further reduction of enzyme costs; and (c) increasing the solids loading for the process to reduce equipment size, energy requirements, and reagent requirements.

Pretreatment activities include studies to identify the most cost effective thermochemical treatments that reduce the recalcitrance of lignocelluloses through chemical or enzymatic de-polymerization. In addition to optimizing the best studied methodology, dilute acid pretreatment, alternative chemistries and configurations will be examined for efficacy and efficiency. In FY 2007, pilot-scale examination of one or more additional chemistries or configurations for thermochemical pretreatment will continue. Pretreated biomass will be reduced to simple sugars and residue by the action of hydrolytic enzymes. Further improvements are believed possible and appropriate and will be sought by work targeted to: (a) improving the specific activity of cellulases; (b) by improving the synergy between cellulase and non-cellulase hydrolases that attack the hemicellulose, protein, waxes, perhaps lignin, and other compounds that contribute to recalcitrance; and (c) by exploring optimization of the cellulase preparations to specific thermochemical pretreatment regimes. Efforts under a solicitation initiated in FY 2006 to address these issues will be continued in FY 2007.

Process integration focuses studies on developing interfaces between unit operations developed in thermochemical pretreatment and enzymatic hydrolysis projects. It further addresses the junctions with Feedstock and Products areas. On-going work addresses: (a) process intensification, the ability to run at high solids; (b) solid-liquid separations; and (c) the feedstock issues of carbohydrate composition variability and analytical methods. Demonstration of a model process at pilot-scale is expected to show successful integration of developed unit operations and to reveal any remaining generic stumbling blocks. In FY 2007, the program will continue efforts initiated under the FY 2006 solicitation (referenced above) aimed at integrating thermochemical pretreatment technology into existing facilities.

The program will formulate improved enzyme mixtures and pretreatment processes based on improved understanding of the structure and function of plant cell walls. Targeted research that utilizes the Biomass Surface Characterization Laboratory Facility, located within the National Renewable Energy Laboratory, supports the more applied technology core research by allowing researchers to view plant components down to the nanometer level and to obtain images of the actual deconstruction of plant cell walls and other components vis-à-vis various pretreatment and enzyme treatments under various conditions.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
SBIR/STTR	**--**	**398**	**1,243**

In FY 2005, $988,000 and $118,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Platforms Research and Development	**29,288**	**15,140**	**50,530**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Thermochemical Platform R&D	
The work proposed for FY 2007 will focus on the thermochemical processing of the unconverted lignin residues, off-spec feedstock, and remaining low quality biomass in a biochemical biorefinery. This reflects the near-term focus of overall program priorities to support the development of biochemical biorefineries with biofuels industry partners (Integration of Biorefinery Technologies). The program will also increase R&D on pyrolysis technology for producing bio-based diesel. The R&D Investment Criteria used are market relevance based on industry's input in terms of the appropriate biorefinery technology pathway for the next decade, and maximizing public benefits	+12,078
Biochemical Platform R&D	
The funding increase is needed to accelerate enabling technologies that can be used in subsequent years to support the development of biorefineries with industrial partners under the Integration of Biorefinery Technologies activity. The R&D Investment Criteria used are market relevance based on industry's input in terms of the appropriate biorefinery technology pathway for the next decade, and maximizing public benefits	+22,467
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+845
Total Funding Change, Platforms Research and Development	**+35,390**

Utilization of Platform Outputs R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Utilization of Platform Outputs R&D			
Integration of Biorefinery Technologies	13,355	10,781	53,065
Products Development	7,118	11,927	33,931
SBIR/STTR	--	614	2,194
Total, Utilization of Platform Outputs R&D	20,473	23,322	89,190

Description

Utilization of Platform Outputs R&D consists of two key activities, Integration of Biorefinery Technologies and Products Development. Utilization of Platform Outputs R&D aims at applying enabling technologies to a variety of opportunities in the biorefinery with the goal of enabling the production of cost-competitive fuels, chemicals and materials, and heat and power in a synergistic fashion. Integration of Biorefinery Technologies will validate the technical performances and economics of core technologies for the production of fuels as well as many value-added products. Industrial cost-shared projects will be initiated to validate integrated biorefinery designs that will focus on the near term pathways with feedstocks such as corn fiber, corn stover and oilseeds as well as the integration of additional products into these biorefineries. The validation of the technical and economic viability of these biorefineries will be the result of these efforts.

Funding for Integration of Biorefinery Technologies, ramping up beginning in FY 2007, is critical to accelerate the validation of pathways. Products Development focuses on the conversion of outputs from both the biochemical platform and the thermochemical platform into fuels, chemicals and materials, and heat and power. This level of funding for the Biofuels Initiative allows for the establishment of public/private partnerships focused on fermentation organism development critical in reducing the cost of ethanol production from biomass. Besides sugars and syngas, the program is considering lignin, biomass-derived oils and proteins as feedstocks for making bio-based products.

Benefits

Biobased products with high market value will increase the profitability and efficiency of future industrial biorefineries whose other major products may be fuels for the transportation sector and/or other sectors, including hydrogen. Producing a slate of bio-based chemicals would also add a dimension of seasonal flexibility to the biorefineries in view of the seasonal nature of biomass harvesting.

An indicator of progress toward achieving those benefits include:

- In FY 2007, complete a preliminary engineering design package, market analysis, and financial projections for at least 2 industrial-scale projects for near term agricultural pathways (corn wet mill, corn dry mill, oilseed) to produce a minimum of 5 million gallons of biofuels per year using advanced production techniques, cellulosic feedstock conversion, and/or featuring the production of co-products in addition to biofuels. The intent is to establish that the resultant biorefineries could produce and market biofuels at prices competitive (on an integrated systems basis) with petroleum fuels with oil at $50 per barrel.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Integration of Biorefinery Technologies	**13,355**	**10,781**	**53,065**

In FY 2007, the Initiative will allow a major competitive solicitation to increase validation of various biorefinery technologies for converting biomass to fuels, chemicals and/or materials. Increased funding will support engineering design, market analysis, and financial projections for industrial-scale projects resulting in the validation of technology performance and economics for up to 3 technologies as a needed step to commercialization. Industry partners will accelerate the work necessary to refine engineering and economic evaluations, and develop commercialization plans for a biorefinery system. University and National Laboratory personnel will conduct research to support industrial partners in overcoming barriers identified by these high profile projects that will become the lead biorefineries deployed with program support. These efforts will result in the validation of biorefinery performance and cost goals to improve commercialization prospects.

Products Development	**7,118**	**11,927**	**33,931**

In FY 2007, the program will continue activities from FY 2006, which include competitively selected R&D projects aimed at core technology development to enable a broad suite of bio-based products.[a] A number of projects are expected to be completed in FY 2006, for example, production technologies for polyols, improved chemical intermediates, adhesives, and foams. Aside from these, projects focused on the development of processes for the production of chemicals and materials that can be integrated into biorefineries will continue. Projects with industrial partners will focus on development of technologies for value-added chemical intermediates, novel separations technologies and bio-based plastics. Additional work with industry, universities and the National Laboratories will focus on improvements to increase the efficiency of individual process steps, e.g., catalysis, separations, etc. These projects

[a] Core technology areas were defined through an analytical effort that resulted in the selection of the top twelve building block chemicals that can be produced from sugars via biological or chemical conversions. These twelve building block chemicals can be subsequently converted to a number of high value bio-based chemicals or materials.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

will continue to bridge the gaps between products development and full integration into a biorefinery. Collaborative efforts with industry and academia will be accelerated significantly via solicitations to develop fermentation organisms that have increased stability, robustness, and lower cost. These organisms will have the ability to ferment mixed sugars from cellulosic residues to ethanol. The organisms will be tested to verify that they meet the requirements of the biorefinery performance goals. The program will continue collaborative efforts with stakeholders in validating the sustainability of biobased products. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR.....	**--**	**614**	**2,194**

In FY 2005, $158,000 and $19,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Utilization of Platform Outputs R&D.....	**20,473**	**23,322**	**89,190**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Integration of Biorefinery Technologies	
The increase will allow for the accelerated industrial-scale validation of biorefineries along the nearer term pathways. The focus will be on the integration of advanced technologies, improved efficiencies and the establishment and enhancement of value-added co-products on a systems level for the production of biofuels. The program's selection of projects for funding will be based on strict criteria similar to those used by investment bankers in high risk project finance decisions. With DOE support, the projects will result in technological risk reduction, thereby enhancing the probability of success for the private sector's commercialization and expansion efforts. The R&D Investment Criteria used are market relevance based on industry's input, and maximizing public benefits by redirecting resources from areas with lower priority.....	+42,284

	FY 2007 vs. FY 2006 ($000)
Products Development	
The increase will allow for the accelerated development of advanced micro-organisms to ferment mixed sugars from cellulosic residues, thus increasing the ethanol output from future biorefineries. The R&D Investment Criteria used are market relevance based on industry's input, and maximizing public benefits by redirecting resources from areas with lower priority	+22,004
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+1,580
Total Funding Change, Utilization of Platform Outputs R&D	**+65,868**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	35,332	51,777	0
Total, Congressionally Directed Activities	35,332	51,777	0

Description

In general, congressionally directed activities do not support program goals because such activities were not a result of the program's planning effort which is focused on overcoming technical barriers.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2006, there were 36 Congressionally directed activities funded out of the Biomass Program. The program does not request any funds to continue these projects as they do not further the achievement of DOE's goals. The following projects were directed by Congress to be included in this program:

Biomass Restoration by Eastern Nevada Landscape Coalition	**248**	**0**	**0**

Improving vegetation via thinning and increasing more desirable species.

Center for Biomass Utilization at University of North Dakota	**992**	**0**	**0**

Development of technologies for biomass-based power and fuels and transfer of information to potential users.

Mississippi State Biodiesel Production Project	**1,489**	**0**	**0**

Development of new feedstock and technologies for bio-diesel production.

Regional Biomass Energy Program	**3,969**	**0**	**0**

Dissemination of information and networking to overcome market barriers and accelerate biomass utilization.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
ThermoEnergy Research Project at the University of Nevada-Reno	**496**	**0**	**0**

Preliminary design and economic evaluation of a biomass-fueled process, the ThermoEnergy Integrated Power System.

Vermont Biofuels Initiative	**496**	**0**	**0**

Activities aimed at increasing biodiesel use by organizing Vermont institutional purchases and fostering growth in the state's biodiesel supply.

Recycling for Energy Conservation in Wells, Nevada	**248**	**0**	**0**

Demonstration of modular technology for recycling waste tires using microwave technology.

Alternative Fuels Plant in Livingston Parish	**496**	**0**	**0**

Completion of a feasibility study, aerial survey, and business plan, and initiation of permitting, environmental, and engineering/procurement/construction activities for a plant.

Alaska Wood Biomass Project	**198**	**0**	**0**

Design and construction of a wood-fired heating facility through the Alaska Energy Authority's biomass energy program and the Alaska Wood Energy Development Task Group.

Mississippi Technology Alliance – Alternative Energy Enterprise	**2,977**	**0**	**0**

Partnership with universities for biomass utilization in Mississippi and with companies to cost share promising biomass-based technologies.

Kentucky Rural Energy Supply	**1,984**	**0**	**0**

Activities of the Kentucky Rural Energy Consortium focus on research on biomass and bioenergy of importance to Kentucky, and networking and partnerships to increase biomass utilization.

South-Eastern and North-Central Regional Sun Grant Centers	**1,488**	**0**	**0**

Centers at the University of Tennessee and South Dakota State University for developing biomass technologies, evaluating the effects of biomass utilization, increasing synergy among land-grant universities, and fostering National Laboratories/universities collaboration.

Purdue-Midwest Consortium for Sustainable Biofuels	**496**	**0**	**0**

Research on pretreatment, hydrolysis, and fermentation aimed at reducing the cost of converting distiller's dry grains to alcohols and chemicals; life cycle analyses of environmental impacts of new processes.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
SUNY-Morrisville Anaerobic Digester Project	**198**	**0**	**0**

Anaerobic digestion technology for converting wastes to useful products using a digester that can accommodate larger flows of input and more diverse materials such as cafeteria food waste, agricultural residues, horse wastes, and other biomass.

NREL Demonstration for Small-Scale Biomass (BioMax)	**2,976**	**0**	**0**

Demonstration of small, modular biopower production system that uses high bulk density biomass.

Anaerobic Digestion – Ohio Agricultural Research Development Center	**992**	**1,485**	**0**

Anaerobic digestion technology for converting organic food wastes to syngas and hydrogen useful products.

Alabama Alternative Fuel Source Study	**496**	**0**	**0**

Survey of Alabama waste materials as potential fuel sources and evaluation of the use of alternative fuel sources in energy intensive operations (e.g., cement production) focusing on fuel burn characteristics.

Georgia Biorefinery and Hydrogen Fuel Cell Research	**1,488**	**0**	**0**

Research on improved electrode surfaces of fuel cells, wood pyrolysis, and adsorption of ammonium ions on pyrolysis char.

National Center for Energy Management and Building Technologies	**708**	**0**	**0**

Activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.

National Biofuel Energy Laboratory	**1,984**	**1,980**	**0**

Research on biodiesel/petroleum diesel with carefully controlled compositions to determine impacts on emissions, exhaust system life and vehicle operation.

Texas A&M – Renewable Energy from Animal Biowaste	**992**	**990**	**0**

Research on co-firing of animal wastes (including carcasses) with coal in power boilers to reduce emissions during combustion.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Ag-Based Industrial Lubricants - University of Northern Iowa	**496**	**990**	**0**
Establish a testing laboratory for bio-based lubricants.			
Sugar-Based Ethanol Biorefinery at Louisiana State University	**1,984**	**495**	**0**
Development of technology for converting sugarcane residues from harvesting and processing operations (cane leaf matter, bagasse and molasses) to ethanol and co-products.			
Biotech-to-Ethanol Project	**1,488**	**990**	**0**
Research on fractionating biomass for conversion to various products; development of a process model for techno-economic analysis.			
Research Triangle Biomass, North Carolina	**992**	**1,238**	**0**
In FY 2005, develop new and optimized catalysts and catalytic processes that can efficiently convert biomass-derived syngas into diesel fuel and C2 to C4 alcohols. In FY 2006, develop catalysts capable of removing contaminants in the synthesis gas stream to levels enabling catalytic conversion of the synthesis gas to liquid transportation fuels.			
Iowa Switchgrass Project - Chariton Valley	**496**	**742**	**0**
Testing of co-firing coal and switchgrass, conducting field research to enable the use of switchgrass for energy, and developing this market.			
Oxygenated Diesel Emissions Testing in California and Nevada, AAE Technologies	**496**	**495**	**0**
Demonstration of diesel and ethanol mixture in heavy vehicles.			
Biorefinery at Louisiana State University	**496**	**495**	**0**
Development of technology for converting sugar cane wastes and molasses into fuels and chemicals.			
Vermont Biomass Energy Center	**496**	**495**	**0**
Accelerating adaptation of near-term renewable biomass technologies.			
Consortium for Plant Biotechnology Research	**2,977**	**3,465**	**0**
Competitive awards to universities based on industry needs and focusing on plant-derived energy resources and plant-based energy industries. The membership is comprised of three dozen institutions of higher education and over 30 companies.			

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
University of Georgia Biomass Pyrolysis Biorefinery Project	**0**	**1,238**	**0**
Research on pyrolysis of biomass for hydrogen production and fuel cell fabrication techniques.			
Wood Debris Bioenergy Project	**0**	**990**	**0**
Develop technology for utilizing wood wastes.			
Clarkson University Dairy Waste Partnership	**0**	**247**	**0**
Anaerobic digestion of dairy waste, cheese whey and other strong food wastes.			
Madison County Landfill Gas-to-Energy	**0**	**990**	**0**
Power generation using landfill gas in internal combustion engines.			
Asphalt Roofing Shingles into Energy, Xenia	**0**	**990**	**0**
Develop technology for converting roofing shingles to energy.			
Ohio State University 4-H Green Building	**0**	**990**	**0**
Use of a heat pump for the heat source for a new building.			
Solid Waste Authority Pyramid Resource Center	**0**	**1,980**	**0**
Convert organic components into energy products such as methanol, compressed natural gas, biodiesel, and hydrogen for power production using a fuel cell.			
City of Stamford Waste-to-Energy Project	**0**	**1,485**	**0**
Use a low emission combustion process to convert dried sewage sludge pellets to 10 MW of power using conventional steam turbine technology.			
Iowa State University Biomass Energy Conversion Project	**0**	**495**	**0**
Conduct research on the use of supercritical fluids to extract fermentable sugars from biomass.			
Iroquois Bioenergy Consortium Ethanol Project	**0**	**3,465**	**0**
Construction of starch-based ethanol plant in Indiana.			
New York Biomass/Methane Gas Power Fuel Cell	**0**	**1,980**	**0**
Testing of simulated landfill or digester gas in solid oxide fuel cells.			

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Western Massachusetts Biomass Project	**0**	**495**	**0**
Develop the requirements necessary to establish a biomass feedstock infrastructure to serve the needs of various industries. Modeling will be developed to identify the costs associated with different processing and handling costs.			
Greenville Composite Biomass Project	**0**	**742**	**0**
Project on biomass technology or utilization.			
Laurentian Bioenergy Project	**0**	**1,238**	**0**
Develop tree plantations that are to be part of a biomass-to-combined heat and power project. Forest products residues will be used in the interim.			
Kona Carbon Biomass Project	**0**	**990**	**0**
Convert macadamia nut shells into carbon products (activated carbon, carbon for tire manufacture, etc.).			
Sustainable Energy Center at Mississippi State University	**0**	**10,890**	**0**
Establish a center focusing on energy studies and related activities.			
Missouri Biodiesel Demonstration Project	**0**	**990**	**0**
Validate biodiesel utilization in specific application.			
Auburn Alternative Fuel Source Study of Cement Kilns	**0**	**990**	**0**
Study the potential use of alternative fuel sources for cement kiln operation.			
Canola-Based Automotive Oil Research	**0**	**990**	**0**
Research on automotive oil made from oil seed crops.			
Center for Advanced Bio-based Binders	**0**	**792**	**0**
Establish center for development of binders made from biomass-derived intermediates.			
Development of Applied Membrane Technology	**0**	**495**	**0**
Research on innovative membranes for use in chemical processes.			
Michigan Biotechnology Institute	**0**	**990**	**0**
Research on new chemical and bio-chemical processes.			

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Washington State Ferries Biodiesel Demonstration	**0**	**495**	**0**
Test biodiesel in ferries and evaluate the effect on air quality in Puget Sound.			
UNLV Research Foundation for Developing Biofuels	**0**	**2,970**	**0**
Use of novel ionic transfer membranes to recover ethanol from fermentation broths.			
Total, Congressionally Directed Activities	**35,332**	**51,777**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal	-51,777
Total Funding Change, Congressionally Directed Activities	**-51,777**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	394	0	0
Total, Technical/Program Management Support	394	0	0

Description

This activity previously supported Technical Management activities, including planning; project and performance tracking; program reviews and evaluations; peer reviews; GPRA baseline data development; data collection and publication; and market, economic, and other analyses.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	**394**	**0**	**0**
This activity previously supported Technical Management activities, including planning; project and performance tracking; program reviews and evaluations; peer reviews; GPRA baseline data development; data collection and publication; and market, economic, and other analyses.			
Total, Technical/Program Management Support	**394**	**0**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funding requested in FY 2006 or FY 2007	0
Total Funding Change, Technical/Program Management Support	**0**

Solar Energy

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Solar Energy					
Photovoltaic Energy Systems.....	65,844	60,573	-606	59,967	139,472
Concentrating Solar Power	5,873	7,500	-75	7,425	8,900
Solar Heating and Lighting.....	2,418	1,480	-15	1,465	0
Congressionally Directed Activities.....	10,120	14,400	-144	14,256	0
Total, Solar Energy.....	84,255[b]	83,953	-840	83,113	148,372

Public Law Authorizations:

P.L. 93-409, "Solar Heating and Cooling Demonstration 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. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-590, "Solar Photovoltaic Energy Research, Development and Demonstration Act" (1984)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990" (1990)
P.L. 102-46, "Solar, Wind, Waste, and Geothermal Power Production Incentives Technical Amendments Act" (1991)
P.L. 102-486, "Energy Policy Act (EPACT)" (1992)
P.L. 109-190, "Energy Policy Act" (2005)

Mission

The mission of the Solar Energy Program ("Solar Program") is to accelerate widespread commercialization of clean solar energy technologies across America by 2015, diversifying the Nation's electricity supply options, while increasing national security and improving the environment.

Benefits

Through its research and development activities, the Solar Program develops solar energy technologies –photovoltaics (PV) and concentrating solar power (CSP) – that are reliable, affordable, and environmentally sound. Transforming the Nation's vast supply of direct solar energy into a widely available, affordable energy resource will increase energy security both by increasing electricity

[a] Includes a rescission of $840,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $1,423,000 was transferred to the SBIR program and $170,000 was transferred to the STTR program.

production and diversifying domestic energy supply, as well as provide energy options in both normal market conditions and emergency situations. It will also reduce our dependence on fossil fuels, both domestic and imported, for electricity generation.

Beginning in FY 2007, the Office of Energy Efficiency and Renewable Energy (EERE) proposes a refined program investment portfolio to accelerate program contributions to the critical national objectives of improving national energy security, providing for a cleaner environment, and ensuring continued domestic energy and economic development. As part of this effort, EERE is proposing a new initiative -- The Solar America Initiative (SAI) – which will accelerate R&D efforts designed to achieve market competitiveness for photovoltaic (PV) solar electricity by 2015 instead of 2020. The accelerated R&D effort will focus on PV technology pathways that have the greatest potential to lower costs and improve performance. New industry-led R&D partnerships, known as "Technology Pathway Partnerships," will be funded to aggressively address the issues of cost, performance and reliability associated with each technology pathway. Potential partners within the Technology Pathway Partnerships include industry, universities, laboratories, States and other governmental entities. In 2015, benefits are estimated to include 5-10 GW of new capacity, equivalent to the amount of electricity needed to power 1-2 million homes; 10 million metric tons of avoided carbon dioxide; and 30,000 new jobs created in the U.S. PV industry.

The Solar Program provides additional types of public benefits in the areas of reliability, security, and environment.[a] PV systems can either be integrated with the electricity grid or work independently as distributed systems, a flexibility which increases our national energy security by providing a widely available and flexible source of power not dependent on our aging and vulnerable electricity grid system. CSP systems use dishes for smaller, decentralized systems, and dish arrays and troughs for larger, centralized power applications. The addition of thermal energy storage to CSP systems will enable utilities to use solar energy during their entire periods of peak demand.

Solar energy is particularly valuable in reducing the need for new generating and transmission capacity because its natural availability matches daily and seasonal electricity peaks. Solar energy promotes energy security during emergencies by providing power and hot water that is not dependent on fuel deliveries or overhead wires (subject to disruption) and which will not contribute to local air pollution during a protracted emergency. Solar energy displaces demand on the electricity grid most during the hottest, sunniest days of the year when demand for space cooling peaks, helping to avoid blackouts; this also reduces Clean Air Act criteria pollutant emissions from fossil-fueled generation plants when air pollution levels are at their highest and non-attainment status is most at risk.

More detailed, integrated and comprehensive economic, energy supply and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

[a] Not reflected in the quantified benefits reported in the Expected Program Outcomes section.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Solar Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Solar Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.03.00.00: Solar Energy. The Solar Program goal is to improve performance of solar energy systems and reduce development, production, and installation costs to competitive levels, thereby accelerating large-scale usage across the Nation and making a significant contribution to a clean, reliable and flexible U.S. energy supply.

Contribution to Program Goal 04.03.00.00 (Solar Energy)

The key Solar Program contributions to the Department's General Goal 4, Energy Security, is increased production of electricity and diversification of energy supply. The Solar Program works to improve the performance of next-generation solar energy technologies which reduce system, manufacturing, and installation costs to levels competitive with conventional energy sources. When Federal solar energy research increased in the 1970s in response to oil price shocks, the cost of electricity from solar resources was about $2.00 per kilowatt-hour (kWh). Technological advances over the last two decades have reduced solar electricity costs by more than 90 percent. Today, in areas with favorable conditions, solar electricity can be produced at costs as low as $0.12/kWh for CSP and as low as $0.18 for PV applications.

The Solar Program goal of achieving cost-competitive solar electricity translates to a range of costs based on specific markets. For PV, the estimated cost ranges for market-specific cost-competitive electricity are:

- $0.05/kWh - $0.07/kWh for centralized power markets,
- $0.06/kWh - $0.08/kWh for commercial markets, and
- $0.08/kWh - $0.10/kWh for residential markets.

The long-term cost goal for centralized CSP systems is currently $0.08/kWh - $0.10/kWh.

Key technology pathways to the goal include (detailed annual performance progress indicators are presented in their respective benefits sections):

- By 2010, reduce the 30-year user cost for PV electric energy to $0.11 - $0.18/kWh from $0.18 - $0.23/kWh in 2005.

- By 2010, reduce the cost of large-scale CSP power plants in the Southwest to $0.10 - $0.12/kWh from $0.12 - $0.14/kWh in 2005.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.03.00.00, Solar Energy			
Photovoltaic Energy Systems	65,844	59,967	139,472
Concentrating Solar Power	5,873	7,425	8,900
Solar Heating and Lighting	2,418	1,465	0
Subtotal, Program Goal 04.03.00.00, Solar Energy	74,135	68,857	148,372
All Other			
Congressionally Directed Activities			
Evaluation of Solar-Powered Thermo-Chemical Hydrogen Project, UNLV	4,464	0	0
Photonics Research and Development, UNLV	1,488	0	0
Conductive Coatings for Solar Cells	1,488	0	0
Yucca Valley Project	248	0	0
Solar Technology Center, UNLV	744	0	0
University of Louisville Sustainable Buildings Project	397	0	0
National Center on Energy Management and Building Technologies	1,291	0	0
Rensselaer Polytechnic Institute Syracuse University “Green Building”	0	742	0
Crowder College Alternative Renewable Energy Center	0	990	0
University of Arkansas Research in Solar Energy Field	0	495	0
Oregon Nanoscience and Microtechnologies Institute	0	1,485	0
Conductive Coating Solar Cell Research Project	0	1,485	0
Ultra Thin Film Photovoltaic Charging System	0	990	0
Brightfield Solar Energy	0	693	0
National Orange Photovoltaic Demonstration	0	446	0
Sandia National Lab Development Of Advanced Cells and Modules	0	990	0
Sandia National Lab Megawatt Demonstration Concentrating Solar Project	0	3,465	0
UNLV Research Foundation For Photonics Research, Including Evaluation Of Advanced Fiber Optics For Hybrid Solar Lighting	0	2,475	0

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Total, Congressionally Directed Activities	10,120	14,256	0
Total, All Other	10,120	14,256	0
Total, General Goal 4 (Solar Energy)	84,255	83,113	148,372

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.03.00.00 (Solar Energy)					
Photovoltaic Energy Systems					
Reduce the manufacturing cost of PV modules to $2.25 per Watt (equivalent to a range of $0.20 to $0.25 per kWh price of electricity for an installed solar system). [MET]	Reduce manufacturing cost of PV modules to $2.10 per Watt (equivalent to a range of $0.19 to $0.24 per kWh price of electricity for an installed solar system). [MET]	Verify, with standard laboratory measurements, U.S.-made commercial production crystalline silicon PV modules with 12.5 percent conversion efficiency. Verify, with standard laboratory measurements, U.S.-made commercial production thin-film PV modules with 10 percent conversion efficiency. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 13.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.95 per Watt. [MET]	Verify, using standard laboratory measurements, a conversion efficiency of 13.8 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.90 per Watt.	Verify, using standard laboratory measurements, a conversion efficiency of 14.5 percent of U.S.-made, commercial crystalline silicon PV modules. Production cost of such modules is expected to be $1.80 per Watt.
			Develop thin-film PV modules with an 11.0 percent conversion efficiency that are capable of commercial production in the U.S. [MET]	Develop thin-film PV modules with an 11.2 percent conversion efficiency that are capable of commercial production in the U.S.	Develop thin-film PV modules with an 11.8 percent conversion efficiency that are capable of commercial production in the U.S.
Concentrating Solar Power					
				Conduct advanced research on trough collectors and receivers that will lead to a reduction in the modeled cost of energy from CSP troughs to $0.12-$0.14/kWh.	Develop CSP trough collector and receiver technologies that enable a system conversion efficiency of 13.1%. The levelized cost of energy from such a system is expected to be in the range of $0.11-$0.13/kWh.
Solar Heating and Lighting					
		Developed conceptual designs of a low-cost polymer solar water heater capable of operation in freezing climates. [MET]	Achieve 5.0 cents per kilowatt-hour modeled cost of energy from solar water heater capable of operating in non-freezing climates. [MET]		[No target]
		Contributed proportionately to EERE's corporate goal of	Contribute proportionately to EERE's corporate goal of	Maintain total administrative overhead costs (defined as	Maintain total administrative overhead costs (defined as

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
		reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [MET]	reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline($19,342K) until the target range is met. [MET]	program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Solar Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Solar Program will implement these goals using the following means:

- Perform research, development, deployment and demonstration activities in partnership with coalitions of industry members, universities, National Laboratories and/or States;
- Increase photovoltaic module efficiency, system reliability, and manufacturing capability and efficiency;
- Select technology pathways for accelerated development of improved manufacturing methods, materials use, defect control and throughput;
- Increase the efficiency and reliability of CSP systems;
- Establish low-cost thermal storage for trough systems;
- Conduct technology analysis and systems driven analysis to help identify research priorities; and
- Accelerate the reduction of production costs for all solar energy technology systems.

The Solar Program will achieve these goals using the following strategies:

- Concentrating resources on technology pathways that have the highest potential for cost reduction in the near-term to accelerate their development and deployment;
- Working with partnerships consisting of industry members, universities, National Laboratories, States and/or other governmental entities to solve scientific and technical barriers necessary to improve performance and reliability, while reducing cost in PV technology pathways;;
- Using cost-sharing arrangements with industry and other partners to leverage Federal resources; and
- Working with States, industry, and other entities to communicate technology advances and opportunities effectively, reduce barriers, and accelerate market penetration of technology applications.
- Working with the Office of Science, the Building Technologies Program (EERE) and the Federal Energy Management Program on PV R&D and deployment opportunities.

These strategies will significantly reduce the cost of solar technologies, which will improve energy security by increasing the amount, availability and diversity of the domestic energy supply.

The following external factors could affect the Solar Program's ability to achieve its strategic goal:

- material costs;

- labor costs;
- currency exchange rates;
- the price and availability of alternative technologies and conventional fuels;
- international R&D and deployment efforts;
- financial incentives and other policies;
- interest rates and inflation;
- state and local regulation; and
- market participant withdrawal or entry.

In carrying out the mission, the Solar Program performs the following collaborative activities:

- research, development, demonstration and deployment activities, as well as information sharing, with DOE programs, industrial manufacturers, universities, National Laboratories, States and other governmental entities;
- work with solar energy and other industry experts outside of the Department to:
    - ensure that the Solar Program's research directions and priorities address the needs of manufacturers, utilities, state agencies, consumers, and other stakeholders;
    - ensure that program activities are within the realm of technical feasibility and properly aligned with market forces; and
    - develop technology roadmaps and peer reviews, versions of which have been completed within the last two years for each of the primary solar subprograms.

Validation and Verification

To validate and verify program performance, the Solar Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	Annual Energy Review 2006 (EIA); Renewable Energy Annual 2006 (EIA); Annual Energy Outlook 2007 (EIA); Zero Energy Homes Roadmap (2002); Peer Review of the U.S. Department of Energy's Solar Buildings Technology Research Program (2001); National Research Council, Critique of the Sargent and Lundy Draft Assessment of Cost and Performance Forecasts for Concentrating Solar Power (2002); Sargent and Lundy, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts (2003); Peer Review of the DOE Photovoltaic Program (2003); Our Solar Power Future: The U.S. Photovoltaic Industry Roadmap for 2005 and Beyond (2004).
Baselines:	The Solar Program's 2003 baselines for system production cost reduction goals are: $0.19 – $0.24/kWh for PV electric energy (See the Solar Program Multi-Year Technical Plan) and ; $0.12 - $0.14/kWh for electricity from CSP technologies (See the CSP Technology Transition Plan 2004).

Frequency: Annual.

Evaluation: In carrying out the program's mission, the Solar Program uses several forms of evaluation to assess progress and to promote program improvement.

- Technology validation and operational field measurement;
- Critical peer review of both the program and subprogram portfolios and activities by independent outside experts;
- Annual internal Technical Program Review of the Solar Program;
- A Technical Review Team specific to the SAI will be established;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and re-computation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: EIA and other organizations, such as National Laboratories (including the National Renewable Energy Laboratory (NREL), Sandia National Laboratories (Sandia), store data on computer servers.

Verification: Peer reviews; National Laboratory system and component test data; trade association reviews; National Laboratory survey of PV manufacturing cost/capacity data from U.S. industry; EIA survey of solar manufacturers; literature reviews.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to access the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Solar Program has incorporated feedback from OMB into the FY 2007 Budget Request and has taken or will take necessary steps to continue to improve performance.

The 2003 PART rated the Solar Program "moderately effective" - the second highest rating category-scoring well in purpose (80%), planning (80%) and management (100%). The 2003 PART review and score, and subsequent follow-up activities by the Solar Program, provided suggestions that resulted in refined long-term and annual measures incorporated in this FY 2007 budget request. The PART review also recognized that the Solar Program has implemented a new "systems driven" approach to help

prioritize activities in its portfolio by analyzing present and potential markets, technology trade-off studies, and research and development reviews, and recognized that the program had developed a Multi-Year Technical Plan to guide its research efforts. In addition, the PART review also recognized that congressionally directed activities reduce the program funding available for competitive solicitations and core National Laboratory research designed to support program goals. The Solar Program is attempting to adhere to the specific direction of congressional appropriation earmark language while increasing the contribution to program goals to the maximum extent possible.

In response to the lessons learned from the DOE FY 2003 performance audit by KPMG and consistent with production cost measures developed for the 2003 PART, the Solar Program has transitioned its annual performance targets to the extent possible from external outcomes to program outputs strongly linked to outcomes. Annual technical targets, such as sunlight-to-electricity conversion efficiency measures, reflect the actual technical work conducted by the program, allow for improved validation and verification of program performance, and minimize the potential for target achievement disruption caused by market factors beyond the program's control.[a] Cost measures are useful indicators that show market trends and assist the program in responding to a changing marketplace. Therefore, the Solar Program is using "hybrid" targets for its activities that emphasize technical outputs, but maintain a strong connection to relevant costs.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. The Applied R&D programs in DOE have improved use of common baselines, assumptions and more consistent methods for generating their benefits estimates. But benefits estimates are not comparable across the entire applied R&D portfolio. DOE will continue to address this finding corporately.

Expected Program Outcomes

The Solar Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other air pollutants; enhance national security by increasing the production and diversity of domestic fuel supplies and reducing dependence on foreign fuels; and provide greater energy security and reliability by improving our energy infrastructure.

Of particular importance to national security, solar energy technologies can produce emergency power without fuel. Fuel-free generation obviates the need to transport fuel during emergency situations in which critical fuel and transportation infrastructure may be damaged or incapacitated. In addition to these "EERE business-as-usual" benefits, realizing the Solar Program goals would provide the technical potential to reduce conventional energy use even further. In particular, estimated benefits would be sensitive to assumptions about the structure of future electricity prices and markets, particularly in the areas of peak pricing and load management market opportunities. If technology targets and market expectations are met under SAI, activities are expected to result in an estimated 67 gigawatts (GW) of

[a] Market factors outside the program's control that could affect the achievement of cost goals include, but are not limited to, raw material costs, labor costs, interest rates, currency exchange rates, inflation, foreign competition, state and local regulations, and market participant withdrawals or entries.

electric capacity additions and $8 billion in energy expenditure savings annually by 2025, rising to 264 GW of electric capacity additions and $10 billion in energy system cost savings annually by 2050. Adding 264 GW of capacity is roughly equivalent to avoiding the construction of more than 1,600 new conventional power plants, based on the current average U.S. power plant size of 160 MW.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and solar electricity capacity additions that result from the realization of Solar Program goals are shown in the table below through 2050. Benefits are expected to grow beyond 2050 as research advances, market penetration grows, and capital stock turns over.

The estimates reported here also do not reflect additional consumer demand for solar energy because it provides increased reliability of service, an emergency source of power, and/or an improvement in load management capabilities. As a result, the benefits reported here likely understate the demand for solar energy. Alternatively, the high first costs of PV installations may be a deterrent to market penetration; the program is addressing this issue by working with the investment and building communities on options to address this impediment.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the Solar Program's ability to achieve its goals. Also note that the modeling long term benefits assumes that funding levels will be consistent with the President's commitment and assumptions in the FY 2007 Budget, and that funding will be applied to the core program. Reduced funding can lead to a reduction in estimated future benefits.

The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits which follow assume that individual technology plans and market assumptions obtain. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html.

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[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

FY 2007 GPRA Benefits Estimates for Solar Energy Program[a]

Mid-Term Benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	ns	0.06	0.35	1.07
Energy expenditure savings (Billion 2003$)	1	2	8	8
Carbon emission reductions (MMTCE)	0	1	8	29
Natural gas savings (Quads)	ns	0.05	0.09	ns
Program specific electric capacity additions (GW)	1	5	30	67

Long-Term Benefits[d]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	1.65	3.15	5.22
Energy system net cost savings (Billion 2003$)	3	6	10
Carbon emission reductions (MMTCE)	40	65	111
Natural gas savings (Quads)	0.18	1.40	2.06
Program specific electric capacity additions (GW)	73	159	264

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are achieved and funding continues at levels consistent with assumptions in the FY 2007 Budget.
[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.
[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.
[d] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Photovoltaic Energy Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Photovoltaic Energy Systems			
Fundamental Research	26,591	26,449	28,927
Advanced Materials and Devices	24,370	19,577	92,925
Technology Development	14,883	12,608	14,306
SBIR/STTR	--	1,333	3,314
Total, Photovoltaic Energy Systems	65,844	59,967	139,472

Description

Photovoltaic (PV) technologies utilize semi-conducting materials that directly convert sunlight into electricity. Modular by nature with no moving parts, they can be sized to almost every need and placed almost anywhere sunlight is available.

Benefits

The Solar Program focuses on achieving the Department's goal of making solar energy an integral part of the national energy supply portfolio through the development of highly-reliable PV systems with user lifetime energy costs competitive with electricity from conventional resources. The PV subprogram attempts to achieve this goal by: 1) increasing their sunlight-to-electricity conversion efficiency (performance); 2) reducing the manufacturing cost of cells, modules, and systems; and 3) increasing system operating lifetime and reliability.

The basic building block of a PV system is a power module, which is typically one square meter in size and produces 120 Watts (W) of power. The module comprises 50-60 percent of the cost of an installed PV system and presents the greatest opportunity for cost savings. Current (2005) crystalline silicon (c-Si) power modules produced in the U.S. are approximately 13.5 percent efficient and produce electricity at 18 to 23 cents/kWh (lifetime system user cost over 30 years in areas with a wide range of favorable conditions). Costs could be greater in certain areas depending upon climate and financing available. Crystalline silicon is the most mature technology and comprises 94 percent of the market. New technologies which have potential for low cost include thin films and high performance multi-junction cells for use in concentrating collectors.

To more rapidly lower costs and improve performance, the photovoltaic subprogram is accelerating and realigning its R&D activities under the Solar America Initiative (SAI) to focus on technology pathways that have the highest potential to reach cost competitiveness by 2015. New industry-led partnerships, known as "Technology Pathway Partnerships," will be funded to aggressively address the technical issues associated with each pathway. In addition to PV industry members, potential partners within the Technology Pathway Partnerships include universities, National Laboratories, States, and other

governmental entities. Aggressive milestones and metrics will be used in a stage-gate process to monitor and accelerate progress.

The condition of the international marketplace for PV technologies makes the timing of SAI appropriate. Several nations, including Korea, China, and Germany are expanding photovoltaic markets by investing large amounts of public dollars to spur commercial deployment. The SAI is intended, in part, to maintain U.S. R&D leadership in PV technologies and maintain U.S. leadership in PV installations.

The SAI strategy to reach the program's 2015 cost-competitiveness goal is to aggressively promote and compete the best technology options. Significant funding will be expended only on those technology pathways that have the most potential and can rapidly produce tangible results. This strategy is aimed to maximize public funding benefits while increasing the chance of achieving program goals.

SAI activities will be coordinated with the Office of Science, the Building Technologies Program and the Federal Energy Management Program (FEMP). The Solar Program is working with the Office of Science to coordinate the Department's basic research activities that are crucial to addressing fundamental technical problems associated with conversion efficiency, reducing cost and improving reliability. Likewise, closely coordinated planning and research with the Building Technologies Program's zero energy buildings activities will lead to PV products that are easily integrated in new and existing building designs. The Solar Program will work with FEMP to seek Federal deployment opportunities for SAI technologies. Coordinating this research with other Federal offices both ensures the most efficient use of resources and the best opportunity for the Department to achieve its goals.

For FY 2007, the PV subprogram's priorities are:

- Realign R&D activities to concentrate funding priority on the most promising technology pathways.
- Issue new competitive solicitation for multi-year cost-shared contracts for Technology Pathway Partnerships and make awards.
- Work closely with the Office of Science and the Building Technologies Program on the scientific, technical, and strategic issues that limit PV performance and application. Improved understanding of the scientific underpinnings of PV materials and devices, deposition and fabrication processes, and the optimal methods for fitting PVs to buildings—ultimately providing a key component of the zero energy buildings—will help the Solar Program achieve its goals.
- Advance module manufacturing technologies to achieve higher performance and lower-cost products with faster throughput.
- Continue systems reliability research to increase the lifetime of thin-film modules and the mean time to failure of DC-to-AC current inverters for low-cost, grid-tied distributed PV systems.

Increasing module efficiency is a critical component to lowered system production costs (per Watt) and successful entry of PV systems into energy markets. Although a main focus of SAI is on improving manufacturing processes through industry-led consortia, module efficiency levels remain an important component of lowering the cost of energy from PV systems. Efficiencies differ for the two main types of PV modules. Crystalline silicon is the dominant PV technology, while thin films are a family of promising PV technologies that have recently entered commercial production. Accordingly, the

projected efficiencies in the table below address both technologies for systems in domestic commercial production.

U.S.-Produced PV Module Efficiency Targets and Actuals

(Conversion Efficiency (%))

	Historic			Planned						
Efficiency	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Crystalline Silicon (c-Si)										
Target	12.5	13.0	13.5	13.84	14.5	15.5	16.0	16.5	17.0	20.0
Actual	12.5	13.0	13.5	-	-	-	-	-	-	-
Thin Film										
Target	10.0	10.5	11.0	11.2	11.8	12.3	12.7	13.0	13.3	15.0
Actual	10.0	10.5	11.0	-	-	-	-	-	-	-

The Solar Program uses the following PV module manufacturing cost data and projections presented below as helpful indicators of progress toward achieving program benefits:

Historic and Projected Solar Energy Costs

	Historic			Planned						
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Manufacturing Cost of Crystalline Silicon PV Modules ($/Watt)										
Target.....	2.10	1.95	1.95[a]	1.90	1.80[b]	1.70	1.60	1.50	1.40	1.00
Actual[c]	2.10	1.95	1.92	-	-	-	-	-	-	-
Cost of Power from Crystalline Silicon PV Modules ($/kWh) [d]										
Target.....	0.19-0.24	0.18-0.23	0.18-0.23	0.17-0.22	0.16-0.21	0.15-0.20	0.13-0.19	0.11-0.18	0.09-0.17	0.05-0.10
Actual	0.19-0.24	0.18-0.23	0.18-0.23	-	-	-	-	-	-	-

To implement the budget and performance integration portion of the President's Management Agenda, the Solar Program participated in the Administration's R&D Investment Criteria (R&DIC) evaluation process, the OMB Program Assessment Rating Tool (PART) process, and an internal multi-year program planning (MYP) process. These exercises guided program budget planning, management decisions, and performance goals and targets. As a result, this budget request for this subprogram redirects requested funding from congressionally directed activities in FY 2006 to R&D that better supports the program's accelerated performance goals.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Fundamental Research	**26,591**	**26,449**	**28,927**

Fundamental Research is critical to the advancement of photovoltaic technology to meet the Solar Program's accelerated goal of making solar electricity cost-competitive with electricity from traditional sources by 2015. There have been four focus areas within Fundamental Research:

[a] PV cost targets were adjusted for 2005 and outward due to verification processes. No technical targets were changed but the target *verification* process caused the stated targets to slip one year due to availability of market data.
[b] Outyear cost targets have been modified based on recent increases in material costs (e.g., silicon).
[c] "Actual" cost data represents the lowest costs reported by a major U.S. module manufacturer during an annual manufacturing survey.
[d] Cost of power is expressed in ranges due to the diversity of PV module applications. The low end of costs reflect commercial applications under good conditions, such as advantageous financing terms and sunny locations, while the higher end of the range is more common in residential applications. Costs could be impacted by changing key factors, such as interest rates, labor costs, raw material costs, Federal, State and local incentives, global deployment efforts, and geography of installation.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

Measurements and Characterization, the University Research Project, the High Performance Initiative, and the Collaborative Crystalline Silicon Initiative. In FY 2007, Fundamental Research will be reduced in scope and realigned to devote more financial resources to the Advanced Materials and Devices activity to support the Technology Pathway Partnerships. The Solar Program is also working with the Office of Science to coordinate and accomplish basic solar research needs.

There are three parts to the realignment under Fundamental Research: 1) the work under the University Research Project, the High Performance Initiative and the Collaborative Crystalline Silicon Initiative will be reduced in scope in FY 2007 and transferred to Advanced Materials and Devices starting in FY 2008; 2) the Module Reliability R&D under Advanced Materials and Devices will be transferred into Fundamental Research starting in FY 2007; and 3) new research activities will begin in the Science and Technology Facility at the National Renewable Energy Laboratory (NREL).

Under the Measurements and Characterization activity, researchers work in partnership with universities, industry and the National Laboratories to improve the efficiency of cell materials and devices by investigating their fundamental properties and operating mechanisms. This teamed research approach identifies efficiency-limiting defects in cell materials and analyzes their electrical and optical properties. In FY 2007, the Measurements and Characterization activity will focus its efforts on supporting the new Technology Pathway Partnerships under Advanced Materials and Devices. Researchers will work with the partnerships to improve the understanding of materials, impurities and defects and their impact on device performance and reliability.

The University Research Project investigates innovative ideas and leap-frog technologies through university and collaborative laboratory research. This high-risk research opens the door to non-conventional concepts that could dramatically improve cost effectiveness in the long term. In FY 2007, this activity will be scaled back and refocused to support the nearer-term research necessary to reach the accelerated goals.

The High Performance Initiative, which supports research to substantially increase the efficiency of two promising next-generation technologies: 1) monolithically interconnected multi-junction thin films; and 2) super high-efficiency multi-junction concentrating cells, will be scaled back in FY 2007 and transferred by the end of the year to Advanced Materials and Devices where further work will be included within the Technology Pathway Partnership competitive solicitations.

The Collaborative Crystalline Silicon Initiative is designed to feature cost-shared collaborative contracts with a wide array of industry members and universities to improve c-Si technologies. In FY 2007 this activity will be scaled back and transferred to Advanced Materials and Devices where the work will become part of the Technology Pathway Partnership competitive solicitations.

Starting in FY 2007, Module Reliability R&D will be transferred from Advanced Materials and Devices (AM&D) into Fundamental Research to allow the work under AM&D to focus all its resources on the Technology Pathway Partnerships. This transfer is appropriate because the primary

(dollars in thousands)

FY 2005	FY 2006	FY 2007

focus of the reliability research is to address degradation mechanisms and intrinsic instabilities of pre-commercial thin film modules. Much of this work is done with support from the Measurements and Characterization laboratory facilities and researchers. Reliability research is necessary for thirty-year PV module life, a key to reaching the program's goals.

The Science and Technology Facility (S&TF) at the National Renewable Energy Laboratory will be completed in FY 2007. This new laboratory facility is designed to accelerate the time from laboratory bench discovery to manufacturing and use. The S&TF encompasses a new approach to enabling better science and accelerated technology development to reduce barriers and cost through a flexible and integrated laboratory capability for processing photovoltaic materials and devices. New laboratory processing equipment will be installed and research will begin in collaboration with industry partners to address scale-up issues associated with the technology pathways selected under SAI.

In support of this research, $790,000 from this subactivity will be used in FY 2007 to complete the purchase of laboratory instrumentation to equip the S&TF.

Important to all research activities, the subprogram will conduct necessary analysis activities to help insure performance measures and goals are attained.

Advanced Materials and Devices.....	**24,370**	**19,577**	**92,925**

The Advanced Materials and Devices activity has had three focus areas: the Thin Film Partnership, Advanced Manufacturing R&D, and Module Reliability R&D. Starting in FY 2007 these activities will be realigned to support the new SAI. The SAI will expand the R&D effort and is designed to accelerate the cost reduction of solar electricity by focusing resources on five technology pathways: crystalline silicon, three thin film technologies, and high performance multi-junctions.

To accomplish the work, a competitive cost-shared solicitation will be issued by the beginning of FY 2007 so that awards can be made and work begun by mid-year. The new partnerships, known as "Technology Pathway Partnerships," will aggressively address the technical issues associated with each pathway. In addition to PV industry members, potential partners within the Technology Pathway Partnerships include universities, National Laboratories, States and other governmental entities. A detailed plan for implementing the work and accomplishing the goals of will be developed during FY 2006.

Starting in FY 2007, the SAI will expand the R&D effort to aggressively accelerate the cost reduction of PV technologies. As stated, the goal of the SAI is to achieve market competitiveness for solar electricity by 2015 instead of 2020.

Key photovoltaic technologies which have the greatest potential for cost-competitiveness in this accelerated time frame will be selected for aggressive development. Examples of promising PV technologies include: 1) crystalline silicon modules and systems; 2) amorphous silicon thin film

(dollars in thousands)

FY 2005	FY 2006	FY 2007

modules and systems; 3) copper indium gallium diselenide (CIGS) thin film modules and systems; 4) cadmium telluride (CdTe) thin film modules and systems; and 5) high performance multi-junction cells, modules and systems. Other module and system technologies could be selected as well. SAI partnerships may also consider development and testing of balance-of-system component designs that address emerging requirements for modularity, interface standardization, reliability, and decreased installation cost.

In FY 2010, the Technology Pathway Partnerships will undergo a rigorous evaluation with the objective of down-selecting so that only the most successful pathways receive further funding. Another down-select, if needed, will occur in the 2012 timeframe.

To accommodate SAI, the Thin Film Partnership and Advanced Manufacturing R&D cost-shared contracts with industry will be scaled back and brought to completion. All work under these two activities will be restarted under the Technology Pathway Partnership competitive solicitations. The Module Reliability R&D activity will be transferred to Fundamental Research to allow the work under AM&D to focus all its resources on the Technology Pathway Partnerships.

The existing Thin Film Partnership has maintained strong research teams to focus R&D on promising thin-film technologies. These research teams are comprised of university, industry, and laboratory researchers who work to solve generic issues as well as industry specific problems. In FY 2007, the program will be brought to conclusion by completing the final year of the three-year cost-shared contracts under the Thin Film Partnership solicitation issued in FY 2004. All future work in thin film technology R&D will be performed under the competitive solicitation for Technology Pathway Partnerships.

In Advanced Manufacturing R&D, strong partnerships with the domestic PV industry have been formed with the goal of reducing costs, increasing efficiency, and increasing capacity to help enhance the industry's competitiveness in the development and manufacture of PV modules. Many areas of manufacturing R&D are critical to further reduce the cost of PV systems. University, industry, and National Laboratory researchers have worked to identify deficiencies and develop solutions that will improve sunlight-to-electricity conversion efficiencies, while lowering manufacturing costs. In FY 2007, the final year of the PV Manufacturing R&D three-year, 50-50 cost-shared subcontracts will be brought to conclusion. All future work in manufacturing R&D will be performed under the competitive solicitation for Technology Pathway Partnerships.

In Module Reliability, researchers have been working to solve reliability issues such as degradation mechanisms and intrinsic instabilities of pre-commercial thin film modules. This important activity will be transferred to Fundamental Research where it will be continued.

In addition, necessary analysis and communication activities will be conducted to help ensure performance measures and goals are attained.

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Technology Development	**14,883**	**12,608**	**14,306**

The Technology Development activity has four focus areas: Systems Engineering and Reliability; Building Integrated PV R&D; Solar Powers America, and Outreach and Analysis. All activities under Technology Development will be adjusted toward achieving the accelerated cost goals under SAI.

Systems Engineering and Reliability research focuses on the critical need to improve reliability of the entire PV system, including balance-of-system components such as DC-to-AC power inverters and battery charge controllers. Emphasis is placed on four technical objectives: 1) reducing life-cycle costs; 2) improving reliability of systems and system components; 3) increasing and assuring the performance of fielded systems; and 4) removing barriers to the use of the technology. To help remove barriers, the engineering and reliability activity supports development of codes and standards, as well as procedures for certifying performance of commercial systems.

In FY 2007, performance evaluation of thin-film systems will be conducted in the field to compare against benchmark data in both hot, humid climates representative of the southeastern U.S. and hot, dry climates representative of the southwestern U.S. Accelerated lifetime testing in the laboratory will be conducted in parallel of the field testing. Any failures found in the field or in the laboratory will be analyzed to determine the degradation mechanisms. Work will continue to improve the reliability of distributed grid-tied systems, especially in the buildings sector.

The Solar Program will coordinate with the Building Technologies Program in the areas of Building Integrated Photovoltaics (BIPV) and Zero Energy Buildings (ZEB). BIPV is a promising solar application in which PV modules serve the dual purpose of replacing conventional building materials and generating electricity. By serving dual roles as power generators and building products, BIPV systems offer lower PV installation costs from a buildings system perspective and provide opportunities for significant growth in distributed, grid-connected electricity markets. In FY 2007, the program will expand BIPV research to more fully integrate PV into buildings by working with university schools of architecture and engineering, in addition to builders. Input from ZEB activities will also provide insight into how best to integrate PV technologies into building designs in order to maximize cost-effective energy production.

A new activity, Solar Powers America (SPA), replaces the former Million Solar Roofs Initiative (MSRI) as the Solar Program's primary deployment vehicle. While MSRI involved small grants and technical assistance to a wide spectrum of partners across the country, SPA emphasizes a small number of larger, sustained Federal investments of funds and expertise in targeted urban areas to engage key players that have emerged in solar deployment, including system benefit fund managers, State Energy Programs, and domestic industry members. By deploying a broad range of solar technologies and methods, including PV, solar water heating, and passive solar design, SPA should be able to engage a more diverse set of stakeholders than former deployment efforts. SPA will provide the tools -- technical support, concept and information sharing, and matching funds -- to turn innovative concepts into functioning systems. SPA will serve as a deployment vehicle for

(dollars in thousands)

	FY 2005	FY 2006	FY 2007

technologies developed under the Solar America Initiative. (Funding for SPA: FY 2007 request - $2.0 million).

Outreach and Analysis activities are necessary for a national R&D program to remain viable in a rapidly changing energy sector. Such activities include testing and verification of grid-connected applications and analysis of public-private sector opportunities to commercialize PV technologies. In FY 2007, core technology analysis and outreach activities will continue, as well as the systems-driven approach activity to help identify research priorities. The Solar Decathlon, a high-profile university competition held biannually in Washington, D.C., promotes awareness of solar energy technologies among the general population and encourages incorporation of solar technologies into engineering and architecture school curricula.

SBIR/STTR	**--**	**1,333**	**3,314**

In FY 2005, $1,266,000 and $170,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Photovoltaic Energy Systems	**65,844**	**59,967**	**139,472**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Fundamental Research	
Fundamental Research will undergo significant realignment in FY 2007 as some activities are reduced in scope while some new activities are started. The University Research Project which looks at long-term, high-risk research will be reduced in scope and brought to completion (-$1,200,000). However, new university research opportunities are created by the realignment through competitive solicitations. The High Performance Initiative and the Crystalline Silicon Research project will be reduced in scope and transferred to AM&D (-$1,323,000). New activities, which result in the increase, include Module Reliability (+$2,500,000), which will be transferred from AM&D, and PV research to be performed within the Science and Technology Facility (+$2,500,000). These changes are consistent with RDIC guidelines in which the research has already been found to be of public benefit	+2,478

	FY 2007 vs. FY 2006 ($000)
Advanced Materials and Devices	
Advanced Materials and Devices will be increased substantially to accommodate the Solar America Initiative. A major new competitive solicitation will be issued in FY 2007 to accelerate the development of more cost-effective photovoltaic technologies by 2015 (+$80,000,000). The competitive solicitation will be issued early in FY 2007 with the goal of awarding contracts by mid-year. All other activities within AM&D will be transferred or completed to devote all resources to the initiative. Module Reliability R&D (-$2,500,000) will be transferred to Fundamental Research and the Thin Film Partnership (-$2,152,000) and Advanced Manufacturing R&D (-$2,000,000) activities will be reduced. These changes are consistent with RDIC guidelines regarding funding activities that build on or complement existing R&D and are focused on removing market barriers	+73,348
Technology Development	
System Engineering and Reliability research will be increased to support the SAI. The increase will also be used to expand research needed to more fully integrate PV into buildings, which will help reduce system costs.....	+1,698
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of Program activities	+1,981
Total Funding Change, Photovoltaic Energy Systems	**+79,505**

Concentrating Solar Power

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Concentrating Solar Power	5,873	7,342	8,775
SBIR/STTR	--	83	125
Total, Concentrating Solar Power	5,873	7,425	8,900

Description

Concentrating solar power (CSP) systems utilize the heat generated by concentrating and absorbing the sun's energy to produce electric power. The concentrated sunlight produces thermal energy at temperatures ranging from 600°F to over 1500°F to run heat engines or steam turbines for generating power or producing clean fuels such as hydrogen.

There are currently three types of solar thermal systems – parabolic trough, dish-engine systems and power tower – that are capable of producing power using the sun's heat. Trough systems use linear parabolic concentrators to focus sunlight along the focal lines of the collectors. Dish-engine systems comprise a parabolic dish concentrator, a thermal receiver, and a heat engine/generator located at the focus of the dish to generate power. The Solar Program is not currently conducting any work on the third type of CSP system, power tower technologies.

Trough systems are best suited for large-scale power applications (30 - 200 MW plants) and have the valuable attribute of dispatchability due to their use of thermal storage. Dish-engine systems are well suited for distributed mini-grid applications ranging in size from 2 to 25 kilowatts (kW), but can also be configured for large power applications in the hundreds of megawatts. The prospects for CSP brightened considerably in FY 2005 with major announcements of four utility projects: the completion of a 1 MW power plant in Arizona, final preparations for a 64 MW plant in Nevada, and the initiation of two projects in California that, if built, would become the largest solar power plants in the world.

Benefits

The CSP subprogram contributes to the overall program goal by developing energy supply technologies that are reliable, affordable, and environmentally sound. Expanding our national electricity generation fuel portfolio will increase energy security by diversifying our domestic energy supply options for use both in normal and emergency situations.

The subprogram has recently benefited from several rigorous technology reviews which have established CSP as one of the most attractive renewable energy options in the U.S. Southwest, with a

cost target of $0.08-0.10/kWh by 2012, and the possibility of achieving $0.035-0.062/kWh, assuming increased Federal funding, initial market incentives and aggressive research and development.[a]

The CSP performance metric focuses on system efficiency, or the annual solar-to-electricity conversion efficiency of a CSP system. Using this measure will reflect the actual technical progress of the Solar Program, allow for improved verification and validation of results, and minimize the potential for target achievement disruption caused by market factors beyond the program's control.[b]

Similar to the relationship between conversion efficiency of PV modules and PV electricity cost, CSP system efficiency correlates strongly with the cost of electricity from CSP. As with PV efficiency measures, CSP system efficiency measures are by no means the exclusive factor affecting cost, but provide a valuable method of tracking technical progress. In addition, the Solar Program will continue to track cost data, as cost measures remain useful indicators of market trends and assist the program in responding to a changing marketplace. Therefore, the program is using a "hybrid" target for its work that emphasizes technical accomplishments, but maintains a strong connection to modeled, or projected, cost of energy from CSP.

U.S.-Produced Parabolic Trough System Efficiency Targets and Actuals

	Historic			Planned						
Annual Solar-to-Electric Conversion Efficiency (%)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
Target.....	n/a	n/a	n/a	11.9	13.1	13.4	13.7	14.0	14.2	14.6
Actual	11.1	11.9	11.9	-	-	-	-	-	-	-

[a] R. Charles, et al., "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts," Sargent & Lundy Consulting Group, SL-5641, May 2003.
[b] Market factors outside the program's control that could affect the achievement of cost goals include, but are not limited to, raw material costs, labor costs, currency exchange rates, interest rates, inflation, foreign competition, state and local regulations, and market participant withdrawals or entries.

The Solar Program uses the below historical cost data and projections as indicators of progress toward achieving program benefits.

CSP Solar Energy Cost Targets and Actuals[a]

Levelized Electricity Cost from CSP	Historic			Planned						
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Target	0.12-0.14	0.12-0.14	0.12-0.14	0.12-0.14	0.11-0.13	0.11-0.13	0.10-0.12	0.10-0.12	0.09-0.11	0.08-0.10
Actual	0.12-0.14	0.12-0.14	0.12-0.14	-	-	-	-	-	-	-

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Concentrating Solar Power	**5,873**	**7,342**	**8,775**

In FY 2007, the CSP subprogram will focus research in three main areas: advanced parabolic trough component development, dish/engine system reliability testing, and technical support for the Western Governors' Association 1,000 MW CSP initiative in the southwest.

For parabolic troughs, the top priority will be to provide technical support for the 64 MW trough project in Nevada and the 1 MW project in Arizona. Support will include optical testing for current industrial partners who are optimizing receiver and concentrator designs. There will be a competitive solicitation for next generation solar field technology components. In-house laboratory activities will include the development of improved receiver testing capabilities, advanced selective coatings, receiver maintenance systems, and optical characterization tools. Together these component improvements have the potential to significantly reduce the levelized cost of energy.

One attribute that makes CSP of particular interest to utilities is the ability to provide power when needed. It does this through the use of thermal energy storage. Work will continue on the development of advanced heat transfer fluids like organic salts that may allow for more efficient operation at higher temperatures (500º C vs. 390º C today). In addition, researchers will field test a single tank thermocline energy storage system that may offer a near term low-cost storage option for trough industry projects.

In dish/engine research, the laboratories will continue to work cooperatively with industry on their six-dish mini power plant at the industry/laboratory test facility in Albuquerque, New Mexico. Efforts will focus on engineering solutions to reliability issues related to the Stirling engine (e.g., valves, seals

[a] In this table, years indicate the years in which field verification of modeled cost occurs.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

and controls) while gaining valuable experience on the operation of multiple dishes in a power plant configuration. Researchers will also work with industry to improve the manufacturability of dish systems in preparation for upcoming projects.

Finally, DOE will continue analysis in support of the Western Governors Association (WGA) task force initiative to install between 1,000 and 4,000 MW of CSP in the U.S. Southwest within the next ten years. Laboratory and university researchers will provide technical and economic analysis to state-led task forces in California, New Mexico, Arizona, and Nevada, with emphasis on the regional coordination of utility consortia, which will consider transmission and policy issues. In addition, researchers will complete development of the regional CSP penetration analysis model with sensitivity to R&D and policy scenarios. (Funding for WGA: FY 2005 - $150,000; FY 2006 - $0; FY 2007 request - $200,000).

SBIR/STTR	**--**	**83**	**125**

In FY 2005, $107,000 and $0 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Concentrating Solar Power	**5,873**	**7,425**	**8,900**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Concentrating Solar Power	
Additional funding will support activities in the areas of solar field technology, thermal energy storage, and dish system reliability. In solar field technology, EERE will support optical testing with current industrial partners who are optimizing receiver and concentrator designs. In thermal energy storage, a single tank thermocline energy storage system will be field tested that may offer a near term low-cost storage option for trough industry projects. This activity will be initiated through a competitive solicitation with industry and utility participation. Finally, researchers will work with industry to improve the manufacturability of dish systems, consistent with RDIC guidelines regarding funding activities that work to eliminate market barriers and incorporate industry involvement	+1,433

	FY 2007 vs. FY 2006 ($000)
SBIR/STTR	
No significant change	+42
Total Funding Change, Concentrating Solar Power	**+1,475**

Solar Heating and Lighting

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Solar Heating and Lighting	2,418	1,444	0
SBIR/STTR	--	21	0
Total, Solar Heating and Lighting	2,418	1,465	0

Description

The Solar Heating and Lighting (SHL) subprogram develops solar technologies that provide hot water and hybrid solar lighting for residential and/or commercial buildings in collaboration with industry partners. The program has achieved most of its research goals and the technology is now sufficiently developed for use in Southern climates that it can now be transferred to industry for commercialization. The R&D on solar water heaters suitable for non-freezing climates will be completed in FY 2006 and the technology and knowledge base will be transferred to industry. In addition, the development of hybrid solar lighting has reached a point where the second generation of the technology was installed and evaluated at several sites during FY 2006, providing industry with much of the information necessary to determine a commercialization strategy. No funds are requested for SHL in FY 2007.

Benefits

There are no benefits associated with SHL beyond FY 2006 as the subprogram is being terminated.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Solar Heating and Lighting	**2,418**	**1,444**	**0**
All research and development on non-freezing climate solar water heaters will be completed by FY 2006.			
SBIR/STTR	**--**	**21**	**0**
In FY 2005, $50,000 and $0 were transferred to the SBIR and STTR programs respectively. The FY 2006 amount shown is the estimated requirement for the continuation of the SBIR and STTR programs.			
Total, Solar Heating and Lighting	**2,418**	**1,465**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Solar Heating and Lighting	
No funding is requested for FY 2007 due to the achievement of non-freezing climate water heater performance targets in FY 2006, consistent with RDIC guidelines regarding commercialization of technologies and the use of off-ramps in the research agenda	-1,444
SBIR/STTR	
No significant change.	-21
Total Funding Change, Solar Heating and Lighting	**-1,465**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	10,120	14,256	0
Total, Congressionally Directed Activities	10,120	14,256	0

Description

In general, Congressionally Directed activities do not support program goals because such activities do not result from the program's multi-year planning effort, which is focused on overcoming technical barriers.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2006, there were 11 Congressionally Directed activities funded out of the Solar Energy Program. The program does not request any funds to continue these projects as they do not further the achievement of DOE's goals. The following projects were directed by Congress to be included in this program:

Evaluation of Solar-Powered Thermo-Chemical Project of Hydrogen, UNLV	**4,464**	**0**	**0**

In FY 2005, the U.S. Congress directed funds to assist the University of Nevada – Las Vegas with solar-powered thermo-chemical hydrogen activities.

Photonics Research and Development, UNLV	**1,488**	**2,475**	**0**

In FY 2005, the U.S. Congress directed funds to assist the University of Nevada – Las Vegas with photonics research and development activities.

Conductive Coatings for Solar Cells Project	**1,488**	**1,485**	**0**

In FY 2005, the U.S. Congress directed funds to assist with conductive coatings for solar cells activities.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Yucca Valley Project	**248**	**0**	**0**

In FY 2004 and FY 2005, the U.S. Congress directed funds to assist the Yucca Valley Project (Yucca Valley, California) with solar energy activities.

Solar Technology Center, UNLV	**744**	**0**	**0**

In FY 2005, the U.S. Congress directed funds to assist the Solar Technology Center, UNLV with solar energy activities.

University of Louisville Sustainable Buildings Project	**397**	**0**	**0**

In FY 2005, the U.S. Congress directed funds to assist the University of Louisville (Louisville, Kentucky) with solar energy activities.

National Center on Energy Management and Building Technologies	**1,291**	**0**	**0**

In FY 2005, activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.

Rensselaer Polytechnic Institute Syracuse University "Green Building"	**0**	**742**	**0**

In FY 2006, the U.S. Congress directed funds to assist Rensselaer Polytechnic Institute (RPI), in Troy, New York, and Syracuse University, in Syracuse, New York, with "green building" activities.

Crowder College Alternative Renewable Energy Center	**0**	**990**	**0**

In FY 2006, the U.S. Congress directed funds to assist Crowder College, in Neosho, Missouri, in solar energy activities within the college's alternative renewable energy center.

University of Arkansas Research in Solar Energy Field	**0**	**495**	**0**

In FY 2006, the U.S. Congress directed funds to assist the University of Arkansas with solar energy activities.

Oregon Nanoscience and Microtechnologies Institute	**0**	**1,485**	**0**

In FY 2006, the U.S. Congress directed funds to assist the Oregon Nanoscience and Microtechnologies Institute in their research and commercialization efforts to accelerate innovation-

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
based economic development in Oregon and the Pacific Northwest.			
Ultra Thin Film Photovoltaic Charging System.....	**0**	**990**	**0**
In FY 2006, the U.S. Congress directed funds to assist Coherent Systems International Corporation, in Tampa, Florida, with ultra thin-film photovoltaic charging system research activities.			
Brightfield Solar Energy.....	**0**	**693**	**0**
In FY 2006, the U.S. Congress directed funds to assist the city of Brockton, Massachusetts with ongoing "brightfield" solar activities.			
National Orange Photovoltaic Demonstration	**0**	**446**	**0**
In FY 2006, the U.S. Congress directed funds to assist the National Orange Show Events Center, in San Bernardino, California, with photovoltaic demonstration activities.			
Sandia National Lab Development Of Advanced Cells and Modules	**0**	**990**	**0**
In FY 2006, the U.S. Congress directed funds to assist Sandia National Laboratory in the development of advanced photovoltaic cells and modules.			
Sandia National Lab Megawatt Demonstration Concentrating Solar Project.....	**0**	**3,465**	**0**
In FY 2006, the U.S. Congress directed funds to assist Stirling Energy Systems in the deployment of a 1-megawatt concentrating solar power system at or near Sandia National Laboratory.			
Total, Congressionally Directed Activities.....	**10,120**	**14,256**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal.....	-14,256
Total Funding Change, Congressionally Directed Activities.....	**-14,256**

Wind Energy

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Wind Energy					
Technology Viability	25,961	18,538	-185	18,353	35,905
Technology Application	10,111	7,711	-77	7,634	7,914
Congressionally Directed Activities	4,559	13,000	-130	12,870	0
Total, Wind Energy	40,631[b]	39,249	-392	38,857	43,819

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act (EPCA)" (1975)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act" (1990)
P.L. 102-4486, "Energy Policy Act (EPACT)" (1992)
P.L. 109-190, "Energy Policy Act" (2005)

Mission

The mission of the Wind Energy Program is to lead the Nation's research and development efforts to improve wind energy technology through public/private partnerships that enhance domestic economic benefit from development, and to address barriers to the use of wind energy in coordination with stakeholders, resulting in greater energy security through more diverse, clean, reliable, affordable and secure domestic supply.

Benefits

The Wind Energy Program's mission and activities contribute directly to EERE's and DOE's mission of improving national, energy and economic security and address the President's National Energy Policy call for increasing the diversity of our Nation's energy resources. The Wind Energy Program has successfully graduated its high speed wind effort, meeting its cost of energy goal of 3 cents/kWh in Class 6 winds in 2004. Since 2002, the program has focused most of its efforts on low wind speed technologies and, through its public/private partnerships, has improved the cost of energy for large systems in Class 4 onshore winds from 5.5 cents in 2002 to 4.3 cents in 2005, based on modeling of a composite turbine that includes improved and new technology. Based on recent emergence of U.S. offshore wind power development prospects and assessment of potential national benefits, the program is also supporting R&D for reducing the cost of offshore systems. Achieving the Wind Energy Program's mission will enhance the competitiveness of wind energy in conventional and higher

[a] Includes a rescission of $392,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $570,000 was transferred to the SBIR program and $70,000 was transferred to the STTR program.

population density electricity markets, growing the domestic energy supply resource in areas of greatest need, yielding environmental benefits by avoiding pollutant emissions and benefiting the Nation's infrastructure posture by reducing economic effects of fuel price or supply disruptions and increasing system reliability.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Wind Energy Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Wind Energy Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.05.00.00: Wind Energy. By 2016, complete program technology research and development, collaborative efforts, and provide the technical support and outreach needed to overcome barriers – energy cost, energy market rules and infrastructure, and energy sector acceptance – to enable wind energy to compete with conventional fuels throughout the Nation in serving and meeting the Nation's energy needs.

Contribution to Program Goal 04.05.00.00 (Wind Energy)

The Wind Energy Program's key contribution to General Goal 4, Energy Security, is through supply growth and diversification. The Wind Energy Program focuses on developing new, cost-effective technologies through research and development with competitively selected public/private partnerships and by facilitating the installation of wind systems by providing supporting research in power systems integration, technology acceptance and other analytical and engineering support. Key technology pathways that contribute to achievement of these benefits include (annual performance indicators are provided in the individual technology benefits narrative):

- Low Wind Speed Technology (LWST):
    - By 2012, reduce the cost of electricity from large wind systems in Class 4 winds to 3.6 cents/kWh for onshore systems (from a baseline of 5.5 cents/kWh in 2002);
    - By 2014, reduce the cost of electricity from large wind systems in Class 6 winds to 5 cents/kWh for shallow water (depths up to 30 meters) offshore systems (from a baseline of 9.5 cents in FY 2005); and
    - By 2016, reduce the cost of electricity from large wind systems in Class 6 Winds to 5 cents/kWh for transitional (depths up to 60 meters) offshore systems (from a baseline of 12 cents in FY 2006).

- Distributed Wind Technology (DWT)[a]: By 2007, reduce the cost of electricity from distributed wind systems to 10-15 cents/kWh in Class 3 wind resources, from a baseline of 17-22 cents/kWh in 2002. [Note: a range of cost performance targets are most appropriate for distributed wind systems, which require an approach based on relative improvement within scale, application, and market segments. The 10 cent/kWh target corresponds to a 50-100 kW turbine that is typical for large farms, small to mid-size commercial and/or remote village applications. The 15 cent/kWh target corresponds to a 3-10 kW turbine for residential applications.]
- Technology Acceptance: By 2010, facilitate the installation of at least 100 MW of wind in at least 30 States from a baseline of 8 States in 2002.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.05.00.00, Wind Energy			
Technology Viability	25,961	18,353	35,905
Technology Application	10,111	7,634	7,914
Subtotal, Program Goal 04.05.00.00, Wind Energy	36,072	25,987	43,819
All Other			
Congressionally Directed Activities			
St. Francis, Pennsylvania Wind Farm Feasibility Study	521	0	0
North Dakota Hydrogen Wind Pilot Project	496	495	0
Great Plains Wind Energy Transmission Development Project	496	0	0
Alaska Wind Energy	1,488	1,485	0
Renewable Energy for Rural Economic Development Program, Utah State University	496	495	0
Iowa Lakes Community College Wind Turbine Project	496	0	0
National Center for Energy Management and Building Technologies	566	0	0
Mt. Wachusett Community College Wind Project	0	990	0
Wyandotte Wind Energy on Brownfields Initiative	0	990	0
Illinois State University Wind Energy Resources	0	990	0

[a] Goals using Cost of Energy are tracked to a fixed technology baseline that reflects a set of standard financial and technology assumptions for each technology (Onshore, Offshore and Distributed Wind Technologies). Cost of energy targets differ from actual market conditions, as baseline technology assumptions do not include such factors as the on and off nature of the Production Tax Credit that leads to turbine demand spikes; varying financial variables; fluctuating commodity prices and currency exchange rates; and changes in expected equipment life.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Texas Tech. University Great Plains Wind Power Facility	0	1,485	0
Brigham City Turbine	0	990	0
TowerPower Wind Project	0	743	0
White Earth Tribal Nation Wind Project	0	990	0
Coastal Ohio Wind Project	0	990	0
Randall's and Ward's Island Wind Project	0	990	0
Synchronous Wind Turbines	0	495	0
Fox Ridge Renewable Energy Education Center	0	495	0
PowerJet Wind Turbine Project	0	247	0
Total, Congressionally Directed Activities	4,559	12,870	0
Total, All Other	4,559	12,870	0
Total, General Goal 4 (Wind Energy)	40,631	38,857	43,819

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results[a]	FY 2006 Targets[a]	FY 2007 Targets[a]
Program Goal 04.05.00.00 (Wind Energy)					
Technology Viability/Low Wind Speed Technology					
	Complete low wind speed turbine conceptual design studies, and fabricate and begin testing advanced wind turbine components optimized for low wind speed application initiated under industry partnership projects. [MET]	Complete testing of prototypes of first advanced low wind speed technology components, and complete detailed design under first public-private partnership project for full system low wind speed turbine development. [MET]	Low Wind Speed Technology (LWST): Complete fabrication and begin testing advanced variable speed power converter. Test first advanced blade, incorporating improved materials and manufacturing techniques. Field test the first full-scale Low Wind Speed Technology prototype turbine. This contributes to the Annual LWST COE Target: 4.3 cents per kWh in Class 4 winds. [MET]	Low Wind Speed Technology (LWST): Annual COE Target: 4.2 cents per kWh in onshore Class 4 winds, and 9.3 cents per kWh for offshore systems in Class 6 winds.	Low Wind Speed Technology (LWST) Annual COE target: 4.1 cents per kWh in onshore Class 4 winds; 8.8 cents per kWh for shallow water offshore systems in Class 6 winds; and 11.8 cents per kWh for transitional offshore systems in Class 6 winds.
Technology Viability/Distributed Wind Technology					
			Distributed Wind Technology (DWT): Complete prototype testing of 1.8 kW Small Wind Turbine, finishing the International Electrotechnical Commission suite of tests for acoustics, power, durability, and safety. This contributes to the Annual DWT COE Target: 12-18 cents per kWh in Class 3 winds. [MET]	Distributed Wind Technology (DWT) COE Target: 11-16 cents per kWh in Class 3 winds.	Distributed Wind Technology COE Target: 10-15 cents per kWh in Class 3 winds.
Technology Application/Technology Acceptance					
			Technology Acceptance: 32 States with over 20 MW installed; 16 States with over 100 MW installed. [PARTIALLY MET]	Technology Acceptance: 19 States with over 100 MW wind installed.	Technology Acceptance: 22 States with over 100 MW wind installed.

[a] Annual targets using Cost of Energy are tracked to a fixed technology baseline that reflects a set of standard financial and technology assumptions for each technology (Onshore, Offshore and Distributed wind technologies). Cost of energy targets differ from actual market conditions, as baseline technology assumptions do not include such factors as the on and off nature of the Production Tax Credit that leads to turbine demand spikes; varying financial variables; fluctuating commodity prices and currency exchange rates; and changes in expected equipment life.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results[a]	FY 2006 Targets[a]	FY 2007 Targets[a]
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($18,371K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Wind Energy Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Wind Energy Program will implement the following means:

- Supporting public/private partnerships for multiple large wind system technology pathways (> 100 kilowatts) to achieve the goal of 3.6 cents/kWh for onshore systems; 5 cents/kWh for shallow water offshore systems in Class 6 winds by 2014, and 5 cents/kWh in Class 6 winds for transitional offshore systems by 2016.
- Under the Distributed Wind Technology (DWT) activity, the program will complete and document public/private partnership efforts for meeting its 10-15 cents/kWh for small scale turbines in Class 3 wind speed areas.
- Use of Systems Integration analysis and model development to facilitate addition and operation of wind energy technologies with the electric power system, to develop information to assure fair treatment of wind energy by power system operators, transmission owners and regulators; and to mitigate barriers.

The Wind Energy Program will implement the following strategies:

- The public/private partnership projects of its three elements (onshore, shallow water offshore, and transitional offshore) are phased to peak in respective succession, thus shifting emphasis over time within the overall funding level. These public-private partnerships are a phased technology development strategy that will enable cost-effectively harnessing an increasing share of the Nation's wind resource base.
- Following its success with high speed wind onshore technologies (onshore Class 6 technology development completed in FY 2004), the program changed focus to development of wind turbines that can operate economically in areas of the country with lower (Class 4[a]) wind resources, thereby increasing the total amount of economically viable wind energy resource by a factor of twenty, and reducing the average distance from source to load centers by a factor of five. This work continues with the Low Wind Speed Technology onshore effort.

[a] The following table defines wind classes and their relative significance to energy production potential.

	(Wind Class)			
	6	5	4	3
Wind speed (annual average wind speed in miles per hour at 33 feet above the ground)	15	14	13	12
Relative Energy Content at Different Wind Classes (percent)	100	81	66	49

- In recent years, increasing program attention has been directed toward offshore technologies to enable harnessing immense wind resources relatively close to many of the Nation's largest population centers. In FY 2005, the program began offshore system technology development under the Low Wind Speed Technology (LWST) project. DOE estimates an offshore resource base of approximately 1,000 GW, after excluding two-thirds of the area from 5 to 20 nautical miles from shore and one-third of the area from 20 to 50 nautical miles from shore.[a] Offshore wind technology could enable harnessing abundant wind resources near major hard-to-serve load centers, such as in the Northeastern and Mid-Atlantic United States. The shallow water (<30 meter depth) offshore wind technology goal of 5 cents/kWh in Class 6 winds by 2014 is expected to lead to commercial viability of approximately 5 percent of the U.S. offshore wind resource base between 5 and 50 nautical miles from shore. Commercially viable sites for shallow water offshore technology would be primarily located in the Northeastern and Mid-Atlantic United States. This activity will be enhanced in FY 2007 with the addition of technology development for transitional (<60 meter depth) offshore sites, to expand the commercially viable U.S. offshore wind resource base to approximately 25 percent of the 5-50 nautical mile coastal band. Transitional offshore wind technology would greatly increase Northeastern and Mid-Atlantic resource viability, as well as viability of a substantial portion of Great Lakes sites. Preliminary efforts will also be undertaken to explore technology requirements and options for deep water (> 60 meters), over-the-horizon technology that could lead to commercial viability of offshore wind in approximately 75 percent of the Nation's 5-50 nautical mile coastal band.
- The Department will complete its activities supporting development of small wind turbines (100 kilowatts or less) under the Distributed Wind Technology project that can serve a range of high-valued, distributed power applications. These applications include supplemental on-site power generation for grid-connected suburban and rural residences, farms, and businesses; stand-alone power supply in conjunction with hybrid system technologies to serve remote or island energy needs; and dedicated power for applications such as water pumping and ice making. Substantial markets for residential and small business applications in the United States are expected to open with emerging state incentive programs, reduced institutional barriers, and improved technology, as detailed in the U.S. Small Wind Turbine Industry's Roadmap.[b]
- The program expects that these strategies will result in significant cost savings and a significant reduction in the cost of wind technology, improving energy security by increasing the generation of reliable, affordable and environmentally sound wind energy, adding to the diversity of the Nation's energy supply and reducing the demand for natural gas.

The following external factors could affect the Wind Energy Program's ability to achieve its strategic goal:

- the availability of conventional energy supplies;
- the cost of competing technologies;
- fluctuating material costs (i.e., steel, cable and concrete) and exchange rates;
- state and international efforts to support wind energy;

[a] "Large-Scale Development of Offshore Wind Power in The United States 2004 to 2020", Walter Musial, draft NREL Technical Paper, expected to be published fall 2005.
[b] The U.S. Small Wind Turbine Industry Roadmap: A 20-year Industry Plan for Small Wind Turbine Technology. American Wind Energy Association Small Wind Turbine Committee, June 2002.

- Federal, state and regional regulatory actions affecting offshore wind installations;
- continuation of Federal tax incentives; and
- implementation of other policies at the national level, including Federal efforts to reduce carbon and criteria emissions.

In carrying out the program's mission, the Wind Energy Program collaborates in several important activities including:

- program activities dependent upon outputs from academia, manufacturers, developers, and National Laboratories (e.g., the Offshore Wind Collaborative, a joint Federal/state/industry/academia collaboration to address barriers to U.S. offshore wind development);
- systems integration, with the DOE Office of Electricity Distribution and Energy Reliability, and the electric transmission and distribution system industry on policy and R&D issues;
- industry and R&D directions for the production of hydrogen for energy use;
- cooperative research and development with the International Energy Agency (IEA); and
- peer review of the Wind Energy Program's overall strategies and its activities by academia, manufacturers and National Laboratories and with independent experts.

Validation and Verification

To validate and verify program performance, the Wind Energy Program will conduct internal and external reviews and audits. The table below summarizes validation and verification activities.

Data Sources:	Musial, W.D.; Butterfield, C.P.; Jonkman, J.; Cohen, J.; Ram, B.; Schwartz, M. "Large-Scale Development of Offshore Wind Power in the United States," NREL, to be published March 2006. "Assessment of Potential Improvements in Large-Scale Low Wind Speed Technology," J. Cohen, Proceedings of Global Wind Power 2004, Chicago, Illinois, March 28-31, 2004, published by American Wind Energy Association. Low Wind Speed Turbine Technology Characterization, Migliore and Cohen, presented at Wind Power 2003; Wind Energy Technology Characterization, 1997, published by EPRI. Low Wind Speed Turbine Technology Benefits, internal analysis for the FY 2002 request, peer reviewed by A.D. Little. FY 2001, FY 2002, FY 2003 and FY 2004 Wind Energy Program Peer Reviews. American Wind Energy Association (AWEA)/Global Energy Concepts Wind Plant Database, reviewed by EIA, contain proprietary data. Various published and confidential data on wind projects economics. AWEA Small Wind Turbine Industry Roadmap.
Baselines:	Low Wind Speed Technology: 5.5 cents/kWh in FY 2002 for onshore applications in Class 4 winds; 9.5 cents/kWh in FY 2005 for shallow water offshore applications in Class 6 winds; and 12 cents/kWh for transitional offshore applications in FY 2006 in Class 6 winds. Distributed Wind Technology: 17-22 cents/kWh in FY 2002 in Class 3 winds. Technology Application: 8 States with at least 100 MW installed wind in FY 2002.
Frequency:	Annual.

Data Storage: Web, paper publications and on-line storage.

Evaluation: In carrying out the program's mission, the Wind Energy Program uses several forms of evaluation to assess progress and to promote program improvement.

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the Wind Energy Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), RDIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common Government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Verification: Activities and accomplishments will be verified by monthly reports from contractor/National Laboratories, including NREL, and from lead program field elements. Determining the cost of energy (COE) for LWST and DWT goals will be derived from the impact of improvements in individual components and subsystems based on comparisons against a baseline turbine composite with a well-understood cost of energy. Determining the number of States with over 100 MW of wind for the Technology Acceptance goal will come from U.S. capacity statistics regularly collected by the National Energy Renewable Laboratory through subcontract. Reporting will be done on a quarterly basis to DOE from NREL.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Wind Energy Program has incorporated feedback from OMB into the FY 2007 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The 2002 PART review of the Wind Energy Program contained a recommendation to continue emphasis on wind technology development for low wind speed areas; Low Wind Speed Technologies are the Wind Energy Program's budget focus. Another PART recommendation suggested the development of practical, but meaningful annual performance measures; the Wind Energy Program has developed annual performance targets for its three PART goals and Budget technology pathways (see the section, "Contribution to Program Goals"), covering about 90 percent of its budget request. The Wind Energy

Program is also attempting to adhere to the specific direction of Congressional appropriation language while increasing the contribution to program goals to the extent possible. These improvements in accountability were reflected in the Wind Energy Program's significantly improved 2003 score in the results/accountability area, resulting in a modest overall score improvement, and a "moderately effective" rating, the second highest rating possible.

The 2003 PART found that the program has a clear purpose, strong planning and management. OMB gave the program fairly high scores (80%), (80%), and (88%) respectively, in Purpose, Planning, and Management. A lower score (67%) in Results/Accountability is being addressed by better performance measures. The PART report findings acknowledged the role of the program in commercial success of high wind speed technologies and report findings to greater focus on low wind speed technologies, reflected in the budget priorities.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. The applied R&D programs in DOE have developed common baselines, assumptions and more consistent methods for generating their benefits estimates. But benefits estimates are not comparable across the entire applied R&D portfolio. DOE will continue to address this finding corporately.

Expected Program Outcomes

The Wind Energy Program pursues its mission through integrated activities designed to increase the use of domestic renewable resources. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic energy supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the Wind Energy Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of non-renewable annual energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and wind electricity capacity additions that result from the realization of Wind Energy Program goals are shown in the tables below through 2050.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals. Also note that the modeling long term benefits assumes that funding levels will be consistent with the President's commitment and assumptions in the 2007 Budget, and that funding will be applied to the core program.

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[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

If the pattern of substantial congressionally directed projects persists over several years, the GPRA benefits estimates will need to be reduced.

The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html.

FY 2007 GPRA Benefits Estimates for Wind Energy Program[a]

Mid-Term Benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	ns	0.14	1.60	3.10
Energy expenditure savings (Billion 2003$)	ns	1	11	18
Carbon emission reductions (MMTCE)	0	3	34	69
Natural gas savings (Quads)	ns	0.10	0.48	0.83
Program specific electric capacity additions (GW)	0	6	53	100

Long-Term Benefits[d]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	2.12	3.57	3.85
Energy system net cost savings (Billion 2003$)	2	2	2
Carbon emission reductions (MMTCE)	47	95	101
Natural gas savings (Quads)	0.63	-0.32	-0.16
Program specific electric capacity additions (GW)	66	99	127

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the Program's technical targets are achieved and funding continues at levels consistent with assumptions in the FY 2007 Budget.
[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.
[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.
[d] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Technology Viability

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Viability			
Low Wind Speed Technology (Large Systems)	9,854	5,041	19,142
Distributed Wind Technology (DWT – Small Systems)	1,908	538	481
Supporting Research and Testing (SR&T)	14,199	12,268	15,310
SBIR/STTR	--	506	972
Total, Technology Viability	25,961	18,353	35,905

Description

Technology Viability focuses on developing new, cost-effective technologies through research and development using competitively selected public/private partnerships (Low Wind Speed Technology and Distributed Wind Technology projects) closely coordinated with Supporting Research and Testing conducted by National Laboratories.

Benefits

The Technology Viability key activities focus on research and development for improving the cost effectiveness of large and small wind energy systems, which is a primary barrier to wind energy competing without disadvantage to serve the Nation's energy needs. Reducing the cost of energy of large and small wind systems will help meet the Wind Energy Program's goals and, in turn help wind energy compete without disadvantage in energy markets. The Distributed Wind Technology goal will be completed as expected in FY 2007.

The following table provides expected annual indicators of progress for the LWST and DWT activities in cents/kilowatt-hour:

	(fiscal year)														
	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Low Wind Speed Technology – Onshore (Class 4)															
Target	5.5	5	4.6	4.3	4.2	4.1	4	3.9	3.8	3.7	3.6				
Actual	5.5	5	4.4	4.3											
Low Wind Speed Technology – Shallow Offshore Systems (Class 6)															
Target				9.5	9.3	8.8	8.2	7.5	6.9	6.3	5.8	5.3	5		
Actual				9.5											

(fiscal year)

	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Low Wind Speed Technology – Transitional Offshore Systems (Class 6)															
Target					12	11.8	11.5	10.8	9.5	8.3	7.3	6.3	5.6	5.2	5
Actual															
Distributed Wind Technology (Class 3)															
Target	17-22	14-20	13-19	12-18	11-16	10-15									
Actual	17-22	14-20	13-19	12-18											

The Wind Energy Program also has developed a methodology for measuring and tracking program performance. Levelized COE, in constant dollars, is the primary performance indicator for the LWST and DWT efforts. Achieving the planned COE target will be possible through the Technology Improvement Opportunities being addressed by the portfolio of LWST, DWT, and Supporting Research and Testing (SR&T) efforts. Cost of energy estimates for full-scale prototypes are based on industry experience in maturation of technologies and manufacturing processes. Determining the COE impact of improvements in individual components and subsystems are based on comparisons against a baseline turbine composite with a well-understood cost of energy. On a yearly basis throughout the course of the LWST and DWT projects, the impact of technology improvements is assessed and the results peer-reviewed. Forecasts of COE impact is based on progress of existing subcontracts and results of research efforts at the time of the assessment, thereby allowing a clear picture of the impact of improvements against the overall goals and objectives. The methodology is available in the *Wind Energy Program Multi Year Technical Plan for 2004 – 2010* at www.eere.energy.gov/windandhydro/.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Low Wind Speed Technology (LWST - Large Systems)...	**9,854**	**5,041**	**19,142**

The Low Wind Speed Technology (LWST) project supports public/private partnerships for multiple large wind system technology pathways (turbines over 100 kilowatts) to achieve the goals of 3.6 cents/kWh for onshore systems in Class 4 winds and 5 cents/kWh for shallow water offshore systems in Class 6 winds by 2014, and 5 cents/kWh for transitional offshore systems in Class 6 winds by 2016.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

For onshore systems, public/private partnerships to catalyze industry adoption of technology developments and emerging innovation, in collaboration with National Laboratory expertise, are supported through a series of three LWST competitive solicitations - Phase I was initiated in FY 2002 (expected completion in FY 2009), Phase II began in FY 2004 (expected completion in FY 2010), and Phase III is planned to commence in FY 2008. These concentrate on three technical areas: 1) conceptual design studies, 2) component development and testing; and 3) full turbine prototype development and testing. To date, the LWST onshore portfolio includes two partnerships for full turbine prototype development, six for components, and ten conceptual design studies. In FY 2005, the first 2.5 MW prototype LWST turbine commenced field operation and testing.

For offshore systems, a similar approach is taken to supporting technology development and innovation through public/private partnerships and collaboration with National Laboratories. There is one partnership to develop a full turbine system prototype. Two concept studies have been completed that target transitional and/or deep water offshore systems, and one concept study has been completed for an advanced offshore atmospheric measurement system. A laboratory led, industry supported transitional and deep water offshore systems study project was initiated in FY 2006 to examine system design tradeoffs across ranges of size, configuration, and available technology innovations, for transitional and deep water systems. These studies will narrow the range of viable options and establish sustainable links to the existing offshore industries. The project will lead to the establishment of a design basis for offshore wind systems, characterizing wind and wave loads, developing and verifying dynamics modeling capability, and assessing marinization and anchoring technologies. This effort will focus the development of a public/private technology development solicitation, leading to cost-shared awards planned for FY 2008. In addition, an offshore turbine field verification project is underway to collect and analyze performance and design verification data from operating offshore projects, to validate analysis tools and direct technology development efforts.

The LWST portfolio and related Supporting Research and Testing activities are continuously coordinated to facilitate technology transfer and transition conceptual design and component projects into full system development. LWST projects will be periodically reviewed against analytically established performance measures to provide the basis for funding and planning adjustments needed to optimize the portfolio for success.

In 2007, the following major milestones are expected under the onshore technology development effort: 1) the acquisition process will be initiated for a Phase III LWST project solicitation for component technology development to enhance the performance of existing low wind speed turbines; and 2) a new sweep-twist adaptive blade for LWST rotor applications will be fabricated.

Under the shallow water offshore technology development effort, the following major milestones are expected in FY 2007: 1) conceptual design studies for an optimized offshore prototype turbine will be completed under a public/private partnership subcontract; and 2) the acquisition process for the next round of shallow offshore component and turbine prototype technology development partnerships will be initiated.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

Under the transitional offshore technology development effort, the following major milestones are expected in FY 2007: 1) laboratory and industry tradeoff studies will be completed to identify preferred wind turbine and support structure pathways and infrastructure requirements; and 2) the acquisition process will be initiated for cost-shared public/private partnerships to develop component and full system prototypes consistent with the preferred pathways.

Distributed Wind Technology (DWT - Small Systems).....	**1,908**	**538**	**481**

The Distributed Wind Technology (DWT) project has supported public-private partnerships for multiple small wind system technology pathways (turbines less than or equal to 100 kilowatts) to achieve the program goal of 10-15 cents per kilowatt-hour in Class 3 resources by 2007. This activity is expected to be largely completed in FY 2006, and FY 2007 activities will focus on completion and final documentation of DWT partnership projects.

Supporting Research and Testing (SR&T)	**14,199**	**12,268**	**15,310**

Supporting Research and Testing (SR&T) is composed of three key program elements that directly support development of Low Wind Speed Technology (LWST): Design Review and Analysis, Enabling Research, and Testing Support. SR&T provides technical support essential to the LWST public/private partnerships by engaging the capabilities of the National Labs, universities and other technical support available in private industry.

The Design Review and Analysis task ensures that improved products resulting from advances in R&D are developed in a logical and safe manner and in compliance with the applicable international certification standards — a vital step in mitigating the risk of market acceptance for LWST output technology.

Enabling Research activities in advanced rotor development, drive train and power systems, inflow and site characterization, and systems and controls provide the technical improvements in components and integrated systems needed to support both onshore and offshore LWST projects. Characterization of the design environment, improved computer simulation codes, advanced components, and integrated systems and controls are the main product outputs.

The third program element, Testing Support, includes both facility and field tests of all newly developed LWST and DWT components and systems to ensure design and performance compliance. Structural testing of blades up to 45 meters in length and fully integrated power drive train tests, up to 2.5 MW, are accomplished in the controlled environments of the Industrial User Facility (IUF) and Dynamometer Test Facility (DTF). Field testing of fully integrated prototypes in actual wind farms and distributed power applications provides the final validation of the LWST and DWT designs.

SR&T also includes funding required for operation and management of the National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL) for specialized engineering test facilities and equipment that directly support LWST public-private technology development partnerships, and to support staff, facilities and Technology Application activities. SR&T funding also provides a

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

number of cross-cutting functions for supporting the achievement of the program's goals. These include systems analysis to track improvements in wind technology in diverse applications; assessment of future improvements in cost performance of wind technology (i.e., technology characterization); investigation of technical, environmental, and institutional issues to address near-term barriers for industry; preparation and updating of Multi-Year Technical Plans; development of inputs and analysis to respond to analytical and reporting requirements involved with GPRA, PART, RDIC and other management tools and process; and participation in development of domestic and international design standards for wind turbines. Capital equipment expenditures of approximately $1,000,000 are planned by the National Renewable Energy Laboratory for FY 2007. Performance is measured for R&D activities using analytically-established targets linking contributions from each activity to meeting LWST program goals. Outputs of this activity include periodic design reviews and conduct of tests at industry and laboratory locations.

SR&T activities in FY 2007 include: completing commissioning of Controls Advanced Research Turbine test facility; developing condition monitoring tools that improve the ability to diagnose and fix wind turbine maintenance requirements; completing the assessment of using laser-based anemometry for turbine inflow analysis and wind turbine control; modifying design codes to include the ability to analyze floating platform stability and wind turbine controls in the offshore environment; and mapping of offshore resources for 2 major prospective U.S. offshore wind power development regions.

SBIR/STTR.....	**--**	**506**	**972**

In FY 2005, $570,000 and $70,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Technology Viability.....	**25,961**	**18,353**	**35,905**

Explanation of Funding Changes

FY 2007 vs. FY 2006 ($000)

Low Wind Speed Technology

The increase supports offshore system technology development activities, including increased funding requirements for shallow water partnerships projects to support hardware fabrication and testing, industry partnership studies to assess transitional offshore system design tradeoffs and technology development challenges, and cost-shared offshore turbine performance monitoring and verification projects.

	FY 2007 vs. FY 2006 ($000)
This is supported by the PART recommendation to continue emphasis on low wind speed areas	+14,101
Distributed Wind Technology	
The decrease is due to the completion of the bulk of activities in FY 2006, with FY 2007 activities focused on documentation and closeout of DWT partnerships	-57
Supporting Research and Testing	
Increase supports additional offshore system support activities including integrated turbine/platform dynamic modeling capability development, resource assessment and field verification, and development of capability to support offshore turbine testing	+3,042
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	+466
Total Funding Change, Technology Viability	**+17,552**

Technology Application

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Application			
Systems Integration	2,665	2,411	3,970
Technology Acceptance	3,815	2,646	3,856
Supporting Engineering and Analysis	3,631	2,481	0
SBIR/STTR	0	96	88
Total, Technology Application	10,111	7,634	7,914

Description

The Technology Application subprogram addresses opportunities and barriers other than turbine cost of energy concerning use of wind energy systems. Activities include Utility Systems Integration, which requires applied technical efforts for dealing with electrical grid operations and the inherent variability of the wind plant output, and development of mitigation strategies, as needed; and Technology Acceptance, which focuses on resolving institutional issues and providing energy sector outreach.

Benefits

Technology Application helps the program achieve its mission by focusing on the non-energy cost barriers that impede wind energy use in the United States. Helping stakeholders and officials within States understand wind energy technologies and how wind can be integrated into their state energy systems will in turn reduce institutional and regulatory barriers, helping wind to compete without disadvantage.

The following table provides expected annual indicators of progress for Technology Application:

	(fiscal year)										
	00	01	02	03	04	05	06	07	08	09	10
Technology Acceptance											
# of States with 100 MW Target			--	10	12	16	19	22	25	27	30
# of States with 100 MW Actual	4	7	8	10	12	15					

The Technology Application performance targets above are used as a way to measure the success of the Wind Energy Program's outreach activities. Since each State is a unique regulatory, policy and economic entity, reaching 100 MW installed capacity threshold is an important indicator that wind is being accepted as a large-scale generating option by the State's utilities, regulators, and investors.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Systems Integration	**2,665**	**2,411**	**3,970**

Systems Integration is comprised of efforts to enhance the compatibility of wind energy technologies with the electric power system, and to develop information to assure fair treatment of wind energy by power system operators, transmission owners and regulators and to mitigate barriers. System integration includes development of data on wind turbine and wind plant performance from onshore and offshore applications of interest to the power industry; analytical techniques to represent the wind plant in planning and operating tools used by the electric power industry; investigation of transmission tariffs and policies to ensure that wind projects are treated fairly, and transfer of this information and techniques to stakeholders in the power industry, including regional transmission operators, state and Federal regulators, wind plant operators and wind turbine manufacturers. The geographical scope of the activity ranges from distributed application, such as a 10 kW turbine interconnected with a rural cooperative farm, to isolated village power systems using wind and diesel power plants, to large wind plants covering several tens of square kilometers. The issues to be considered are largely the same for each scale of the wind project – issues arising from the compatibility of wind generation with the needs of the host power system for well-controlled voltage and stable electric power. Recent studies have shown that the additional cost to interconnect wind plants at moderate penetrations are on the order of 0.2 cents per kWh. These ancillary service costs are thought to increase slowly with increasing wind plant penetration, i.e., as wind supplies a greater fraction of the instantaneous demand.

Systems Integration also includes consideration of how wind energy competes in the competitive marketplace and new applications such as wind-hydrogen production, desalination, purification and delivery of water, and wind/hydropower coordination to develop operating strategies to create improved economics and benefits for both technologies.

In FY 2007, several large scale operating studies will be undertaken in conjunction with regional transmission system, utility, and wind plant operators. Key inputs include improved resolution of wind plant hourly and subhourly output for typical years needed to observe the set of wind energy output variations that may challenge power system operators. Mitigation strategies will be developed for periods of adverse impact and guidelines will be developed for use by regional transmission organization (RTO) staff and wind plant operators. In addition, opportunities for improved tariffs such as flexible-firm for low capacity factor and variable output wind projects will be pursued to provide feedback to regulators and the community on how well this promising option works. Simulation tools previously developed to represent geographical diversity of several wind plants connected to the same power system will be evaluated in conjunction with industry and verified to provide an analytical basis for integration of larger amounts of wind energy. The geographic diversity and integration of offshore wind plants will also be investigated. The results of all of these investigations will be transferred to power industry regulators and stakeholders. Staff from at least two RTOs as well as state and Federal regulators will be engaged to transfer results of these activities and to provide feedback on their usefulness. In addition, regional transmission consortia will be encouraged to explore wind energy development and develop scenarios for deployment to be used in RTO planning studies. Feedback on performance of the Grid

(dollars in thousands)

	FY 2005	FY 2006	FY 2007

System Integration activity and need for further research will be sought from regional stakeholder and power system organizations.

Technology Acceptance	**3,815**	**2,646**	**3,856**

Technology Acceptance includes activities to build on the national R&D investment in wind technology through work with national stakeholder groups to move the technology into the power generation market. The Wind Powering America (FY 2005-$2,700,000, FY 2006-$2,200,000 and FY 2007-$3,100,000) component of Technology Acceptance addresses barriers to wind development at the national, state, and local levels. The focus is on facilitating the deployment of wind technology to bring economic benefits to the country; enhancing the use of domestic energy resources, including offshore wind resources; and stimulating sustainable tribal and rural-based energy sectors. Activities are conducted in partnership with utility generators, equipment manufacturers, project financiers and developers, public and private officials, regulators, industrial and public sector consumers, other Federal and state agencies, and citizen stakeholder groups to provide technical support, guidance, and information on national, regional, state, and local efforts to explore and develop their wind energy resources, both on land and offshore. Technology Acceptance also supports cooperative activities with utility-based and other key stakeholder organizations to expand access to wind resource data and to provide information on technical and institutional barriers to development. Performance for this activity is measured by tracking the number of States that have installations of 100 MW indicating that there is a considerable level of acceptance of in these States.

In FY 2007, activities will focus on continuing support for existing and emerging state wind working groups, particularly for States with viable offshore wind resources; tribal wind technical assistance on wind resources and project planning and development; partnership activities with agriculture-sector national and state organizations; collaboration with public power national and state-based organizations; community and rural schools project concepts; and small wind system support activities. FY 2007 performance targets for this activity: 22 States with at least 100 MW of wind installed.

Supporting Engineering and Analysis	**3,631**	**2,481**	**0**

The Supporting Engineering and Analysis (SE&A) activity has provided a number of cross-cutting functions for supporting the achievement of the program's goals. These include systems analysis to track improvements in wind technology in diverse applications; assessment of future improvements in cost performance of wind technology (i.e., technology characterization); investigation of technical, environmental, and institutional issues to address near-term barriers for industry; participation in development of domestic and international design standards for wind turbine design and testing, and operation and management of the National Wind Technology Center (NWTC) to support staff, facilities and Technology Application activities. Design review and testing support for the Underwriters Laboratories wind turbine certification program was discontinued in FY 2005.

For FY 2007, remaining Supporting Engineering and Analysis activities are being allocated to Technology Viability (analysis, design standards support, pro rata share of NWTC operations based on budget percentage) and Technology Application (wind project database, publications, outreach, pro rata

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

share of NWTC operations based on budget percentage) activities to allow appropriate tracking of funding with program goals.

SBIR/STTR.....	**0**	**96**	**88**

The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Technology Application.....	**10,111**	**7,634**	**7,914**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Systems Integration	
The increase is due to increased support for research related to higher wind penetration and technology support to transmission system operators, grid operators, and regulators as wind deployment expands, as well as addition of a portion of communications and NWTC Operations activities from Supporting Engineering and Analysis.....	+1,559
Technology Acceptance	
Increase reflects addition of support for state level technical assistance and outreach activities and associated laboratory analytic support, as well as addition of a portion of communications and NWTC Operations activities from Supporting Engineering and Analysis.....	+1,210
Supporting Engineering and Analysis	
Decrease reflects completion of certification support for Underwriters Laboratories, and transfer of continuing standards development, analysis, communications, and NWTC Operations activities to remaining program sub-elements as described under Detailed Justification.....	-2,481
SBIR/STTR	
No significant change	-8
Total Funding Change, Technology Application.....	**+280**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	4,559	12,870	0
Total, Congressionally Directed Activities	4,559	12,870	0

Description

In general, Congressionally Directed activities do not support program goals because such activities were not a result of the program's planning effort which is focused on overcoming technical barriers.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

There were a total of 15 Congressionally Directed activities in FY 2006. The program does not plan to request any in future years. The following projects were directed by Congress to be included in this program:

St. Francis, Pennsylvania Wind Farm Feasibility Study	**521**	**0**	**0**

Supports a wind energy education and training center at St. Francis University.

North Dakota Hydrogen Wind Pilot Project	**496**	**495**	**0**

Continuation of project to explore dynamic scheduling of wind power through the grid to supply electrolysis-based hydrogen production.

Great Plains Wind Energy Transmission Development Project	**496**	**0**	**0**

To support project at University of North Dakota Energy and Environmental Research Center for analysis of transmission requirements for wind power development in the Great Plains region.

Alaska Wind Energy	**1,488**	**1,485**	**0**

To support competitively selected wind projects in the State of Alaska.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Renewable Energy for Rural Economic Development Program, Utah State University	**496**	**495**	**0**
To support the Rural Economic Development Program at the university.			
Iowa Lakes Community College Wind Turbine Project	**496**	**0**	**0**
For installation of a wind turbine for the College which will be used for educating and training students about wind power.			
National Center for Energy Management and Building Technologies	**566**	**0**	**0**
In FY 2005, activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.			
Mt. Wachusett Community College Wind Project	**0**	**990**	**0**
To conduct tests on the feasibility of using wind power locally in Massachusetts.			
Wyandotte Wind Energy on Brownfields Initiative	**0**	**990**	**0**
To demonstrate feasibility of using wind on a brownfields site.			
Illinois State University Wind Energy Resources	**0**	**990**	**0**
To demonstrate the feasibility of wind energy in Illinois and develop related curriculum.			
Texas Tech. University Great Plains Wind Power Facility	**0**	**1,485**	**0**
To demonstrate feasibility of using wind for water resources application and other purposes.			
Brigham City Turbine	**0**	**990**	**0**
To determine and demonstrate feasibility of using wind for municipal applications.			
TowerPower Wind Project	**0**	**743**	**0**
To demonstrate feasibility of using wind for power-related applications.			
White Earth Tribal Nation Wind Project	**0**	**990**	**0**
To develop a wind energy project to help power community buildings on the reservation.			
Coastal Ohio Wind Project	**0**	**990**	**0**
To undertake activities in support of using wind in coastal applications.			

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Randall's and Ward's Island Wind Project	**0**	**990**	**0**
To determine feasibility of using wind for island-based application.			
Synchronous Wind Turbines	**0**	**495**	**0**
To determine use of advanced generator in wind turbine.			
Fox Ridge Renewable Energy Education Center	**0**	**495**	**0**
To determine feasibility of wind energy in rural application.			
PowerJet Wind Turbine Project	**0**	**247**	**0**
To determine use of advanced generator in horizontal-axis wind turbine.			
Total, Congressionally Directed Activities	**4,559**	**12,870**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal.	-12,870
Total Funding Change, Congressionally Directed Activities	**-12,870**

Geothermal Technology

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Geothermal Technology					
Technology Development	15,390	15,317	-153	15,164	0
Technology Application	6,186	4,232	-42	4,190	0
Congressionally Directed Activities	3,680	3,750	-38	3,712	0
Total, Geothermal Technology	25,256[b]	23,299	-233	23,066	0

Public Law Authorizations:

P.L 93-410, "Geothermal Energy Research, Development, and Demonstration Act of 1976"
P.L 95-91, "Department of Energy Organization Act (1977)"
P.L 95-618, "Energy Tax Act of 1978"
P.L 96-294, "Energy Security Act (1980)"
P.L 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L 102-486, "Energy Policy Act of 1992"
P.L. 109-190, "Energy Policy Act" (2005)

Mission

The mission of the Geothermal Technology Program ("Geothermal Program") was to work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. The Department plans to closeout the Geothermal Program in FY 2007 and transfer results of its research and development work related to geothermal technology to industry and the public sector.

Benefits

The Geothermal Program's mission and activities directly supported DOE's mission to promote scientific and technological innovation in support of advancing the national, economic and energy security of the United States. Industry application of technology and resources developed to date will continue to benefit the Nation.

The production tax credit mandated by the Energy Policy Act (EPAct 2005) will accelerate the development of new geothermal power plants. This is evident from the contracts for new geothermal

[a] Includes a rescission of $233,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $301,000 was transferred to the SBIR program and $40,000 was transferred to the STTR program.

power plants in 2005 which total over 500 megawatts. Two additional States, Idaho and Alaska, are expected to join California, Nevada, Utah, and Hawaii this year with operating geothermal power plants. EPAct 2005 directs the U.S. Forest Service and Bureau of Land Management to develop streamlined leasing and permitting processes for geothermal projects. EPAct 2005 also directs that 25 percent of royalties from geothermal projects go to local jurisdictions, thereby providing incentives for local governments to pursue and facilitate development.

While geothermal energy remains an important regional contributor to energy needs of the Nation, current EERE priorities are focused on technology development with broadly applicable and more readily accelerated public benefits. EERE funding for higher priority investments is consistent with key components of the R&D Investment Criteria guidance for incorporating technology "off-ramps," and supporting research with a clear public benefit and a path towards commercialization.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Geothermal Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Geothermal Program had one goal which contributed to General Goal 4 in the "goal cascade":

Program Goal 04.07.00.00: Geothermal. With the completion of final reporting on funded projects, the Geothermal Program's goal is to closeout this program and to effectively transition remaining program activities and information (e.g., R&D results, technical data and findings) to private/public sector programs.

Contribution to Program Goal 04.07.00.00 (Geothermal Technology)

The Geothermal Program will effectively transition remaining program activities and information to industry and the public sector.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.07.00.00, Geothermal Technology			
Technology Development	15,390	15,164	0
Technology Application	6,186	4,190	0
Congressionally Directed Activities	1,682	0	0
Subtotal, Program Goal 04.07.00.00, Geothermal Technology	23,258	19,354	0
All Other			
Congressionally Directed Activities			
Lake County Full Circle Effluent Pipeline Project	496	0	0
Klamath and Lake Counties Geothermal Agricultural Industrial Park	298	0	0
Geothermal Mill Redevelopment	744	0	0
National Center for Energy Management and Building Technologies	460	0	0
Ohio Wesleyan University Geothermal Demonstration Project	0	742	0
Springfield Equestrian Center Energy Efficiency Project	0	1,485	0
Lipscomb University Geothermal System	0	495	0
Geothermal and Renewable Energy Laboratory of Nevada	0	990	0
Total, Congressionally Directed Activities	1,998	3,712	0
Total, All Other	1,998	3,712	0
Total, General Goal 4 (Geothermal Technology)	25,256	23,066	0

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.07.00.00 (Geothermal Technology)					
Technology Development/Systems Development					
Completed design and environmental assessment of a small-scale (300 kW to 1MW) geothermal power plant for field verification.	Support industry opening and initial operation of a 1 MW small-scale geothermal plant in the State of New Mexico. [MET]	Create an Enhanced Geothermal System (EGS) with an industry partner and test associated technology needed to operate and monitor the system. [NOT MET]	Field test a fully integrated Diagnostics-While-Drilling (DWD) advanced drilling system in a high-temperature geothermal well, verifying control of drilling operations in real time, thereby reducing costs. If successful, DWD will reduce drilling costs by one half of the total cost reduction target for drilling. [MET]	Develop an Electronic Repository which makes digitized copies of all Geothermal Technology Program Research Development and Deployment Technical Reports available via the internet, while demonstrating reduction in cost of power for flash systems to 4.9 cents/kWh from 5.3 cents/kWh in 2005 and reducing cost of binary to 8.2 cents/kWh from 8.5 in 2005 based on modeled analysis.	Report on completion of program activities and previous year funded projects. Complete closeout of Geothermal Technology Program.
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,644K) until the target is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Geothermal Program had adopted a two-fold strategy to achieve its goal: (1) provide selected, but aggressive, technology improvements that have the greatest impacts on performance and cost; and (2) mitigate non-technical barriers that can influence or affect performance and costs. Means and strategies in FY 2007 will focus on closing out remaining program elements such as completing documentation of technology partnerships and transferring research findings to industry, and archiving legacy documents.

Validation and Verification

To validate and verify program performance, the Geothermal Program conducted internal and external reviews and audits with the assistance of experts from a variety of stakeholder organizations. The table below summarizes validation and verification activities.

Data Sources:	Geothermal Resources Council Bulletin; Geothermal Energy Association Update; Energy Information Administration's Annual Energy Review, Renewable Energy Annual, and Annual Energy Outlook; Geothermal Resources Council Transactions; Stanford Geothermal Program Workshop Proceedings; various system analyses by NREL and other contractors; International Energy Agency's Geothermal Implementing Agreement Annual Report; Peer Reviews of the U.S. Department of Energy's Geothermal Technology Program: August 23-24, 2001, March 25-27, 2002, July 29-August 1, 2003, June 7-8, 2004, April 7-8, 2005 Enhanced Geothermal Systems, June 6-9, 2005 Systems Development and July 26-28, 2005 Resource Development; Geothermal Program Briefings: March 20, 2003, March 16, 2004.
Baselines:	The Geothermal Program's baselines for cost reduction goals are contained in its Strategic Plan, August 2004, and the revised draft Multi-Year Technical Program Plan, September 2005. The cost of geothermal power in 1995 was 4.2 cents/kWh for flash power and 7.7 cents/kWh for binary power.
Evaluation:	Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results).
Frequency:	Annual.
Data Storage:	Corporate Planning System.
Verification:	Trade association and educational association reviews; open bids on electric power purchase agreements; Federal leasing applications; filings with state and Federal regulatory agencies; commercial sales of new technology.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The program has incorporated feedback from OMB into the FY 2007 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The Geothermal Program has taken action to address the PART recommendations. A strategic plan has been prepared that specifies program goals and the means to achieve them, while a multi-year program plan has been drafted that describes the technical pathways the program will follow to achieve the performance measures derived from the programmatic goals. In response to one of the 2002 PART recommendations, the Geothermal Program developed a set of annual performance measures dealing with the cost of drilling wells and the cost of building geothermal surface systems. In addition, the program developed performance measures for the number of new geothermal fields expected to be discovered in the United States, and the amount of developable geothermal resources confirmed by resource assessment. These improvements in planning, management and accountability were reflected in the program's improved 2003 PART score in those three areas, resulting in a "moderately effective" rating.

The 2003 PART found that the program has a very clear purpose (88%) and strong planning (80%) and management (88%). The PART acknowledged the role of the program in cost reduction and subsequent growth of competitive power production from expanded geothermal resources and implementation of the recommendation to shift resources to Enhanced Geothermal Systems. The PART also found that Congressionally Directed Activities reduced program funding available for competitive solicitations designed to contribute toward program goals.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. The applied R&D programs in DOE have improved the use of common baselines, assumptions and more consistent methods for generating their benefits estimates. However, benefits estimates are not comparable across the entire applied R&D portfolio. DOE will continue to address this finding corporately.

Expected Program Outcomes

Since the Geothermal Program will be terminated in FY 2007, benefits to the market are from past research and development, not from research conducted in FY 2007. Therefore, expected program outcomes will not be reported.

Technology Development

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Development			
Resource Development	2,542	2,722	0
Enhanced Geothermal Systems	6,788	5,879	0
Systems Development	6,060	6,138	0
SBIR/STTR	--	425	0
Total, Technology Development	15,390	15,164	0

Description

This subprogram examined processes affecting the economical production of geothermal systems with the intent of providing technology to increase productivity substantially. The three components of this activity involved: (1) finding resources; (2) creating new techniques for increasing the productivity of geothermal reservoirs; and (3) developing advanced technology in wellfield construction and energy conversion, the two major cost elements of geothermal electric power production and direct use. Consistent with the R&D investment criterion on here to mid-term for incorporating "off-ramps" and the expected commercialization of these technologies, activities under this subprogram will be completed and transitioned to the public and private sector.

Benefits

Efforts in FY 2007 will focus on closing out field verification activities and the final reporting of outstanding projects. The Geothermal Technology Program has designed, constructed, and tested innovative technologies in close collaboration with industry, such as high temperature borehole televiewers used in geothermal wells and high temperature oil and gas wells; a reservoir analysis code with important applications for geothermal and other hydrothermal systems; applications for nuclear waste isolation and carbon sequestration; and a prototype for innovative air cooled condensers to improve cooling in power generation and reduce consumptive use of water.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Resource Development	**2,542**	**2,722**	**0**

Resource Development deals with finding, characterizing, and assessing the geothermal resource through understanding the formation and evolution of geothermal systems. The work builds on continuing research that investigates seismicity, isotope geochemistry, 3-D magnetotellurics, remote sensing, and

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

other techniques such as exploration tools. Available exploration technology from related industries (e.g., petroleum, mining, waste management) is evaluated for adaptation to geothermal environments.

In FY 2007, the program will close out activities and report on the completion of field tests of technologies for exploration, such as remote sensing, geophysical, and geochemical techniques to locate geothermal resources. The program also will report on the completion and closeout of the national geothermal resource assessment conducted in collaboration with the U.S. Geological Survey (USGS) and state agencies. The assessment is expected to identify important new resources, resulting in reduced development risk for industry and lower exploration costs. Because DOE associated work will be completed in FY 2006, no funds are requested in FY 2007, all remaining activities, such as reporting and transfer of technologies, will be completed using prior year funds. Streamlined leasing and permitting, royalties to local jurisdictions, and the production tax credit mandated by EPAct 2005 should accelerate the exploration for geothermal resources in the western United States, improving exploration technologies through experience and learning.

Enhanced Geothermal Systems	**6,788**	**5,879**	**0**

Natural geothermal systems depend on three factors to produce energy: heat, water, and permeability. Heat is present virtually everywhere at depth; water and permeability are more problematic. Enhanced Geothermal Systems (EGS) are engineered reservoirs created to produce energy from geothermal resources deficient in economical amounts of water and/or permeability.

During FY 2007, the program will prepare final reports on cooperative research projects with universities, private companies, and National Laboratories using prior year funds. The work to prepare a dedicated EGS field site will terminate; a final report will be prepared. An analysis of state-of-the-art technology for EGS applications will be completed using prior year funds. Improvements to technologies that support EGS, such as exploration, drilling, and energy conversion, should occur from increased development resulting from the EPAct-mandated activities such as streamlined leasing and permitting, royalties to local jurisdictions, and the production tax credit.

Systems Development.....	**6,060**	**6,138**	**0**

Drilling and completion of wells account for 30 - 50 percent of the cost of a geothermal power project. High up-front costs and the chance of unsuccessful drilling can drive financial risk to unacceptable levels relative to anticipated project return on investment. Drilling research aims to produce new technologies for reducing the cost of geothermal wells through an integrated systems approach that focuses on improvements to key subsystems.

During FY 2007, the program will prepare final reports, using prior year funds, on the completion of FY 2006 projects such as: integrated Diagnostics-While-Drilling data management; verification of the field-worthiness of advanced primary cementing technology such as nitrified, high-temperature, reverse-circulated cements; completion of field demonstrations of hydraulically augmented drag bits and high-strength drill pipe; field-test enhanced air-cooled condensers; development of a laser-based instrument for real-time detection of hydrogen sulfide in cooling towers. Because all research and development work will be concluded in FY 2006, no additional funds are requested in FY 2007. Streamlined leasing

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

and permitting, royalties to local jurisdictions, and the production tax credit mandated by EPAct 2005 should accelerate the development of new geothermal power plants and new geothermal wells which will result in reduced cost of key drilling and power plant subsystems through experience and learning.

SBIR/STTR.....	**--**	**425**	**0**

In FY 2005, $301,000 and $40,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Technology Development	**15,390**	**15,164**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Resource Development	
Conclude funding of research on geothermal exploration tools, consistent with R&D Investment Criteria guidance on incorporating "off-ramps" and the expected commercialization of the technology. Activities under this subprogram will be completed and results transferred to the public and private sector. The 2005 Energy Policy Act provides incentives and structural changes that promote geothermal development.....	-2,722
Enhanced Geothermal Systems	
Due to reassessment of technical risk, program will conclude research and development on Enhanced Geothermal Systems (EGS) consistent with technical pathways in the Geothermal multiyear plan and the R&D investment criteria risk components. The 2005 Energy Policy Act provides incentives and structural changes that promote geothermal development.....	-5,879
Systems Development	
Research and development in energy conversion and drilling will be concluded, consistent with R&D investment criteria on incorporating "off-ramps" and the expected commercialization of the technology. Activities under this subprogram will be completed and transitioned to the public and private sector. The 2005 Energy Policy Act provides incentives and structural changes that promote geothermal development	-6,138

	FY 2007 vs. FY 2006 ($000)
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	-425
Total Funding Change, Technology Development.....	**-15,164**

Technology Application

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Application			
Technology Verification	3,058	1,532	0
Technology Deployment	3,128	2,658	0
Total, Technology Application	6,186	4,190	0

Description

This subprogram has focused on practical application of advancements made under the Technology Development subprogram. The focus involves the field verification of new technology, deployment of that technology, and its transfer to commercial applications. In addition, the activity examines barriers to the transfer and use of geothermal technology within the U.S. The success of this transfer effort depends upon involvement by industry partners and other interested parties.

Benefits

Efforts in FY 2007 will focus on closing out field verification activities and the final reporting of outstanding projects. Partnering with industry, the Geothermal Technology Program has established geothermal as an economically competitive contributor to the U.S. energy supply due to the high baseload reliability of geothermal with nearly 2600 MWe of capacity generating over 14.76 GWh/year of electrical energy and 600 MWt of direct use energy. Due to research and application efforts of the program, power generation projects are currently in operation or under development in California, Nevada, Utah, Idaho, Alaska, Hawaii and New Mexico.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Verification	**3,058**	**1,532**	**0**

Technology Verification includes cost-shared resource verification projects and demonstration of near-term commercial research products. Technology Verification moves technologies from research and development to a level where the technologies are accepted and actively used and applied by the U.S. geothermal industry and other stakeholders. All development components of exploration, EGS, drilling, and energy conversion should eventually be field tested to demonstrate improvements in technology performance at a commercial scale. Such verifications of improved technology are done in collaboration with cost-sharing industry partners, who will adopt the

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

technology.

In FY 2006, the program will complete collaboration with industry partners to find and evaluate new geothermal resources in the western United States using DOE-sponsored technology improvements and complete design and construction of the electrical power systems field verification projects selected in FY 2005. Shallow hydrothermal systems have successfully completed verification and are ready for site application with the potential to expand the development of geothermal resources. These activities will be completed using prior year funds. Because work will be completed in FY 2006, no funds are requested for FY 2007. Streamlined leasing and permitting, royalties to local jurisdictions, and the production tax credit mandated by EPAct 2005 should accelerate the exploration and evaluation of new geothermal resources in the western United States. EPAct mandates also will accelerate the development of new geothermal electrical power systems.

Technology Deployment	**3,128**	**2,658**	**0**

Institutional issues, such as complex regulations, can often prevent the transition from a prototype of new technology to a commercial product. This activity addresses the factors affecting the deployment of geothermal systems. Education, outreach, technical support, and systems analysis are used to encourage greater deployment. Interested parties come from the public and private sectors working in concert to raise awareness levels and solve problems of common interest.

Most deployment activities will be completed in FY 2006; therefore no funds are being requested for FY 2007. Any residual deployment responsibilities will be managed through EERE corporate outreach activities. EPAct 2005 mandates is expected to accelerate deployment of both electrical and direct use geothermal applications.

Total, Technology Application	**6,186**	**4,190**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Technology Verification	
The decrease will end field tests of exploration technologies in FY 2006, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology. Activities under this subprogram will be completed and results transferred to the public and private sector. The 2005 Energy Policy Act provides incentives and structural changes that promote geothermal development.....	-1,532

	FY 2007 vs. FY 2006 ($000)
Technology Deployment	
The decrease is due to the completion of deployment activities. Responsibility for any residual/ongoing communications requirements will be addressed by EERE's Office of Technology Advancement and Outreach. The 2005 Energy Policy Act provides incentives and structural changes that promote geothermal development	-2,658
Total Funding Change, Technology Application	**-4,190**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	3,680	3,712	0
Total, Congressionally Directed Activities	3,680	3,712	0

Description

The content of this section reflects 11 separate Congressionally Directed activities ("earmarks") within Geothermal Technology. In general, such activities do not support program goals because they are not well-aligned with established research pathways or focused on overcoming the technical barriers as identified in the program's detailed planning documents.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

There were a total of 4 Congressionally Directed activities in FY 2006. The program does not request further funding for these projects. The following projects were directed by Congress to be included in this program:

Geothermal Research at the University of Nevada-Reno	**992**	**0**	**0**

Geothermal resource assessment and exploration of the Great Basin.

Lake County Basin (Full Circle) Geothermal Project	**496**	**0**	**0**

Final design and procurement for construction of Phase III Full Circle pipeline.

Tuscarora Geothermal	**496**	**0**	**0**

Drilling of a geothermal production well in northern Nevada.

Klamath and Lake Counties Geothermal-Agricultural Industrial Park	**298**	**0**	**0**

Promotion of the use of geothermal energy for agriculture in south central Oregon.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Geothermal Mill Redevelopment	**744**	**0**	**0**
Installation of a geothermal heat pump system for space heating.			
University of Texas Permian Basin Center for Energy Economic Diversification	**194**	**0**	**0**
Assessment of feasibility of heat extraction from the Permian Basin in Texas.			
National Center for Energy Management and Building Technologies	**460**	**0**	**0**
Activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.			
Ohio Wesleyan University Geothermal Demonstration Project	**0**	**742**	**0**
Installation of ground source heat pump in Ohio.			
Springfield Equestrian Center Energy Efficiency Project	**0**	**1,485**	**0**
Installation of ground source heat pump in Ohio.			
Lipscomb University Geothermal System	**0**	**495**	**0**
Installation of ground source heat pump in Ohio.			
Geothermal and Renewable Energy Laboratory of Nevada	**0**	**990**	**0**
Geothermal resource assessment and exploration of the Great Basin.			
Total, Congressionally Directed Activities	**3,680**	**3,712**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal and the program itself is being closed out	-3,712
Total Funding Change, Congressionally Directed Activities	**-3,712**

Hydropower

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Hydropower					
Technology Viability	3,353	150	-1	149	0
Technology Application.....	1,527	350	-4	346	0
Total, Hydropower.....	4,880[b]	500	-5	495	0

Public Law Authorizations:

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. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-238, "Department of Energy Act – Civilian Applications" (1978)
P.L. 95-619, "National Energy Conservation Policy Act (NECPA)" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 104-303, "Water Resources Development Act" (1996)
P.L. 109-190, "Energy Policy Act" (2005)

Mission

The mission of the Hydropower Program has been to lead the Nation's efforts to improve the technical, societal, and environmental benefits of hydropower, and develop cost-competitive technologies that enable the development of new and incremental hydropower capacity, adding to the diversity of the Nation's energy supply. The Department plans to closeout the Hydropower Program in FY 2006 and transfer results of its research and development related to testing of fish-friendly large turbines to industry. No funding is requested in FY 2007.

Benefits

The Hydropower Program's mission and activities have contributed directly to EERE's and DOE's mission of improving National, Energy, and Economic security by increasing supply and diversity. Benefits are provided in Expected Program Outcomes Section.

[a] Includes a rescission of $5,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.

[b] In FY 2005, $64,000 was transferred to the SBIR program and $16,000 was transferred to the STTR program.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Hydropower Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Hydropower Program has had one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.06.00.00: Hydropower. With the completion of testing on new turbine technologies and consistent with previous congressional direction, the Hydropower Program's goal is to closeout this program and effectively transition remaining program activities and information (e.g., R&D results, technical data and findings) to private/public sector programs.

Contribution to Program Goal 04.06.00.00 (Hydropower)

The Hydropower Program will effectively transition remaining program activities and information to industry and the public sector in FY 2006. No funding is requested in FY 2007.

Funding by General and Program Goal

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.06.00.00, Hydropower			
Technology Viability	3,353	149	0
Technology Application	1,527	346	0
Total, Program Goal 04.06.00.00, Hydropower	4,880	495	0
Total, General Goal 4 (Hydropower)	4,880	495	0

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.06.00.00 (Hydropower)					
Technology Validation, Technology Application					
	Complete the pilot-scale testing of a fish friendly turbine, providing the basis for future full-scale testing at an operational site. Successful testing will provide industry with a proven design, helping attain the 2 percent mortality goal. [MET]	Complete report comparing field tests and model results for the effects of blade strike on turbine-passed fish. [MET]	Complete prototype testing at the Osage project that demonstrates 2 mg/liter improvement in oxygen content of water downstream of the hydropower plant. [MET]	Complete final report for operations and maintenance monitoring of large turbine test sites.	N/A
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($3,022K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	N/A

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Hydropower Program has used various means and strategies to achieve its program goals in the past. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Means and strategies in FY 2006 focused on closing out remaining program elements such as completing documentation of technology partnerships and transferring to industry, and archiving legacy documents. Since no funding is being requested in FY 2007, no program activity will take place.

Validation and Verification

To validate and verify program performance, the Hydropower Program has conducted internal and external reviews and audits. The table below summarizes past validation and verification activities.

Data Sources:	DOE Final Report, US Hydropower Resource Assessment (1998); DOE Low Head/Low Power Hydropower Resource Assessment (2003); FY 2003 Peer Review; Energy Information Administration Annual Energy Outlook; Annual Energy Review.
Evaluation:	In carrying out the program's mission, the Hydropower Program used several forms of evaluation to assess progress and to promote program improvement: ▪ Technology validation and operational field measurement, as appropriate; ▪ Peer review by independent outside experts of both the program and subprogram portfolios; ▪ Annual internal Technical Program Review of the Hydropower Program; ▪ Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate; ▪ Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and ▪ Annual review of methods, and recomputation of benefits for the Government Performance and Results Act (GPRA).
Baselines:	Dissolved Oxygen: 1.8 mg/l in 2002, Fish survivability: 95 percent for the best existing turbines.
Frequency:	Annual.
Data Storage:	Computer storage and available on DOE/EERE and EIA websites.

Verification: To validate the development of environmentally improved hydropower turbines, the program had been conducting field testing at four hydropower sites. The tests were expected to measure the progress made toward improving the environmental and operational performance of this technology. FY 2006 activities will focus on closing out these projects. No program activity will take place in FY 2007.

Expected Program Outcomes

Consistent with R&D investment criteria on the necessity of market barriers to justify Federal investment, the Hydropower Program was closed out in FY 2006. The industry is expected to continue benefiting from the program as it implements the environmentally-improved advanced turbine designs developed by the program, including from:

- Increased fish survivability and improved dissolved oxygen level, overcoming factors that often lead to reductions in the allowable generation during relicensing;
- Increased generation efficiency due to improved turbine designs; and
- Improved water optimization from models made available by the program.

Technology Viability

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Viability			
Advanced Hydropower Technology	2,188	145	0
Supporting Research and Testing	1,165	0	0
SBIR/STTR	--	4	0
Total, Technology Viability	3,353	149	0

Description

The Technology Viability key activity has focused on development of advanced technologies to enhance environmental performance and greater energy efficiencies. In 2003, the program could not find a partner willing to cost share in the full-scale testing of a new, innovative turbine, indicating a lack of interest and/or need by the industry. The program shifted focus in 2004 and 2005 to R&D on existing commercial designs with potential for efficiency gains and/or increased fish survivability. Market barriers to private sector investment in this R&D are minimal. Consistent with R&D investment criterion on the necessity of market barriers to justify Federal investment, the Hydropower Program will be closed out in FY 2006 (RDIC market barriers). No funding is requested in FY 2007.

To ensure that work completed by the Hydropower Program can be used effectively in the future, the program's FY 2006 closeout activities will include making the following available electronically on the DOE/EERE website: a basic history of the program areas of inquiry; R&D plans; documented results; and other relevant information to enable the current industry community and potential future interests to make best use of the program efforts to date.

Benefits

Efforts in FY 2006 will focus on closing out contracts at sites where technology has been implemented. No program activity will take place in FY 2007.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Advanced Hydropower Technology	**2,188**	**145**	**0**

In FY 2005, the program completed testing of fish-friendly turbines at Wanapum and Osage hydropower plants; completed work with the U.S. Army Corps of Engineers on laboratory scale

(dollars in thousands)

	FY 2005	FY 2006	FY 2007

modeling tests of the Ice Harbor hydropower plant; and completed studies to evaluate the effectiveness of environmental mitigation practice. With the completion of these fish-friendly turbine tests in FY 2005, the Department plans to close-out the Hydropower Program and transfer results to industry. FY 2006 activities will focus on completing monitoring of plant operation and maintenance, and documenting of previous Advanced Hydropower Technology activities. Outstanding contracts under this key activity will be closed out in FY 2006. No funding is requested in FY 2007.

Supporting Research and Testing	**1,165**	**0**	**0**

In FY 2005, the program completed a number of studies regarding fish injury mechanisms from hydropower turbine systems. Because all work within this activity was completed in FY 2005, no further funds are requested. The Congressionally directed project, National Center on Energy Management and Building Technologies was included in this activity in FY 2005 ($75,000).

SBIR/STTR	**--**	**4**	**0**

In FY 2005, $64,000 and $16,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.

Total, Technology Viability	**3,353**	**149**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Advanced Hydropower Technology	
The decrease is due to completion of program closeout in FY 2006.....	-145
Supporting Research and Testing	
No change	0
SBIR/STTR	
No significant change	-4
Total Funding Change, Technology Viability	**-149**

Technology Application

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Application			
Systems Integration and Technology Acceptance	1,229	338	0
Supporting Engineering and Analysis	298	0	0
SBIR/STTR	0	8	0
Total, Technology Application	1,527	346	0

Description

The Technology Application Subprogram has included Systems Integration and Technology Acceptance, and Supporting Engineering and Analysis. As part of the close out of the Hydropower Program, funds will be used in FY 2006 to complete hydropower/wind integration studies and close out activities in this area. No funding is requested in FY 2007.

Benefits

FY 2006 activities will focus on closing out remaining contracts. No program activity is planned for FY 2007.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Systems Integration and Technology Acceptance	**1,229**	**338**	**0**

This activity has included the determination of technical, economic, and institutional opportunities to integrate hydropower with wind technology and maintain a dialogue among key stakeholders that will aid in developing and maintaining sustainable hydropower markets. In FY 2006, the funding will be used to complete integration studies and close out activities in this area. No funding is requested in FY 2007.

Supporting Engineering and Analysis	**298**	**0**	**0**

In FY 2005, the program completed characterization of the low head hydropower technology available in the market. No funds are required in FY 2006 or FY 2007.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
SBIR/STTR	**0**	**8**	**0**
The FY 2006 amount shown is the estimated requirement for the continuation of the SBIR and STTR program.			
Total, Technology Application	**1,527**	**346**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Systems Integration and Technology Acceptance	
The decrease is due to completion of program closeout in FY 2006	-338
Supporting Engineering and Analysis	
No change	0
SBIR/STTR	
No significant change	-8
Total Funding Change, Technology Application	**-346**

Vehicle Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Vehicle Technologies					
Vehicle Systems	13,004	13,188	-132	13,056	13,315
Innovative Concepts	494	500	-5	495	500
Hybrid and Electric Propulsion	44,066	44,421	-444	43,977	50,841
Advanced Combustion Engine R&D	48,480	46,048	-460	45,588	46,706
Materials Technology	36,042	35,625	-356	35,269	29,786
Fuels Technology	12,419	13,847	-138	13,709	13,845
Technology Introduction	4,944	6,314	-64	6,250	11,031
Technical/Program Management Support	1,877	2,500	-25	2,475	0
Biennial Peer Reviews	0	1,000	-10	990	0
Congressionally-Directed Activities	0	20,500	-205	20,295	0
Total, Vehicle Technologies	161,326[b]	183,943	-1,839	182,104	166,024

Public Law Authorizations:

P.L. 95-91, "U.S. Department of Energy Organization Act" (1977)
P.L. 102-486, “Energy Policy Act” (1992)
P.L. 109-190, “Energy Policy Act” (2005)

Mission

The mission of the Vehicle Technologies Program is to develop more energy-efficient and environmentally friendly highway transportation technologies (for both cars and trucks) that will enable America to use significantly less petroleum. The long-term aim is to develop “leapfrog” technologies that, through significant improvements in vehicle energy efficiency, will provide Americans with continuing freedom of mobility and greater energy security, at lower costs and with lower impacts on the environment than current vehicles. The program focuses its research and development investments specifically on potential technology improvements that have uncertain or long-term outcomes, yet have

[a] Includes a rescission of $1,839,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $3,649,000 was transferred to the SBIR program and $434,000 was transferred to the STTR program.

the potential for significant public benefit. The high risks associated with these projects make it unlikely that they would be pursued by industry alone.

Benefits

The Vehicle Technologies (VT) Program mission and activities contribute directly to EERE's and DOE's mission of improving National Energy and Economic Security by addressing the President's National Energy Policy call for reducing dependence on oil imports and modernizing conservation technologies and practices. President Bush observed that "We need to get on a path away from the fossil fuel economy. If we want to be less dependent on foreign sources of energy, we must develop new ways to power automobiles." [a] In fact, highway vehicles alone account for 55 percent of total U.S. oil use -- more than all U.S. domestic oil production. Cost competitive and more energy efficient vehicles will enable U.S. citizens and businesses to accomplish their daily tasks while reducing their consumption of gasoline and diesel fuels, thus reducing demand for petroleum, lowering carbon emissions, and decreasing energy expenditures. As the President noted "By harnessing the power of technology, we're going to be able to grow our economy, protect our environment, and achieve greater energy independence."[b]

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Vehicle Technologies Program supports the following goal:

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Vehicle Technologies Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.02.00.00: Vehicle Technologies. The Vehicle Technologies Program goal is developing technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, while remaining cost- and performance-competitive. Manufacturers and consumers can then use these technologies to help the Nation reduce both petroleum use and greenhouse gas emissions.

Contribution to Program Goal 04.02.00.00 (Vehicle Technologies)

The key program contribution to General Goal 4, Energy Security, is the direct reduction of petroleum use. The VT Program supports an R&D portfolio focused on developing technologies that can enable dramatic improvements in the energy efficiency of passenger vehicles (e.g., cars, light trucks, and

[a] Remarks by President George W. Bush on Energy Efficiency, National Small Business Conference, Washington, D.C., April 27, 2005.
[b] IBID

SUV's) and commercial vehicles (heavy trucks, buses, etc.). In addition, the program R&D will focus on reducing the cost and overcoming technical barriers to volume manufacturing of advanced vehicle technologies.

The program's performance measures presented below demonstrate key technology pathways that contribute to achievement of this goal. Some performance measures have been expanded to provide more comprehensive coverage of the program activities as is recommended in the President's Management Agenda.

- Hybrid and Electric Propulsion subprogram: By 2010, develop an integrated electric propulsion system that costs no more than $12/kW peak ($660 per system compared to the cost of $1,900 in 1998) and can deliver at least 55 kW of power for 18 seconds and 30 kW of continuous power. Additionally, the propulsion system will have an operational lifetime of 15 years.
- Hybrid and Electric Propulsion subprogram: Hybrid and Electric Propulsion R&D activities will reduce the production cost of a high power 25 kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by 2010 (with an intermediate goal of $750 in 2006), enabling cost competitive market entry of hybrid vehicles.
- Advanced Combustion Engine R&D subprogram and Fuel Technology subprogram: Improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 45 percent by 2010 for passenger vehicles and from 40 percent (2002 baseline) to 55 percent by 2013 for commercial vehicle applications while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.
- By 2010, develop material and manufacturing technologies which, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to 2002 vehicles.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.02.00.00, Vehicle Technologies			
Vehicle Systems	13,004	13,056	13,315
Innovative Concepts	494	495	500
Hybrid and Electric Propulsion	44,066	43,977	50,841
Advanced Combustion Engine R&D	48,480	45,588	46,706
Materials Technologies	36,042	35,269	29,786
Fuels Technology	12,419	13,709	13,845

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Introduction[a]	4,944	6,250	11,031
Technical/Program Management Support	1,877	2,475	0
Biennial Peer Reviews	0	990	0
Congressionally Directed Activities			
Phase II Heavy Vehicle Hybrid Propulsion, WI (partially supports goal)	0	1,485	0
Oak Ridge National Lab Highway Transportation Technologies, TN (partially supports goal)	0	4,950	0
Mississippi State University CAVS Center, MS (partially supports goal)	0	1,980	0
Total, Congressionally Directed Activities	0	8,415	0
Subtotal, Program Goal 04.02.00.00, Vehicle Technologies	161,326	170,224	166,024
All Other			
Congressionally Directed Activities			
Phase II Heavy Vehicle Hybrid Propulsion (partial $)	0	1,485	0
National Hybrid Truck Manufacturing Program	0	1,980	0
Vehicle Test Strip Equipment Demonstration	0	1,485	0
Oak Ridge National Lab Highway Transportation Technologies (partial $)	0	4,950	0
Mississippi State University CAVS Center (partial $)	0	1,980	0
Total, Congressionally Directed Activities	0	11,880	0
Total, All Other	0	11,880	0
Total, General Goal 4 (Vehicle Technologies)	161,326	182,104	166,024

[a] Includes Clean Cities in 2007

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.02.00.00 (Vehicle Technologies)					
Hybrid and Electric Propulsion/Advanced Power Electronics					
					Demonstrate in the laboratory a motor with a specific power of 1.0 kW/kg, power density of 3.0 kW/liter, projected cost of $9/kW peak, and efficiency of 90%.
Vehicle Systems/Heavy Vehicle Systems R&D and Materials Technologies/Lightweight Materials Technology					
Reduce parasitic losses of heavy vehicle systems to 36 percent. [MET GOAL]	Reduce parasitic losses of heavy vehicle systems to 30 percent of total engine output and benchmark additional reductions through commercial heavy-duty truck electrification. [EXCEEDED GOAL]	Reduce parasitic loses to 27 percent of total engine output in a laboratory test. [MET GOAL]	Reduce parasitic energy loss to 25 percent of total engine output and reduce unloaded tractor-trailer weight to 22,000 pounds. [MET GOAL]	Reduce parasitic energy loss to 24 percent of total engine output.	
Hybrid and Electric Propulsion/Energy Storage					
Complete development of second generation Lithium ion electrochemistry for hybrid vehicle power. [MET GOAL]	Reduce high-power 25 kW estimated battery cost to $1,180 per battery system. [EXCEEDED GOAL]	Reduce high-power 25 kW light vehicle estimated lithium ion battery cost to $1,000 per battery system. [MET GOAL]	Reduce high-power, 25 kW, light vehicle, lithium ion battery cost to $900 per battery system. [MET GOAL]	Reduce the projected cost at high volume of a high power, 25 kW, light vehicle, lithium ion battery to $750 per battery system.	Reduce high power, 25 kW, passenger vehicle, lithium ion battery cost to $700 per battery system.
Advanced Combustion Engine R&D/Combustion and Emission Control and Heavy Truck Engine; Fuels Technology					
	Demonstrate optimized emission control system that achieves 0.07 g/mile NO_x and 0.01 g/mile PM short-term performance in light passenger -vehicles. [MET GOAL]	Complete Light Truck activity with 35 percent fuel efficiency improvement over a gasoline powered light truck and Tier 2 emissions levels (0.07g/mile NO_x). Demonstrate 45 percent thermal efficiency for heavy-duty commercial vehicle diesel engines while meeting EPA 2007 emission standards (1.2g/hp-hr NO_x). [MET GOAL]	Light vehicle combustion engines will reach 39 percent brake thermal efficiency and commercial heavy-duty vehicle combustion engines will be greater than 45 percent efficient while meeting EPA 2007 emission standards (1.2 g/hp-hr NO_x). [MET GOAL]	Achieve 41 percent brake thermal efficiency for light vehicle combustion engines and 50 percent brake thermal efficiency, while meeting EPA 2010 emission standards (0.2 g/hp-hr NOx), for heavy vehicle combustion engines.	In the laboratory, demonstrate passenger vehicle combustion engines with a 42 percent brake thermal efficiency.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Materials Technology/Lightweight Materials Technology					
Fabricate a sport utility vehicle chassis component using carbon fiber in a low cost molding process that is suitable for high volume production. [NOT MET] Completion of their target was delayed due to an equipment failure requiring significant repairs. The target was rescheduled and completed in FY 2003.	Complete R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $7/pound. [EXCEEDED GOAL]	Complete R&D on technologies which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $5/pound. [MET GOAL]	Complete R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $4.50/pound. [MET GOAL]	Complete R&D on technologies, which, if implemented in high volume, could reduce the projected (i.e. modeled) bulk cost of automotive-grade carbon fiber to less than $3.00/pound.	Develop technologies which, if implemented in high volume, could reduce the weight of body and chassis components by 10%.
Efficiency Improvement					
		Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2005) until the target range is met. [MET GOAL]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2006) until the target range is met. [GOAL PARTIALLY MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent..

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Vehicle Technologies Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Vehicles Technologies Program will utilize the following means:

- The program focuses its technology research and development investments specifically on areas that would not be pursued by industry alone due to high risks and uncertain or long-term outcomes. Program activities include research, development, demonstration, testing, technology validation, technology transfer, and education. These activities are aimed at developing technologies that could achieve: 1) significant improvements in vehicle fuel efficiency and 2) displacement of oil by other fuels which ultimately can be produced domestically in a clean and cost-competitive manner;
- Fuel efficiency gains will be achieved through the introduction of more efficient technologies and lightweight materials. The use of advanced technologies will be more economically attractive through DOE research and development efforts that reduce their costs;
- Vehicles with advanced technologies include advanced combustion engines, hybrid internal combustion vehicles, and hybrid fuel cell vehicles. The penetration of these vehicles in the marketplace will be enhanced by DOE research and development that, for example, reduces the cost of high power and high energy batteries, increases battery energy storage, and extends battery life for hybrid vehicles, and allows the introduction of cost effective "plug-in" hybrids (i.e. those that can be plugged in and recharged from the electric grid), improves diesel and other combustion engines by making them more efficient and cleaner, and improves the power electronics and the electric motors needed for fuel cell, combustion hybrid, "plug-in" hybrid electric vehicles; and
- The FreedomCAR and Fuel and 21st Century Truck Partnerships are each developing and maintaining technical roadmaps that outline the pathways for achieving long-range technology-specific R&D goals (including cost targets) and the milestones required to demonstrate progress. Each partnership will consider these goals in implementing its respective R&D program.

The Vehicles Technologies Program will implement the following strategies:

- For passenger vehicles, the long-term strategy is to perfect the technologies that will enable a timely transition to a transportation hydrogen economy. There also are significant reductions in petroleum use possible from R&D to improve highway transportation technologies in the interim. Capitalizing on the interim opportunities to significantly reduce oil use (thus benefiting both our economy and our energy security) and contributing to the development of the technologies needed to make fuel cell vehicles competitive are key outcomes sought from FreedomCAR activities.

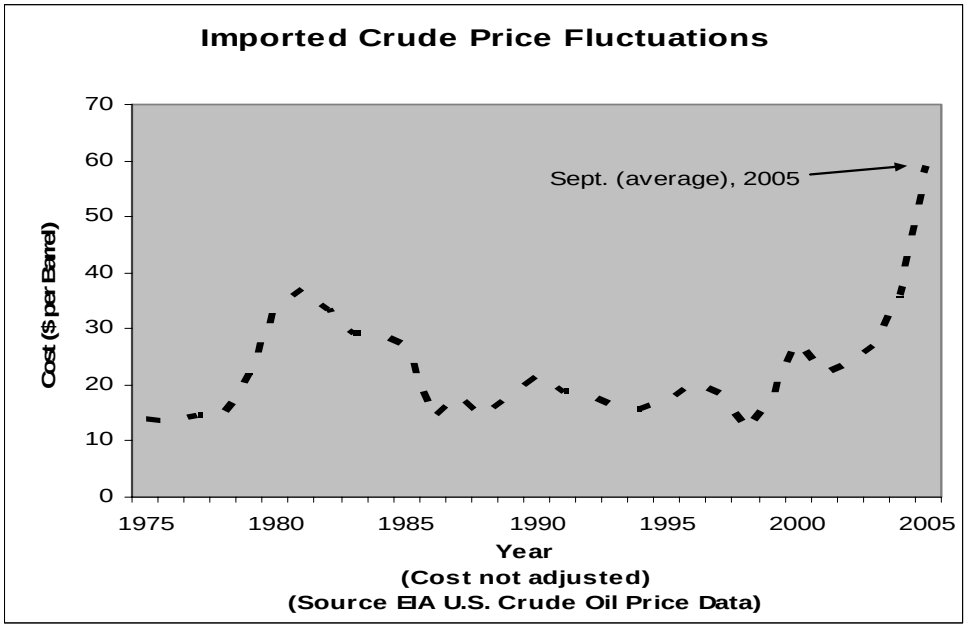
- The program is also extending the battery and hybrid systems R&D to accelerate the development and introduction of "plug-in" hybrids that allow local driving to be powered entirely by charging batteries at night, while allowing normal fuel operation for long trips.
- The commercial vehicle industry and government partners have developed a common vision -- "that our Nation's trucks and buses will safely and cost-effectively move larger volumes of freight and greater numbers of passengers while emitting little or no pollution and dramatically reducing the dependence on foreign oil."[a] Ultimately, the 21st Century Truck Partnership seeks safe, secure, and environmentally friendly trucks and buses that use sustainable and self-sufficient energy sources, thereby helping enhance America's global competitiveness.
- These mission strategies are accomplished by targeted Federal investments in technology research and development and in strategic partnerships with auto manufacturers, commercial vehicle manufacturers, equipment suppliers, fuel and energy companies, other Federal agencies, state government agencies, universities, National Laboratories, and other stakeholders. These strategic partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer. Two government-industry partnerships serve as implementing mechanisms for major portions of the program: the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership. In addition, Clean Cities partnerships with state and local governments serve as deployment mechanisms to promote the use of alternative fuels and petroleum-displacement technologies.
- In addition, the program invests in technical program and market analysis and performance assessments in order to direct effective strategic planning.

These strategies will result in significant cost savings and a significant reduction in the consumption of gasoline and diesel fuels, cost-effectively reducing America's demand for petroleum, lowering carbon emissions, and decreasing energy expenditures—thus putting the taxpayers' dollars to more productive use.

The following external factors could affect the ability of the Vehicle Technologies Program to achieve its strategic goal:

- The interest that consumers place on new vehicle fuel economy is very dependent on the price of gasoline. But because gasoline prices have historically gone up and down, they do not provide a consistent signal. (See "Imported Crude Price Fluctuations" figure.) Surveys suggest neither manufacturers nor consumers generally expect prices to remain high. As a result, manufacturers have been reluctant to assume the risk required for the production and distribution of advanced energy-efficient vehicle technologies; and

[a] Secretary Spencer Abraham, Unveiling of the 21st Century Truck Partnership, Dearborn, Michigan, November 12, 2002



- Energy savings, oil savings, carbon emission reductions, and energy expenditure savings are estimated using an Energy Information Agency (EIA) reference case that has assumed low future oil prices. The recently released "Annual Energy Outlook 2006" from EIA has increased the forecasted price of oil, but it still remains well below CY 2005 prices. The goals and benefits could be affected if changes in energy policy encourage consumers to purchase more efficient vehicles than is currently projected. Future analysis and modeling will include the expected effects of the petroleum-reduction policies included in the Energy Policy Act of 2005.

In carrying out the program's mission, the Vehicle Technologies Program contributes to the following collaborative activities:

- Along with the Hydrogen Technology Program (HT), the program participates in the FreedomCAR and Fuel Partnership, a collaboration among the DOE, the U.S. Council for Automotive Research (USCAR) and five energy companies to support the FreedomCAR goals. The USCAR member companies are Ford, General Motors and DaimlerChrysler. The energy partners are BP America, Chevron Corporation, ConocoPhillips, Exxon Mobil Corporation, and Shell Hydrogen (U.S.). The Partnership is focused on precompetitive high-risk research necessary to provide a full range of affordable energy-efficient cars and passenger trucks, and their fueling infrastructure. The aim is to facilitate an industry decision in 2015 to commercialize hydrogen-powered fuel cell vehicles and the hydrogen infrastructure to support them. The partners also support the development of hybrid combustion-engine technologies that could lead to oil savings in the interim period before large numbers of fuel cell vehicles are commercially available.

- Program R&D pathway integration with EERE (Biomass and Biorefinery Systems R&D, Building Technologies, Hydrogen Technology) and Office of Science Programs.

- The Vehicle Technologies Program, through its FreedomCAR budget and activities, funds research, development, demonstration, and deployment (RDD&D) of the vehicle-related portions of those

technologies, including vehicle systems integration, batteries and power-electronics, advanced combustion engines, lightweight materials, etc. The related fuel-cell work is funded by the Hydrogen Technology Program in this appropriation.

FreedomCAR Budget

(dollars in thousands)

	FY 2005	FY 2006	FY 2007 Request
Vehicle Technologies Portion	83,374	99,000	109,774
Hydrogen Portion	73,419	75,339	81,804
Total	156,793	174,339	191,578

- In establishing technical directions and priorities, the program has obtained substantial inputs from energy and transportation experts from outside of DOE through interaction of government-industry-laboratory technical teams, independent project reviews with recognized experts, solicited review of DOE R&D plans, and critiques by organizations such as the National Academy of Sciences (NAS). The perspectives of these outside experts are extremely valuable in helping to assure that the program's research directions and priorities are aligned properly with the needs of passenger and commercial vehicle manufacturers, equipment suppliers, energy companies, other Federal agencies, state agencies, consumers, and other stakeholders; and

- The FreedomCAR and Fuel partners have identified eight specific technology goals for 2010 and 2015 (one of which is jointly shared between VT and HT) and timetables for government and industry R&D efforts, to measure progress in technologies that could enable reduced oil consumption and increased energy efficiency in passenger vehicles. This request fully supports FreedomCAR goals for both hybrid and internal combustion power-train systems and light-weight materials.

2010 Hydrogen Fuel Initiative and FreedomCAR Coordinated Technology Goals

The Office of FreedomCAR and Vehicle Technologies has sole responsibility for four of the eight goals and joint responsibility, with HT, for one goal:

- Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kW peak;
- Internal Combustion Engine Power train Systems costing $30/kW, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards;
- Electric Drive train Energy Storage with 15-year life at 300 Wh per vehicle and with discharge power of 25 kW for 18 seconds and $20/kW;
- Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50 percent reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials; and

- Internal Combustion Engine Power train Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards *(shared responsibility with HFCIT).*

The Office of Hydrogen, Fuel Cells, and Infrastructure Technologies has sole responsibility for these goals:

- 60 percent peak energy-efficient, durable fuel cell power systems (including hydrogen storage) that achieve a 325 W/kg power density and 220 Wh/l operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015;
- Demonstrate hydrogen refueling and develop commercial codes and standards and diverse renewable and non-renewable energy sources. Achieve a cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $2.00-3.00 per gallon gasoline equivalent produced and delivered to the consumer independent of pathway by 2015; and
- On-board Hydrogen Storage Systems demonstrating specific energy of 2.0 kWh/kg (6 weight percent hydrogen), and energy density of 1.5 kWh/l at a cost of $4/kWh by 2010 and specific energy of 3.0 kWh/kg (9 weight percent hydrogen), 2.7 kWh/l, and $2.00/kWh by 2015.

- The 21st Century Truck Partnership (21CTP) is the major crosscutting effort focused on improving technologies for commercial vehicles. As Secretary Bodman recently noted, "Through the 21st Truck Partnership, and similar initiatives, our Department is expanding the use of clean diesel, and helping to reduce our dependence on foreign oil, improve energy efficiency, and develop new, environmentally friendly fuels to power our economy in the 21st century."[a] The truck partnership involves key members of the commercial vehicle industry, truck original equipment manufacturers, hybrid propulsion developers, and engine manufacturers as well as other Federal agencies. Primarily due to hydrogen's low energy density when compared to petroleum fuels, hydrogen fuel cells are not seen as a viable option as a prime mover for long-haul heavy highway vehicles. The 21CTP effort centers on research and development to:
    - increase engine efficiency;
    - improve performance of hybrid powertrains;
    - reduce fatalities through advanced safety systems;
    - reduce parasitic and idling losses; and
    - validate and demonstrate these technologies.
- The 21st Century Truck Partnership funds a cooperative effort between the commercial vehicle (truck and bus) industry and major Federal agencies to develop technologies that will make our Nation's commercial vehicles more efficient, clean, and safe. The government agency participants are the Departments of Energy, Defense (represented by the U.S. Army), Transportation, and the Environmental Protection Agency. Industry partners are Allison Transmission, BAE Systems, Caterpillar, Cummins, DaimlerChrysler, Detroit Diesel, Eaton Corporation, Freightliner, Honeywell International, International Truck and Engine, Mack Trucks, NovaBUS, Oshkosh Truck, PACCAR, and Volvo Trucks North America.

[a] Remarks by Secretary Bodman, SAE Government Industry Meeting, Washington, DC, May 10, 2005.

21st Century Truck Partnership Budget

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007 Request
21st Century Truck Partnership	68,036	50,322	42,021

Validation and Verification

To validate and verify program performance, the Vehicle Technologies Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the Department's Inspector General, and the National Academy of Sciences. The Vehicle Technologies Program also uses several program performance management methods to validate and verify its performance during the course of the program on an annual and ongoing basis, including: management standards; incorporation of goals; measurement and reporting from program contracts; peer reviewed roadmaps and activities; performance modeling and estimation; prototype testing; site visits; and annual program reviews.

Data Sources: Program Reviews, Peer Reviews, Laboratory Tests, On-Road Tests, and Peer-Reviewed Model Baselines.

Baseline: Weight of unloaded heavy trucks in 2003 (23,000 pounds), cost of hybrid batteries in 1998 ($3,000 projected for volume production of a high power 25 kW battery), combustion efficiency in 2002 (30 percent for passenger vehicles and 40 percent for commercial vehicles), and carbon fiber costs in 1998 ($12 per pound). (Note: cost values are not adjusted for inflation.)

Frequency: Biennial reviews (beginning in FY 2006) will be conducted for the FreedomCAR and 21st Century Truck Partnerships.

Data Storage: EE Corporate Planning System

Evaluation: In carrying out the program's mission, the VT Program uses several forms of evaluation to assess progress and to promote program improvement. These are conducted at both the program and the activity levels. The types of evaluations are:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the VT Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based

performance through Joule, R&D IC, PMA and PART reviews;

- Annual review of methods, and computation of the potential benefits for the Government Performance and Results Act (GPRA); and
- Biennial reviews of both the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. The reviews include evaluation of progress toward achieving the Partnership's technical goals and direction. Based on this evaluation, resource availability, and other factors, the FreedomCAR and Fuel partners and the 21CT partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

Verification: Run and document vehicle simulation tests, conduct bench tests, run laboratory tests on the engine and vehicle dynamometers, run wind tunnel tests, and conduct on-road and track tests to evaluate the technology. Conduct fleet tests and undertake target performance review.

Program Assessment Rating Tool (PART)

PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The Department has implemented this tool to evaluate selected programs in conjunction with OMB. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The VT Program has incorporated feedback from OMB into the FY 2007 Budget Request and is taking the necessary steps to continue to improve performance.

The Vehicle Technologies Program received its first OMB PART review in 2004. The 2004 PART review included ratings of 80% for program purpose, 90% for planning, 100% for management and 75% for program results and accountability with an overall rating of "moderately effective," the second-highest overall rating possible (total weighted score of 83%). These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles. The PART recommended that the program add a peer review to include the 21st Century Truck Partnership, including an assessment of the appropriateness of Federal support in each program area, which is underway.

The Vehicle Technologies (VT) Program is organized into subprograms that are described later in the budget. Nearly all of the subprograms are coordinated with the U.S. auto or trucking industries under either the FreedomCAR and Fuel Partnership or the 21st Century Truck Partnership.

Expected Program Outcomes

The Vehicle Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency of highway vehicles and the productivity of our economy. The metrics

used to measure program benefits are energy reduction, oil reduction, carbon emission reduction and energy savings.

Estimates of the Vehicle Technologies Program potential benefits through 2050 are shown in the table below. These benefits are achieved by targeted Federal investments in technology research and development in partnership with auto manufacturers, commercial vehicle manufacturers, equipment suppliers, fuel and energy companies, other Federal agencies, state government agencies, universities, National Laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer. In addition to the estimated savings shown, the Clean Cities effort, through the introduction of higher efficiency and alternative fuel vehicles, is saving the Nation roughly 13,000 barrels of petroleum each day.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals.

A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at: http://www.eere.energy.gov/ba/pba/gpra_estimates_fy07.html. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. The results shown in the long-term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

FY 2007 GPRA Benefits Estimates for the Vehicle Technologies Program[a]

Mid-term benefits[b,c,d]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	0.04	0.38	1.15	2.32
Energy expenditure savings (Billion 2003$)	ns	4	26	49
Carbon emission reductions (MMTCE)	1	7	20	41
Oil savings (mbpd)	0.02	0.18	0.52	1.07

Long-term benefits[e]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	5.16	11.38	13.51
Energy system net cost savings (Billion 2003$)	4	37	70
Carbon emission reductions (MMTCE)	117	217	260
Oil savings (mbpd)	2.90	5.38	6.48

The model used to estimate these benefits increases the market share of advanced-technology vehicles over time as their projected incremental cost relative to conventional vehicles declines and as their efficiency relative to conventional vehicles increases. Some of the efficiency gains are attained by using lightweight materials while maintaining the safety of the vehicles. By 2025, over 1 million barrels per day (MBPD) of oil (relative to base consumption) is projected to be saved as compared with the reference projection without these technologies. This accounts for nearly 6 percent of projected

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are met and funding continues at levels consistent with assumptions in the FY 2007 Budget.
[b] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.
[c] Cumulative benefits in 2025 would be roughly 2.5 billion barrels of oil saved and approximately $150 billion (at $60 a barrel) saved in the purchase of imported oil, assuming a linear accumulation of the NEMS based benefits from 2010 through 2025.
[d] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.
[e] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

transportation oil use in 2025 (nearly 4 percent of total U.S. oil use). By 2050, the projected oil savings grows to nearly 6.5 MBPD, which is nearly 30 percent of the amount of oil use projected for transportation in that year (nearly 23 percent of total U.S. oil use). The primary non-renewable energy savings are expressed in Quads of energy and they are nearly equal to the oil savings (in normalized units) since oil is a non-renewable energy source. The energy bill savings (in the mid-term benefits) are the savings in fuel costs by vehicle users due to the increased efficiency of their advanced vehicles. The energy savings (in the long-term benefits) are the net savings to the vehicle users, including both the value of fuel saved and the incremental expenditures they made to purchase their advanced vehicles. Carbon emission reductions are based on the amount of carbon that the petroleum products saved would have released if they had been used.

Vehicle Systems

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Vehicle Systems			
Heavy Vehicle Systems R&D			
Vehicle Systems Optimization	8,534	8,457	5,922
Truck Safety Systems	96	96	0
Total, Heavy Vehicle Systems R&D	8,630	8,553	5,922
Ancillary Systems	1,241	962	292
Simulation and Validation	3,133	3,175	6,729
SBIR/STTR	--	366	372
Total, Vehicle Systems	13,004	13,056	13,315

Description

The Vehicle Systems subprogram funds R&D on advanced vehicle technologies and ancillary equipment that could achieve significant improvements in fuel economy for passenger and commercial vehicles without sacrificing safety, the environment, performance, or affordability. This subprogram's funding contributes to both the FreedomCAR and 21st Century Truck budgets.

Benefits

The Vehicle Systems subprogram contributes to the VT Program goal (04.02.00.00) by addressing those system elements that, when resolved and adequately integrated into a vehicle's design, will accomplish improved system efficiency. For example, parasitic engine losses in heavy trucks contribute to overall system inefficiencies and low fuel economy. When appropriately addressed, reductions in parasitic losses will improve the efficiency of freight transportation. These improvements, coupled with other VT Program technical advances, are necessary to achieve the heavy commercial vehicle fuel efficiency goals of the 21st Century Truck Partnership. In addition, the Vehicle Systems subprogram uses a systems approach to define technical targets and requirements, guide technology development, and validate performance of DOE-sponsored technologies for light passenger and heavy commercial vehicles.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Heavy Vehicle Systems R&D	**8,630**	**8,553**	**5,922**

The Heavy Vehicle Systems R&D activity develops, in collaboration with heavy-duty commercial vehicle manufacturers and their suppliers, technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, tire rolling resistance, friction and wear, under-hood thermal conditions, and accessory loads. The goals and technology barriers in this activity were identified and established through workshops involving government, industry and academic expert participants. These activities are undertaken through a variety of mechanisms, including in-house work at the National Laboratories, competitively-awarded contracts or cooperative agreements with industry, and university consortia. Throughout, powertrain and truck system integration issues are considered in order to optimize overall system energy efficiency and to ensure proper accounting of system energy. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

- **Vehicle Systems Optimization** **8,534** **8,457** **5,922**

  In FY 2007, continue the viability assessment of various aerodynamic drag reduction devices, including, but not restricted to, flat boat tails, circulation control, wedges, splitters, and cab extenders. Compare wind tunnel results to on-road testing and to theoretical calculations for increased vehicle energy efficiency using various computational fluid dynamics (CFD) techniques, employing appropriate turbulence models. Incorporate data from on-road tests being conducted by a truck industry consortium (Truck Manufacturers Association). Determine the effect of tire treads on “splash and spray” and compare to CFD models for both increased efficiency and safety. Enhance capabilities of the heavy vehicle systems modeling tool by incorporating on-road test data and by integrating turbulence and other computational fluid dynamics models. Develop surface texturing and coating techniques to reduce friction in the drive train, axle, and various engine components and relate these effects to interactions with selected lubricants. Determine the durability extension of sensitive parts by this approach.

  Continue with a new project on the electrification of medium-duty trucks, building on lessons learned from the very successful More Electric Truck (Class 8). Thermal control approaches will focus on nanofluids, higher temperature coolants, evaporative cooling, heat pipes, re-design of the cooling system and integration of internal heat flow to external aerodynamics with the aim of aerodynamic drag reduction. To increase overall vehicular energy efficiency, apply the determined fractal dimensions of particulate matter at various locations from the engine of spark ignition and diesel engines in order to optimize filters and reduce concurrent fuel penalties. Commence design of a high-thermal-conductivity exhaust gas recirculation (EGR) cooler utilizing nanofluids and carbon foams and resume previously planned aerodynamic drag

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

computational fluid dynamics activities. (21CT, $5,922,000)

▪ **Truck Safety Systems**	**96**	**96**	**0**

No activities are planned in FY 2007 so as to focus efforts on R&D with potentially greater contribution to the Vehicle Technologies' goals. In FY 2006, this activity is funding and concluding simulation studies of the ways in which the stability and braking of heavy trucks could be improved by activity manipulating vehicle aerodynamics.

Ancillary Systems.....	**1,241**	**962**	**292**

The Ancillary Systems activity seeks to reduce direct and indirect fuel-consuming loads imposed on internal combustion engines or fuel cell powered vehicles. These loads include those that negatively impact the fuel efficiency of a vehicle but do not propel the vehicle directly; the primary load in this category is the air-conditioning system.

In 2007, efforts will include:

- Conducting an in the laboratory evaluation of hardware developed by the Ancillary Systems activities to demonstrate the state of the technologies' development;
- Conducting advanced simulations and modeling to determine remaining improvements and their subsequent impacts on efficiency; and
- Preparing a final report on the project activities.

These activities will be conducted to transfer the results of this R&D to industry and to assist them with final development. (FreedomCAR, $292,000).

Simulation and Validation	**3,133**	**3,175**	**6,729**

The Simulation and Validation activity develops and validates models and simulation programs to predict the performance, component interaction, fuel economy, and emissions of advanced vehicles. With industry input, these models are used to develop performance targets for the complete range of vehicle platforms and their components to facilitate prioritization of technology R&D activities that could significantly reduce petroleum usage for transportation. In coordination with industry partners, the simulation and modeling tools are used to develop advanced control strategies to optimize the interaction between components and the overall performance and efficiency of advanced hybrid electric and fuel cell vehicles. The models are also used, in conjunction with "hardware-in-the-loop" (HIL) laboratory testing, to validate the performance of advanced technology components and systems developed within VT R&D activities without the need to build and test a complete vehicle.

In FY 2007, the program will expand the validation of advanced technology components' and systems' performance in the laboratory without building a complete vehicle by utilizing "hardware-in-the-loop" testing techniques. Data collected during these and other tests will be used to enhance vehicle and systems modeling capabilities and to validate the accuracy of the component models. In

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

addition to enhancing modeling tools, the activity will increase interaction between modelers of advanced component specific models within the DOE laboratories. The objective is to create a series of linked models that will ensure the use of the most accurate component data within the systems and vehicle models. The result will achieve greater accuracy for model results and will allow the activity to conduct simulations supporting R&D in all other VT subprograms. The simulations will be used to predict and optimize vehicle systems performance, evaluate technical targets, and link the VT Program objectives of reduced fuel consumption with technology-specific component goals. In FY 2007 the models and simulation tools will also be extended to allow characterization and exploration of design alternatives for "plug-in" hybrids. (FreedomCAR, $6,729,000).

SBIR/STTR.....	**--**	**366**	**372**

In FY 2005, $309,454 and $36,040 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program. (FreedomCAR, $202,000; 21CT, $170,000).

Total, Vehicle Systems.....	**13,004**	**13,056**	**13,315**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Heavy Vehicle Systems R&D	
▪ **Vehicle Systems Optimization**	
Reduction in this subactivity reflects completion of major railroad and transit bus demonstration projects. The effort in this sub-activity will be reduced so as to provide a greater focus on R&D efforts having a potential for greater contribution to reduced oil consumption	-2,535
▪ **Truck Safety Systems**	
This sub-activity will be terminated so as to focus efforts on R&D with a potential for greater contribution to reduced oil consumption.....	-96
Total, Heavy Vehicle Systems R&D	**-2,631**

	FY 2007 vs. FY 2006 ($000)
Ancillary Systems	
Most of the efforts in this area will be phased out because they have reached a point in their development where their commercial potential should be evident to the private sector. Remaining efforts will focus on the research opportunities with the greatest potential for petroleum reduction. The tools developed by the Ancillary Systems Activity will be made available to industry partners through the National Renewable Energy Laboratory on a work for others basis to aid in the transfer of these R&D activities from the Department to industry. These activity close-outs are consistent with the RDIC: they serve as R&D "off ramps" and are based on estimates of the comparative public benefits among VT activities along with assessments of the appropriate government role	-670
Simulation and Validation	
The increase in funding for Simulation and Validation expands activities in two areas. One is the extension of simulation and modeling tools to support development of advanced vehicle systems control strategies applicable to “plug-in” hybrid electric vehicles and integration of advanced batteries, motors, and power electronics technologies into “plug-in” hybrid electric vehicles utilizing these new control strategies. Development of these control strategies will require extensive computer modeling and simulation, as well as coordination with industry partners, but will allow for optimal performance and efficiency of “plug-in” hybrid electric vehicles and the advanced technologies they utilize ($2,357,000). The other area of increase is the level of coordination between the VT-developed component-specific computer models and the Powertrain Systems Analysis Toolkit (PSAT) vehicle/systems level model.	
Establishing the ability for these models to interact will result in an increase in the accuracy of simulations conducted using PSAT and allow for expanded utilization of the Mobile Advanced Technology Testbed (MATT) hardware-in-the-loop testing platform to validate technology developments from VT R&D activities ($1,197,000). These enhanced capabilities will allow Government/Industry R&D Technical Teams to better focus activities on the most promising technologies and will enable further integration of advanced technologies, such as fuel cells, into the most fuel-efficient vehicle possible in the shortest amount of time	+3,554
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+6
Total Funding Change, Vehicle Systems.....	**+259**

Innovative Concepts

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Innovative Concepts			
Graduate Automotive Technology Education	494	495	500
Total, Innovative Concepts	494	495	500

Description

The Innovative Concepts subprogram contributes to activities of both the Vehicle Technologies and Hydrogen Technology Program missions by supporting the development of students with technical skill in the same areas of technology where the program is engaged in advanced R&D.

Benefits

Supporting a pipeline into the auto industry of new engineers familiar with the most advanced technologies will speed the adoption of those technologies, increasing the probability of successful long-term outcomes from the VT R&D activities. The need for more highly trained engineers in hybrid technologies to help overcome barriers in the market place was reinforced throughout the Congressional Joint Economic Committee (JEC) hearing on Alternative Automotive Technologies and Energy Efficiency (July 28, 2005). The automotive manufacturers testifying before the committee noted during their response to questions that there is a need for new scientists and engineers. Shortages of qualified engineers was also noted.[a]

DOE is addressing this need as noted by the Under Secretary of Energy, David Garman, in his testimony to the JEC, "Over the long-term, the program (transportation) also seeks to raise public awareness and foster the development of university and other education programs that will ensure the next generation of scientists, engineers, and technicians needed to develop and sustain the hydrogen economy." The Innovative Concepts subprogram is part of DOE's strategy to address these educational needs.

[a] Phil Martens, Ford's group vice president for product creation, while addressing the Management Briefing Seminars (2005) in Traverse City, Michigan ("Ford High on Hybrids, Says Martins," Automotive News, August 5, 2005).

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Graduate Automotive Technology Education.....	**494**	**495**	**500**

The Graduate Automotive Technology Education activity aids in the development of interdisciplinary curricula to train the future workforce of automotive engineers. This is accomplished by setting up GATE Centers of Excellence at universities that have been competitively selected, establishing focused curricula, and providing funds for research fellowships.

In FY 2007, fund GATE Centers of Excellence (competitively selected) to develop new curricula and provide research fellowships for approximately 25 students for research in advanced automotive technologies, including hybrid fuel cell vehicles. (FreedomCAR, $500,000).

Total, Innovative Concepts.....	**494**	**495**	**500**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No significant change.....	+5
Total Funding Change, Innovative Concepts.....	**+5**

Hybrid and Electric Propulsion

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Hybrid and Electric Propulsion			
Energy Storage			
High Power Energy Storage	16,925	16,720	17,181
Advanced Battery Development	1,453	1,443	7,615
Exploratory Technology Research	4,127	6,279	6,343
Total, Energy Storage	22,505	24,442	31,139
Advanced Power Electronics	12,827	12,895	13,680
Subsystem Integration and Development			
Light Vehicle Propulsion and Ancillary Subsystems	3,534	3,594	4,603
Heavy Vehicle Propulsion and Ancillary Subsystems	5,200	1,815	0
Total, Subsystem Integration and Development	8,734	5,409	4,603
SBIR/STTR	--	1,231	1,419
Total, Hybrid and Electric Propulsion	44,066	43,977	50,841

Description

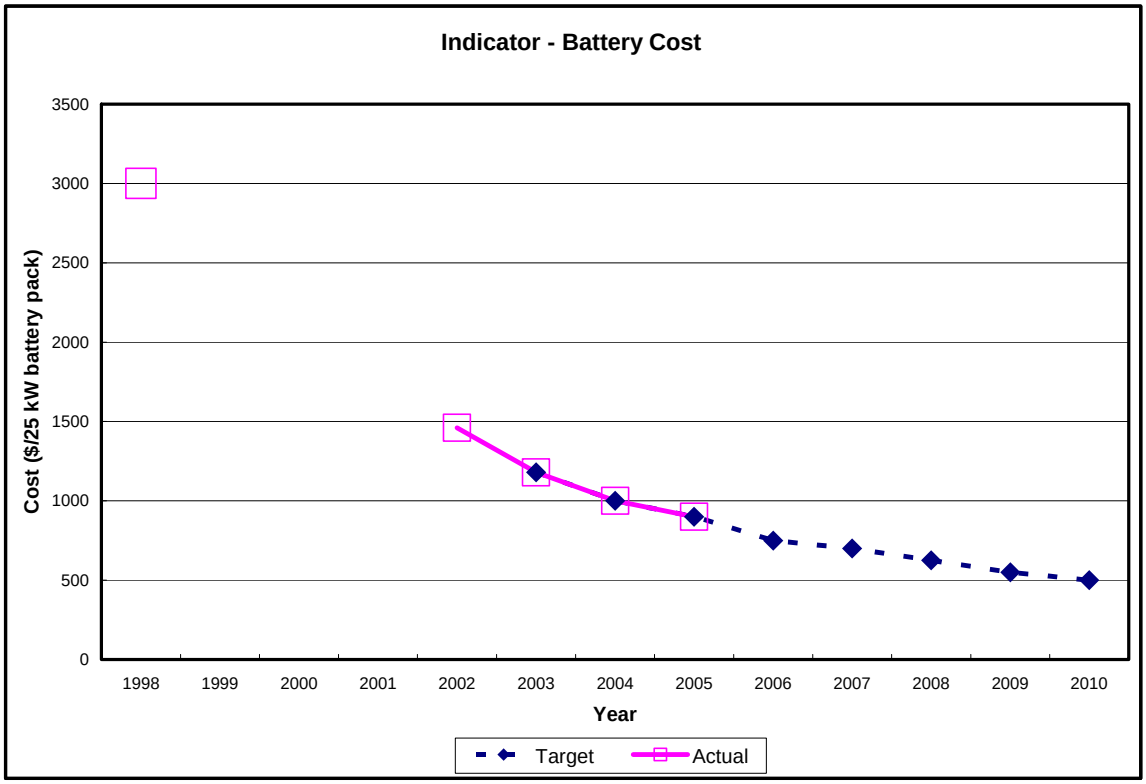
The Hybrid and Electric Propulsion subprogram funds research and development for both passenger and commercial vehicles. R&D efforts include research in energy storage systems, advanced power-electronics and electric motors, and hybrid system development and integration, including new activities in FY 2007 on "plug-in" hybrids. There are three activities: Energy Storage, Advanced Power Electronics, and Subsystem Integration and Development.

Benefits

The Hybrid and Electric Propulsion subprogram supports achieving the VT Program goal (04.02.00.00) by addressing those technology elements important to the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs.

A key objective of the Hybrid and Electric Propulsion R&D subprogram is to reduce the production cost of a high-power 25 kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by 2010 (with an intermediate goal of $750 in 2006), helping to enable cost competitive market entry of hybrid vehicles. Also by 2010, develop an integrated electric propulsion system that costs no more than $12/kW peak and can deliver at least 55 kW of power for 18 seconds and 30 kW of continuous power, with a lifetime of 15 years.

Progress is indicated by cost per 25 kW battery system estimated for a production level of 100,000 battery systems per year. Actual and projected progress for this factor is shown graphically below:



Note: 1998 value is baseline.

Additionally in FY 2007, the subprogram will accelerate the development of low-cost, high-energy batteries and corresponding improvements to the electric drive systems (motors, power electronics, and electric controls) needed for cost-effective "plug-in" hybrid electric vehicles. "Plug-in" hybrids (i.e., those that can be plugged in and recharged from the electric grid) offer a potential to provide significant additional fuel savings benefits, particularly for commuter and local driving, for either combustion or fuel cell powered hybrid passenger vehicles.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Energy Storage	**22,505**	**24,442**	**31,139**

The Energy Storage activity supports long-term research, applied research, and technology development for both passenger and commercial vehicles. Long-term research is focused on developing advanced energy storage technologies for electric and hybrid-electric vehicle (EV and HEV) applications. Applied research is focused on the development and validation of low-cost, abuse-tolerant, and long-life batteries for hybrid vehicle applications. Technology development for all passenger vehicle energy storage is conducted with industry through the United States Advanced Battery Consortium (USABC). All USABC subcontracts to develop advanced vehicle batteries for hybrid and electric passenger vehicles are awarded under a competitive process and are cost-shared by the developers.

The VT Energy Storage activity coordinates with other DOE programs doing relevant work in advanced battery technologies in order to maximize the return on DOE technology investments in this area. Close cooperation between the VT Energy Storage activity and the Office of Science has resulted in several SBIR/STTR contracts that have provided valuable support to EV and HEV battery development efforts. The activity also coordinates with the Energy Storage Program in the Office of Electricity Delivery and Energy Reliability on the development of batteries and components that might serve both transportation and stationary applications. Interagency coordination on advanced battery development is conducted through the government-sponsored Interagency Advanced Power Group (IAPG). The IAPG brings together representatives from the Department of Energy, NASA, the Army, the Navy, and the Air Force to exchange information about agency programs related to energy storage, generation, and conversion. The IAPG is managed by a Steering Committee of senior agency staff. Discussions are carried out through meetings of working groups that bring together technical experts on a regular basis. The Chemical Working Group covers batteries, fuel cells, and capacitors. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **High Power Energy Storage**	**16,925**	**16,720**	**17,181**

Lithium-ion batteries offer twice the performance in a lower-cost, lower weight, lower volume package than the nickel metal hydride batteries developed by DOE and used in today's hybrid electric vehicles. In FY 2007, continue to develop full-sized lithium-ion cells using low-cost, stable, high-performance cathode materials such as manganese oxide. Evaluate novel approaches to enhance the tolerance of batteries to overcharge and/or exposure to high temperatures. Continue early-stage development of an advanced battery for use in fuel cell hybrid vehicles. Develop

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

battery requirements and assess battery technology for "plug-in" hybrid vehicles. Conduct benchmark testing and assessments of non-battery energy storage devices, such as ultracapacitors, that might be applicable in hybrid vehicle systems. This activity also supports cost-shared contracts, through the United States Advanced Battery Consortium, with multiple battery suppliers to develop batteries meeting the FreedomCAR requirements. (FreedomCAR, $17,181,000).

▪ **Advanced Battery Development**	**1,453**	**1,443**	**7,615**

In FY 2007, accelerate the benchmarking of candidate technologies for electric vehicle and "plug-in" hybrid applications. Possible candidates include advanced high-energy lithium-ion systems with gel and/or polymer electrolytes. Combine data from these studies with similar data from other development contracts to identify areas for additional R&D, particularly addressing the needs of "plug-in" hybrid vehicles. Based on positive assessment results, competitively select one or more manufacturers or teams of manufacturers and researchers to develop and begin production of cost-effective batteries suitable for either electric vehicle or "plug-in" hybrid application. (FreedomCAR, $7,615,000).

▪ **Exploratory Technology Research**	**4,127**	**6,279**	**6,343**

In FY 2007, examine innovative energy storage systems that offer the potential for significant improvements over existing technologies for use in both electric and hybrid electric vehicles. These efforts are being coordinated with the Office of Science to assure best utilization of the research efforts. Synthesize novel materials offering the possibility for improved cell performance, life, or cost. Develop and characterize novel anode and cathode materials and electrolytes that have higher energy capability, longer and more stable cycling characteristics, and are lower in cost. In particular, investigate multivalent and alloy based electrodes (such as Sn-based intermetallic alloys of Cu, Sb, and Mg), and electrodes fabricated from higher purity metals, including pure Li.

Continue to develop advanced diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries. Develop and apply electrochemical models to understand failure mechanisms and the mechanisms of thermal runaway in lithium batteries. In particular, measure thermal characteristics of batteries and create and use computer-aided design tools to develop configurations with improved thermal performance. Re-evaluate, investigate, and develop solid polymer electrolytes with high room temperature conductivity and good mechanical strength and improved safety. (FreedomCAR, $6,343,000).

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Advanced Power Electronics	**12,827**	**12,895**	**13,680**

The Advanced Power Electronics activity includes R&D on power electronics, electric motors and other components, and thermal-management systems that are necessary for the development and ultimate adoption of fuel cell and advanced high-efficiency combustion-engine hybrid vehicles. This also includes supporting R&D on capacitors, magnets and wide bandgap (SiC) components for advanced power electronics technologies.

In FY 2007, key efforts will be integrated inverters, advanced permanent magnet motors, DC/DC converters, SiC components, low-cost permanent magnet materials, capacitors, advanced thermal systems, and motor control systems to meet passenger vehicle requirements. Existing work in these areas will be expanded to address the different demands created by "plug-in" hybrid systems. While fundamentally a passenger vehicle activity, applicability and synergisms of technologies to commercial vehicles will be evaluated by maintaining close collaboration among researchers, device manufacturers, and users of the technologies for both passenger vehicles and commercial vehicles. R&D contract deliverables will be tested at National Laboratories for validation of performance and conformance to specifications. Crosscutting technologies will also be evaluated for potential application synergisms between passenger and commercial vehicle applications. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $13,680,000).

Subsystem Integration and Development	**8,734**	**5,409**	**4,603**

Subsystem Integration and Development supports work to validate achievement of technical targets for components and subsystems by emulating a vehicle operating environment for passenger and commercial vehicles using hardware-in-the-loop testing. This activity also benchmarks and characterizes advanced commercial vehicles and components to determine commercial progress against research performance goals. Data are gathered to validate simulation models used to predict fuel economy and emissions using advanced controls and configurations for hybrid vehicles. Commercial hybrid efforts support research and development of advanced, cost-effective components and systems to improve fuel economy by up to 100 percent while meeting 2007 emission standards. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **Light Vehicle Propulsion and Ancillary**	**3,534**	**3,594**	**4,603**

In FY 2007, use hardware-in-the-loop techniques to emulate fuel cell propulsion systems to determine systems interactions required for vehicle system integration (e.g., energy storage requirements for different fuel cell subsystem technologies and configurations). Enhance engine

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

emission models to analyze the impact of emissions control on fuel economy. Conduct hardware studies using HIL to determine the impact of expected emission control requirements on fuel economy of advanced hybrid passenger vehicle systems. Validate, in a systems environment, performance targets for deliverables from the power electronics and energy storage technology research and development activities. Utilize advanced vehicle data from the Testing and Evaluation activity to enhance and validate the PSAT model and determine progress toward meeting FreedomCAR goals. (FreedomCAR $4,603,000)

▪ **Heavy Vehicle Propulsion and Ancillary Subsystems**	**5,200**	**1,815**	**0**

In FY 2006, the program will close out development of advanced heavy hybrid components and systems in support of the 21CT Partnership. The R&D progress to date will be documented and transferred to industry for commercialization. The close out of these activities will allow funds to be applied in areas with larger market, environmental, and energy security benefits. (21CT $0)

SBIR/STTR	**--**	**1,231**	**1,419**

In FY 2005, $1,049,769 and $122,140 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program. (FreedomCAR, $1,419,000; 21CT, $0)

Total, Hybrid and Electric Propulsion	**44,066**	**43,977**	**50,841**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Energy Storage	
▪ **High Power Energy Storage**	
Increased funding will be used to develop high-capacity materials for ultracapacitators	+461

	FY 2007 vs. FY 2006 ($000)
▪ **Advanced Battery Development**	
The increase in Advanced Battery Development will be used to expand benchmarking activities of candidate battery technologies for electric vehicle and "plug-in" hybrid applications, develop battery performance requirements for "plug-in" hybrid vehicles, and potentially initiate a development contract for most promising candidate, and expand research in high energy battery technologies. Advancing battery storage capacity beyond the minimum needed for hybrid vehicle use could offer substantial additional environmental and energy-security benefits. This increase is consistent with RDIC: it builds on and complements existing R&D in order to achieve additional public benefits	+6,172
▪ **Exploratory Technology Research**	
Increased funding will be used to update cell fabrication capability at DOE laboratories.....	+64
Total, Energy Storage	**+6,697**
Advanced Power Electronics	
This increase reflects both a reduction in funding for some current activities where industry is prepared to bear a larger share of the cost and an increase for development of power electronics, electric motors and motor control systems, and other components optimized for use in a "plug-in" hybrid. This shift reflects the RDIC considerations of appropriate Federal role and requiring the maximum reasonable cost-sharing from industry.....	+785
Subsystem Integration and Development	
▪ **Light Vehicle Propulsion and Ancillary Subsystems**	
The FY 2007 increase in funding for Light Vehicle Propulsion and Ancillary Subsystems activities is necessary to conduct hardware-in-the-loop component benchmarking and validation activities, as well as vehicle and systems benchmarking for advanced "plug-in" hybrid electric vehicles. These activities will be conducted using the Advanced Powertrain Research Facility located at Argonne National Laboratory, in collaboration with component technology researchers from other DOE National Laboratories	+1,009

	FY 2007 vs. FY 2006 ($000)
▪ **Heavy Vehicle Propulsion and Ancillary Subsystems**	
In FY 2007, this sub-activity has been terminated so as to focus efforts on R&D with a potential for greater contribution to reduced oil consumption.....	-1,815
Total, Subsystem Integration and Development	**-806**
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities.....	+188
Total Funding Change, Hybrid and Electric Propulsion	**+6,864**

Advanced Combustion Engine R&D

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Advanced Combustion Engine R&D			
Combustion and Emission Control	26,397	23,961	23,864
Heavy Truck Engine	13,474	10,728	14,490
Waste Heat Recovery	3,346	3,849	4,569
Off-Highway Engine R&D	3,362	3,368	0
Health Impacts	1,901	2,406	2,479
SBIR/STTR	--	1,276	1,304
Total, Advanced Combustion Engine R&D	48,480	45,588	46,706

Description

The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines in passenger and commercial vehicles. The goals are to improve the efficiency of internal combustion engines for passenger vehicle applications from 30 percent in 2002 to 45 percent by 2010, and for commercial vehicles from 40 percent in 2002 to 55 percent by 2013, while meeting cost, durability, and emissions constraints. Research is conducted in collaboration with industry and industry partnerships, National Laboratories, and universities. The Advanced Combustion Engine R&D subprogram includes Combustion and Emission Control R&D, Heavy Truck Engine R&D, Waste Heat Recovery R&D, and Health Impacts Research Activities.

Benefits

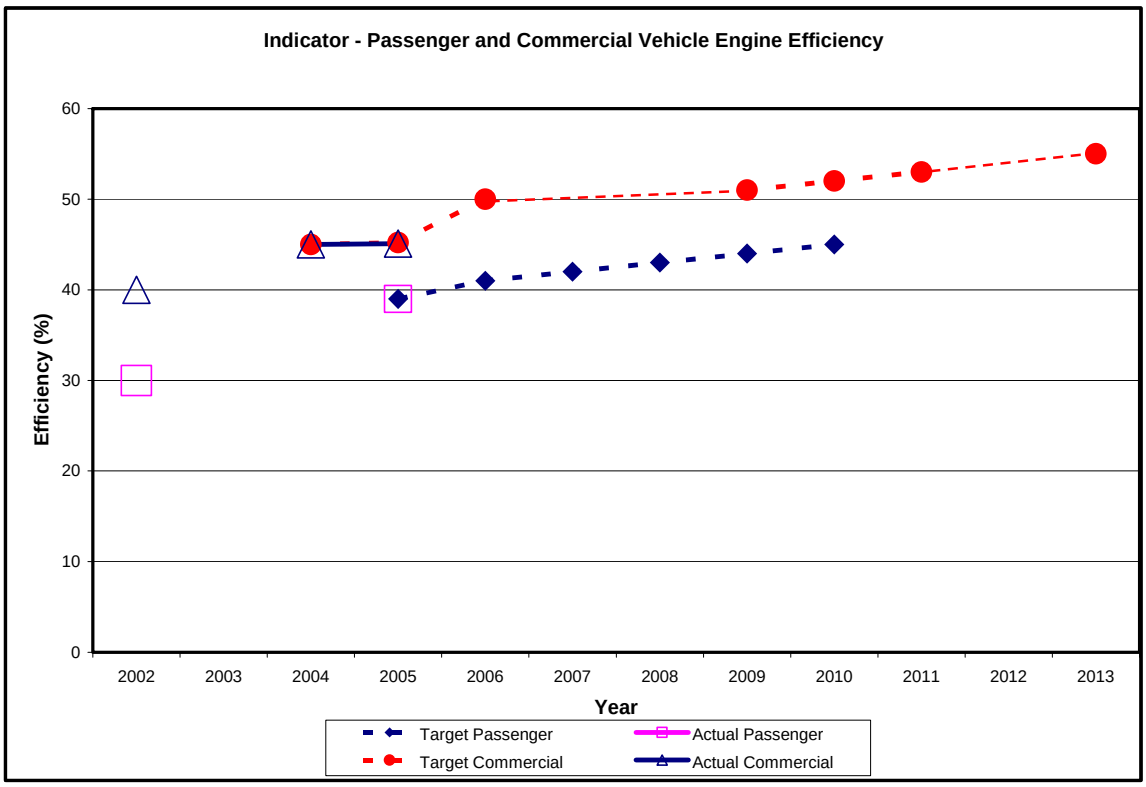
The most promising method to reduce petroleum consumption in the mid-term (10-20 years) and until fuel cell hybrid vehicles dominate the market is to develop high efficiency combustion engines and enable their introduction in conventional and hybrid electric vehicles. Improvements in engine efficiency alone have the potential of increasing fuel efficiency by 40 to 50 percent. Accelerated research on advanced combustion regimes, including homogeneous charge compression ignition (HCCI) and other modes of low-temperature combustion, is aimed at realizing this potential and making a major contribution to improving the U.S. energy security, environment, and economy. This research will benefit from the synergies of the program's cooperative efforts with the Distributed Energy Program, which focuses on natural-gas-fueled HCCI research.

The Advanced Combustion Engine R&D subprogram and Fuel Technology subprogram will contribute to the Vehicle Technologies Program goals by dramatically improving the efficiency of internal combustion engines and will identify fuel properties that improve the system efficiency or can displace

petroleum based fuels. Improved efficiency and petroleum displacement both can directly reduce petroleum consumption.

The key objective is to meet the FreedomCAR and 21st Century Truck goals to improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to an estimated 45 percent by 2010 for passenger vehicles and from 40 percent (2002 baseline) to 55 percent by 2013 for commercial vehicles. An advanced fuel formulation will be utilized that incorporates a non-petroleum based blending agent to reduce petroleum dependence while enhancing combustion efficiency.

Progress is indicated by efficiency of passenger and commercial vehicle internal combustion engines.



Note: 2002 value is baseline.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Combustion and Emission Control	**26,397**	**23,961**	**23,864**

The Combustion and Emission Control R&D activity supports the Vehicle Technologies Program goal to enable energy-efficient, clean vehicles powered by advanced internal combustion engines using clean, petroleum- and non-petroleum-based fuels and hydrogen**.** Although advanced diesel engine technology has demonstrated short-term Tier 2 emissions performance, energy consumption, cost and

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

durability of the emission control system will limit the rate of market penetration. The research in this activity focuses on developing technologies for passenger and commercial vehicle engines operating in advanced combustion regimes, including Homogeneous Charge Compression Ignition (HCCI) and other modes of low-temperature combustion (LTC), which will increase efficiency beyond current advanced diesel levels and reduce engine-out emissions of NO_x and PM to near-zero levels. This will allow the use of lower-cost emission control systems with little or no energy consumption and greater durability. By overcoming these challenges, more efficient combustion engines can be cost-competitive with current gasoline engines and will gain greater market penetration in passenger vehicles. Also, this activity will be closely coordinated with the Fuels Technology subprogram since different fuel characteristics and reduced property variability may be needed to meet the goals.

In FY 2007, increase emphasis on research and development of advanced combustion regimes that achieve FreedomCAR and 21st Century Truck efficiency goals for passenger and commercial vehicles while maintaining cost and durability with near-zero regulated emissions.

Conduct optical laser diagnostics of in-cylinder combustion process for advanced combustion regimes such as, HCCI, other modes of LTC and mixed-mode regimes. Continue cost-shared cooperative agreements awarded in FY 2005 to develop innovative component technologies such as variable valve timing and variable compression ratio, that enable cost effective implementation of advanced combustion regimes with high efficiency and near-zero emissions of NO_x and PM. Through simulation and experimentation, conduct R&D on advanced thermodynamic strategies that will enable engines to approach 60 percent thermal efficiency. Utilize laser-based, optical diagnostics to conduct in-cylinder engine research focused on overcoming barriers to the development of high-efficiency, hydrogen-fueled IC engine technology in coordination with the HFCIT Program. Continue development of detailed chemical kinetic modeling of advanced combustion regimes and emissions processes, including fuel composition effects, to aid the development of advanced, high-efficiency combustion engines using LTC and mixed-mode combustion regimes. Utilize X-rays from the Advanced Photon Source to study fuel-injection spray characteristics near the injection nozzle.

Engine/Emission Controls Integration: Focus of effort is to reduce cost, and improve the performance and durability of NO_x and particulate matter (PM) sensors, variable valve timing and variable compression ratio through cost-shared cooperative research and development agreements (CRADAs) and cooperative agreements with automotive suppliers and universities.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $20,184,000; 21CT, $3,680,000).

Heavy Truck Engine	**13,474**	**10,728**	**14,490**

The Heavy Truck Engine activity develops technologies for diesel engines, such as optimized combustion, fuel injection, emissions control, and waste heat recovery systems, along with reduced friction and pumping losses, with the goal of improving the thermal efficiency to 55 percent by 2013,

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

(from 40 percent in 2002) while meeting Federal emissions standards.

In FY 2007, continue cooperative agreements awarded in FY 2005 to improve engine efficiency through the utilization of advanced combustion regimes (HCCI, LTC and mixed-mode), which are capable of reducing engine-out emissions to near-zero levels of NO_x and PM. This approach will result in a reduced need for emission control equipment, which has a negative impact on fuel economy, cost and durability. Develop and integrate NO_x adsorbers, sulfur traps and PM filters to meet the durability requirement of 435,000 miles for commercial vehicles while meeting emission standards. Continue to optimize fuel injection and waste heat recovery systems, and reduce friction and pumping losses. Continue to evaluate emission control technologies from the Combustion and Emission Control R&D Subprogram for the higher pressures, temperatures, and durability requirements of heavy diesel engines. Issue a competitive solicitation for cost-shared cooperative agreements to develop advanced engine technologies to achieve 55 percent thermal efficiency by 2013 while meeting emission standards. Address the need for advanced components and new approaches to enable better utilization of advanced combustion regimes that will significantly reduce the risk involved in achieving the program efficiency goals. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (21CT, $14,490,000).

Waste Heat Recovery	**3,346**	**3,849**	**4,569**

The Waste Heat Recovery activity develops technologies to convert waste heat from engines to electrical energy or work to improve overall thermal efficiency and reduce emissions.

In FY 2007, continue cost-shared cooperative agreements awarded in FY 2004 and FY 2005 to develop and fabricate devices that will recover energy from waste engine heat. Develop high efficiency thermoelectric devices that will recover greater than 5 kilowatts of electric power from engine waste heat for passenger vehicle and up to 20kW for commercial vehicle application. For these waste heat applications, demonstrate conversion efficiencies greater than 15 percent using direct energy conversion methods, such as thermoelectrics, thermoionics, quantum well, or other innovative concepts. Also, develop and integrate turbo-compound unit with engine and control system, for commercial vehicle application, to produce up to 20kW from engine waste heat. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $763,000; 21CT, $3,806,000).

Off-Highway Engine R&D	**3,362**	**3,368**	**0**

Activities are being concluded in FY 2006 in order to focus on other research opportunities having significantly higher potential for energy savings. Off-highway vehicle manufacturers were among recipients for the cooperative agreements awarded in 2005 to improve engine efficiency through the utilization of advanced combustion regimes.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Health Impacts	**1,901**	**2,406**	**2,479**

The Health Impacts activity evaluates the relative toxicity and consequent health implications for people of emissions from new vehicle technologies developed to meet energy efficiency goals. As the prime mover behind the development of clean diesel engine technology, the Department has a large stake in ensuring that unanticipated deleterious health impacts do not arise from the large-scale deployment of this fuel economy improving technology.

In FY 2007, the second full year of the Advanced Collaborative Emissions Study (ACES), sample collection from 2007 emissions compliant commercial vehicle diesel engines will be completed and any observed acute toxicity response will be reported. Chronic inhalation toxicity response tests will continue using specified time period exposures of animal (rats and mice), bacteria (Ames Test), and mammalian lung cells to engine emissions.

While testing heavy duty diesel engines in controlled laboratory experiments and collecting emissions samples as in the ACES agreement activity, the program also needs to identify potential toxins from new technology engines and fuel compositions. These results will establish a baseline for comparing the expected changes in emissions profiles as the new combustion engine technologies and fuel formulations enter the market.

Because it is quite difficult to collect physical samples of vehicular emissions from moving cars and trucks, an effort to determine the ability to identify and characterize emissions via remote sensing techniques is being carried out at the heavily traveled Watt Road Truck Stop intersection in Knoxville, TN. This research activity, if successful, will enable “on the fly” monitoring and measurement of regulated emissions components from cars and trucks without actually collecting samples from the tailpipe. In FY 2007 continuous monitoring of air toxics (e.g. formaldehyde, benzene, etc.) will be completed and source apportionment techniques will be investigated to determine the most reliable method. Large scale eddy modeling will begin to determine “mixing” parameters occurring in dynamic roadside locations. (21CT, $2,479,000).

SBIR/STTR	**--**	**1,276**	**1,304**

In FY 2005, $1,135,552 and $141,495 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program. (FreedomCAR, $602,000; 21CT, $702,000).

Total, Advanced Combustion Engine R&D	**48,480**	**45,588**	**46,706**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Combustion and Emission Control	
The reduction reflects a focus on advanced combustion regimes that could achieve FreedomCar and 21st Century Truck efficiency goals	-97
Heavy Truck Engine	
The increase in funding will accelerate research efforts to improve engine efficiency through the development of technologies that enable the use of advanced combustion regimes. The additional funding is required to issue a new cost-shared solicitation planned for FY 2007 with the goal of improving the thermal efficiency to 55 percent by 2013 (from 40 percent in 2002), while meeting Federal emissions standards.	
(Consistent with the RDIC, because it addresses market barriers to private sector investment, requires cost-sharing, and builds on current technology and R&D.)	+3,762
Waste Heat Recovery	
Additional funds will accelerate research efforts to fabricate and improve the efficiency of devices that convert waste heat to electricity and useful work. This includes the development of advanced thermoelectric devices that are still at an early stage of development for transportation use and have only recently shown potential for dramatic efficiency improvements. Additional funding is required to continue the cost-shared cooperative agreements to the fabrication phase and evaluate the potential of this technology. (Consistent with RDIC, because it addresses market barriers to private sector investment and complements other existing areas of R&D.)	+720
Off-Highway Engine R&D	
Termination of the off-highway activity allows greater focus on other research opportunities having a higher potential for petroleum savings. This is consistent with the RDIC criteria emphasizing planning using performance indicators and an activity's effectiveness and anticipated benefits	-3,368
Health Impacts	
The increase will allow work to begin on developing new, more sensitive toxicity test and analysis protocols suited to the more stringent EPA emissions standards that will take effect in 2010	+73
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+28
Total Funding Change, Advanced Combustion Engine R&D	**+1,118**

Materials Technology

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Materials Technology			
Propulsion Materials Technology			
Automotive Propulsion Materials	1,913	1,828	1,944
Heavy Vehicle Propulsion Materials	4,600	4,273	3,900
Total, Propulsion Materials Technology	6,513	6,101	5,844
Lightweight Materials Technology			
Automotive Lightweight Materials	16,260	18,283	18,737
Heavy Vehicle High-Strength Weight-Reduction Materials	7,410	2,694	0
Total, Lightweight Materials Technology	23,670	20,977	18,737
High Temperature Materials Laboratory	5,859	7,217	4,374
SBIR/STTR	--	974	831
Total, Materials Technology	36,042	35,269	29,786

Description

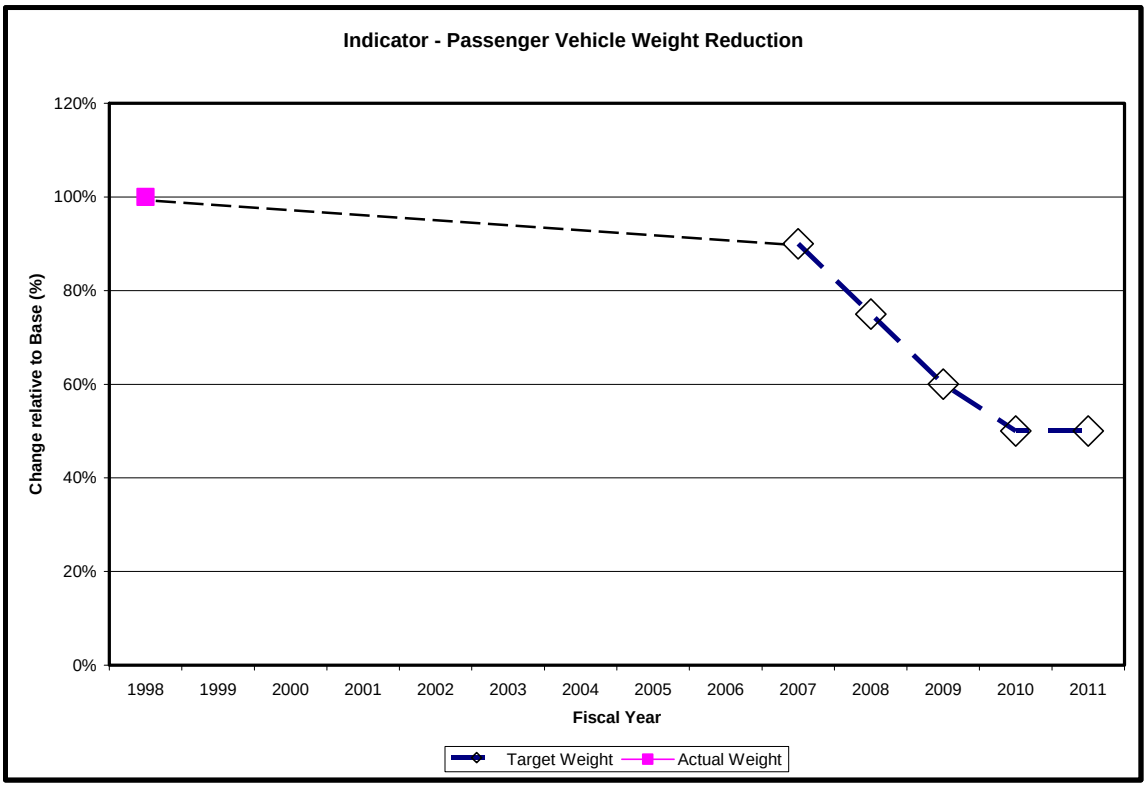
The Materials Technologies subprogram supports the development of cost-effective materials and materials manufacturing processes that can contribute to fuel-efficient passenger and commercial vehicles. This subprogram is a critical enabler for concepts developed elsewhere in the FreedomCAR and 21st Century Truck budgets. The subprogram consists of three activities: Propulsion Materials Technology, Lightweight Materials Technology, and the High-Temperature Materials Laboratory (HTML).

Benefits

The Materials Technology subprogram contributes to the VT Program goal by developing better, more cost effective materials that will make lighter vehicle structures and more efficient power systems possible. Lighter vehicles (that provide comparable safety) require less energy to operate and thus reduce fuel consumption. Likewise, better propulsion materials can enable more efficient power systems, thus also contributing to a vehicle's reduced energy consumption.

A key subprogram goal for the transportation Materials Technologies R&D activity is to develop material and manufacturing technologies by 2010 that, if implemented in high volume, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50 percent with safety, performance, and recyclability comparable to that of 2002 vehicles. This is a broader goal than the previous goal of reducing the projected mass-production price of carbon-fiber materials to $3 per

pound, which EERE expects to achieve by the end of FY 2006. The broader goal encompasses both further progress in carbon-fiber composites and advances in a variety of other lightweight automotive materials.



Note: 1998 value is baseline

A related milestone that will contribute to the VT Program goal is:

In 2007, develop and validate Materials Technologies that will commence full operation of the carbon fiber pilot line at ORNL to validate carbon fiber processing technologies.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Propulsion Materials Technology.....	**6,513**	**6,101**	**5,844**

Propulsion Materials Technology develops technologies that can dramatically improve the efficiency of engines and electric drive systems of personal and commercial vehicles. Propulsion materials include improved materials for engines, valve trains, fuel injectors, thermal management systems, and electric motors. In addition, these funds may be used to support efforts such as peer reviews; data

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

collection and dissemination; and technical, market, economic, and other analyses.

- **Automotive Propulsion Materials** **1,913** **1,828** **1,944**

  Develop and characterize specialized materials, such as magnets and sensors, for electric drive system components and advanced combustion engines. Ramp up efforts to develop durable, specialized propulsion materials for hydrogen and advanced combustion regime engines. Improve the performance of prototype electrochemical NO_x sensors with industrial partners. (FreedomCAR, $1,944,000).

- **Heavy Vehicle Propulsion Materials**..... **4,600** **4,273** **3,900**

  In FY 2007, complete the design of a titanium engine block and head and calculate the resulting efficiency gain compared to cast iron class 8 tractor engine blocks. Extend this modeling approach to aluminum and magnesium engine blocks to compare potential benefits with those for titanium. Relate ceramic processing to improved fracture toughness and ductility of novel ceramics to replace metal parts with cost-effective, lightweight, durable ceramics. Characterize the effects of electromagnetic fields on the deformation, processing, and machining of both metal and ceramic materials with regard to their use in high efficiency diesel engine components. Continue investigation of new surface modification techniques to reduce friction/wear in engine components to increase fuel efficiency without sacrificing durability. Measure critical performance parameters for lightweight intermetallics, ceramic matrix composites, and cermets for applications in components of advanced high-performance, fuel-efficient diesel engines. Continue characterization of rolling contact fatigue, integrated surface modification of materials, and new applications for magnesium. (21CT, $3,900,000).

Lightweight Materials Technology..... **23,670** **20,977** **18,737**

Lightweight Materials Technology activity develops materials and materials processes for manufacturing and recycling vehicle components out of advanced lightweight materials while maintaining safety, performance, and reducing cost. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

- **Automotive Lightweight Materials** **16,260** **18,283** **18,737**

  This sub-activity supports R&D on advanced concepts for light weighting of light-duty vehicles. The light weighting is done by substitution of lower density or stronger dense materials for current materials. Since cost-effectiveness is the major challenge, the element also supports R&D on designing and manufacturing those materials into components and structures. In Phase 1, from about 1994 to 2001, emphasis was on aluminum and glass-fiber reinforced polymer matrix composites (PMCs) in order to achieve a 40 percent reduction in weight; some of the technologies developed in that phase have already been introduced in production vehicles. In Phase 2, from

about 2002 to 2006, emphasis is on exploration and development of materials of even greater light weighting potential needed to meet the FreedomCAR goal of 50 percent weight reduction. Phase 2 materials included carbon-fiber-reinforced PMCs (carbon-FRPMCs), magnesium, advanced high-strength steels (AHSSs), titanium and metal-matrix composites. FY 2007 is the ramp-up year of the third phase in which efforts will be dominated by the design and manufacturing of lightweight components made from the various materials researched and developed in previous years. The objective is to lower the potential costs and cost uncertainties even further toward the FY 2010 goal of cost neutrality.

The National Academies, in their peer review of FreedomCAR activities, have emphasized the value of continuing to work on reducing the cost of carbon-fiber composites suitable for automotive applications. Consistent with that finding, a major portion of the Automotive Lightweight Materials continues to support research, development, and validation of the design and manufacturing of automotive grade structural carbon fiber and carbon-fiber–reinforced polymer-matrix composite (carbon-FRPMC) structures, as it has in previous years. (From 1998 through 2006, EERE's research has brought the projected mass-production cost of automotive carbon-fiber materials down from $12 per pound to $3 per pound.) Some projects on natural-FRPMCs and predictive modeling of FRPMCs will be continuing from FY 2006. The processing line at ORNL for integrating and validating advanced technologies developed in previous years for production of low-cost carbon fiber, will be in full operation. R&D on design and manufacture of cost-effective components and structures from magnesium, low-cost titanium and AHSSs will continue. A project exploring the casting of very large, integrated (one-piece) subassemblies from magnesium and aluminum will conclude. Efforts on stamping and joining of aluminum, AHSS and magnesium sheet, on-line/real-time, nondestructive evaluations/inspections, and recycling will continue at roughly the pace of FY 2006. (FreedomCAR, $18,737,000)

- **Heavy Vehicle High-Strength Weight-Reduction Materials** **7,410** **2,694** **0**

  Development of lightweight materials and processing technologies for commercial vehicle applications will be closed out in FY 2007. The results of research to date will be transferred to industry for commercialization. (21CT, $0).

High Temperature Materials Laboratory **5,859** **7,217** **4,374**

The High Temperature Materials Laboratory (HTML) activity is an advanced materials R&D industrial user center located at the Oak Ridge National Laboratory. The HTML strives to maintain world-class, state-of-the-art advanced materials characterization capabilities not available elsewhere and makes them available to U.S. industries for use in solving complex materials problems. It develops cutting-edge analytical techniques to identify innovative materials for use in transportation applications. Activities include the investigation and determination of the physical and chemical properties and performance characteristics of metals, alloys, ceramics, composites and even novel

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

nano-phase materials under development for vehicle applications.

In FY 2007, the new sub-angstrom level clear imaging and chemical analysis capabilities of the Aberration Corrected Electron Microscope (ACEM) will continue to be applied to study and characterize various formulations of lean NO_x and NO_x adsorber emissions-control catalytic materials identified as promising candidates by the FreedomCAR and 21st Century Truck partnerships. Such catalysts will enable higher efficiency diesel engines to meet emissions regulations and thereby be capable of replacing lower efficiency spark ignition engines in automobiles, light trucks and commercial vehicles. Selected members of the characterized catalysts will be submitted for computational modeling in order to understand, predict, and simulate modifications to their mechanisms of catalytic action. (HTML $4,374,000)

SBIR/STTR	**--**	**974**	**831**

In FY 2005, $858,428 and $99,901 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program. (FreedomCAR, $595,000; 21CT, $112,000).

Total, Materials Technology	**36,042**	**35,269**	**29,786**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Propulsion Materials Technology	
▪ **Automotive Propulsion Materials**	
Increase emphasis on materials for advanced combustion engines	+116
▪ **Heavy Vehicle Propulsion Materials**	
The decrease in FY 2007 reflects a refocusing of this research on materials with the greatest potential for improving thermal management in heavy-duty engines	-373
Total, Propulsion Materials Technology	**-257**
Lightweight Materials Technology	
▪ **Automotive Lightweight Materials**	
The increase will allow full operation of the advanced carbon-fiber process validation line at ORNL, which integrates advanced technologies developed in	+454

	FY 2007 vs. FY 2006 ($000)
previous years	
▪ **Heavy Vehicle High-Strength Weight-Reduction Materials**	
Research on heavy-vehicle weight reduction is terminated in FY 2007, and the funds are applied in areas with greater potential contributions to petroleum displacement and energy security consistent with the RDIC emphasis on public benefits and technology "off-ramps"	-2,694
Total, Lightweight Materials Technology	**-2,240**
High Temperature Materials Laboratory	
The Design of the VULCAN Neutron Port on the operational Spalation Neutron Source (SNS) was completed in FY 2006	-2,843
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	-143
Total Funding Change, Materials Technology	**-5,483**

Fuels Technology

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Fuels Technology			
Advanced Petroleum Based Fuels	5,724	6,255	6,511
Non-Petroleum Based Fuels and Lubricants			
Medium Trucks	1,249	0	0
Heavy Trucks	672	0	0
Fueling Infrastructure	1,152	0	0
Renewable and Synthetic Fuels Utilization	2,662	7,070	6,948
Total, Non-Petroleum Based Fuels and Lubricants	5,735	7,070	6,948
Environmental Impacts	960	0	0
SBIR/STTR	--	384	386
Total, Fuels Technology	12,419	13,709	13,845

Description

The Fuels Technology subprogram supports R&D that will provide vehicle users with cost competitive fuel options that enable high fuel economy, deliver low emissions, and contribute to petroleum displacement. Future refinery feedstocks will increasingly be from non conventional sources including, but not limited to, oil sands, shale oil, and tar sands. The focus is to assess mid- to long-term changes in the make-up of refinery feedstocks and identify the best use of these to produce a refining product that matches the needs of extremely-efficient internal combustion engines that are envisioned for the post-2010 time frame. This subprogram supports the mission of the Vehicle Technologies Program (VT) to develop more energy-efficient and environmentally-friendly highway transportation vehicles that enable America to use less petroleum. It consists of two activities: Advanced Petroleum-Based Fuels (APBF) and Non-Petroleum-Based Fuels and Lubricants (NPBFL).

Benefits

The APBF and NPBFL activities are undertaken: (1) to enable post-2010 advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and, (2) to reduce reliance on petroleum-based fuels. To differentiate these two activities, an advanced petroleum-based fuel is envisioned as consisting of highly-refined petroleum-base fuel derived from what are considered to be future refinery feedstocks, possibly blended with performance-enhancing non-petroleum additives derived from renewable resources such as biomass or from non-petroleum fossil resources such as natural gas or coal. In contrast, a non-petroleum-based fuel consists of a fuel or fuel-blending component derived primarily from non-crude-oil sources such as agricultural products, biomass, natural gas, bitumen, shale, or coal. The benefit of the APBF activity is that it will enable fuel

providers to work cooperatively with engine manufacturers to match up future refinery products with future engine needs. The benefit of NPBFL is that it will provide non-petroleum based blending agents that enable both high fuel economy and direct displacement of petroleum fuels.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Advanced Petroleum Based Fuels (APBF)	**5,724**	**6,255**	**6,511**

The APBF activity develops petroleum-based fuels and lubricants that will enable extremely high efficiency engines for passenger and commercial vehicle applications. This effort employs the expertise and shared funding of the Government, energy companies, and emission control and engine manufacturers. The goal is to identify fuel properties that can enable engines to operate in the highest efficiency mode while meeting future emissions standards.

In FY 2007, initiate activity involving vertically-integrated teams, including passenger vehicle manufacturers and energy companies, to identify fuel-property requirements of post-2010 passenger vehicle advanced internal combustion engines. This activity is crosscutting with the Advanced Combustion Engine subprogram. Utilizing the in-house National Laboratory expertise through multi-partner cooperative research and development agreements (CRADA), continue development of predictive tools that relate molecular structure to ignition behavior and heat release of fuels in commercial vehicle advanced internal combustion engines. This effort is conducted through experimentation and modeling, utilizing Government provided specialized equipment and scientists. Through the combined industry/Government effort two base fuel properties that effect advanced combustion regime engine operation will be identified and optimization of a base fuel will be initiated. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses. (FreedomCAR, $3,000,000; 21CT, $3,511,000).

Non-Petroleum-Based Fuels and Lubricants (NPBFL)...	**5,735**	**7,070**	**6,948**

The NPBFL activity formulates and evaluates biomass-based and synthetic fuels for use as blending agents in advanced combustion regime engines. Specific areas being investigated include molecular make-up, effect on bulk fuel properties, and effect on engine performance, storage, handling, toxicity, and volatility. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **Medium Trucks**	**1,249**	**0**	**0**

In FY 2007, no efforts are planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercialization.

▪ **Heavy Trucks**.....	**672**	**0**	**0**

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2007, no efforts are planned. Prior work in this area that supported natural gas engine/vehicle systems development and the technology is now considered mature and ready for commercial development.

▪ **Fueling Infrastructure**	**1,152**	**0**	**0**

In FY 2007, no efforts are planned. Previous work in this area supported natural gas fueling infrastructure R&D and is now considered mature and ready for commercialization.

▪ **Renewable and Synthetic Fuels Utilization**	**2,662**	**7,070**	**6,948**

In FY 2007, continue development of baseline data on the relationships between molecular structure and bulk fuel properties, ignition behavior, and heat release for renewable and synthetic fuels in advanced combustion regime engines. Continue development of a predictive model based on these data. Continue development of an index to describe and compare the suitability of renewable and synthetic fuels for use in advanced combustion regime engines. (FreedomCAR $3,889,000; 21CT $3,059,000).

Environmental Impacts	**960**	**0**	**0**

In FY 2007, no efforts are planned as work in this area is not considered to be within the mission of DOE.

SBIR/STTR	**--**	**384**	**386**

In FY 2005, $295,797 and $34,424 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program. (FreedomCAR, $196,000; 21CT, $190,000)

Total, Fuels Technology	**12,419**	**13,709**	**13,845**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Advanced Petroleum Based Fuels	
The increase will allow initiation of a new activity involving vertically-integrated teams, including passenger vehicle manufacturers and energy companies, to identify fuel-property requirements of post-2010 passenger-vehicle advanced internal combustion engines	+256

	FY 2007 vs. FY 2006 ($000)
Non-Petroleum Based Fuels and Lubricants	
▪ **Medium Trucks**	
No change	0
▪ **Heavy Trucks**	
No change	0
▪ **Fueling Infrastructure**	
No change	0
▪ **Renewable and Synthetic Fuels Utilization**	
In FY 2007 R&D on road emissions and durability testing of heavy duty trucks operating on Fischer Tropsch fuels will be reduced	-122
Total, Non-Petroleum Based Fuels and Lubricants	**-122**
Environmental Impacts	
No change	0
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities and projected allocation among activities	+2
Total Funding Change, Fuels Technology	**+136**

Technology Introduction

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Introduction			
Legislative and Rulemaking			
State and Fuel Provider Fleet	887	990	990
Private and Local Fleet	99	297	0
Fuel Petitions	0	311	0
Federal Fleets	507	693	700
Regulatory Support	0	198	114
Total, Legislative and Rulemaking	1,493	2,489	1,804
Clean Cities[a]	0	0	4,393
Testing and Evaluation			
Vehicle Evaluation	2,416	2,425	3,484
Infrastructure Testing	49	49	50
Total, Testing and Evaluation	2,465	2,474	3,534
Advanced Vehicle Competitions	986	1,287	1,300
Total, Technology Introduction	4,944	6,250	11,031

Description

The Technology Introduction subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles to help meet national energy and environmental goals. This subprogram's efforts logically follow and complement successful research by industry and government. The primary functions of Technology Introduction are legislative and rulemaking and public education supported are the Energy Policy Acts of 1992 and 2005 (EPAct 1992 and EPAct 2005) alternative fuel and fleet activities; testing and evaluation of advanced technology vehicles; Clean Cities, a public/private partnership between DOE and 88 local coalitions around the Nation, to implement strategies and projects to displace petroleum (which in FY 2005 and 2006 was funded in EERE's Weatherization and Intergovernmental Activities); and advanced vehicle competitions. As identified in the National Energy Policy, consumer education and demonstration activities are critical to accelerating the use of advanced energy technologies.

[a] Clean Cities was funded in Weatherization and Intergovernmental Activities in FY 2005 and FY 2006 under the heading of Gateway Deployment. Comparable funding for FY 2005 and 2006 was $10.626 million and $6.510 million respectively.

Benefits

The Technology Introduction subprogram contributes to the VT Program goal by accelerating the adoption and use of alternative fuels, hybrid and fuel efficient vehicles, and idle reduction technologies in commercial highway vehicles. These fuels and vehicles will reduce the consumption of petroleum-based fuels thus contributing to achieving the program goal. As noted in the Innovative Concepts subprogram, activities such as the Advanced Vehicle Competitions encourage the interest of university engines and engage their participation in advanced technology development. This helps address the need for more highly trained engineers in hybrid technologies to overcome barriers in the market place.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Legislative and Rulemaking	**1,493**	**2,489**	**1,804**

The Legislative and Rulemaking activity consists of the State and Alternative Fuel Provider Regulatory Program, Fuel Petitions, Private and Local Government Fleet Regulatory Program, Federal Fleet requirements and the normal implementation of other EPAct requirements including reports and rulemaking, the analysis of the impact of other regulatory and pending legislative activities, and the implementation of legislative changes to EPAct as they occur. The fleet programs require selected covered fleets to procure alternative fuel passenger vehicles annually as well as the Department's compliance with the Federal fleet requirements. The Department also reviews and processes petitions to designate new alternative fuels under EPAct. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

- **State and Fuel Provider Fleet** **887** **990** **990**

  In FY 2007, promote the use of alternative fuel in the state fleets through outreach and partnership building between the state and alternative fuel providers (EPAct Sec 507 (1992)).

- **Private and Local Fleet**..... **99** **297** **0**

  Beginning in FY 2007, activities in support of this area will be conducted by in-house DOE staff.

- **Fuel Petitions** **0** **311** **0**

  Beginning in FY 2007, activities in support of this area will be conducted by in-house DOE staff.

- **Federal Fleets** **507** **693** **700**

  In FY 2007, continue tracking and reporting Federal Fleet compliance (EO 13149). Upgrade the FAST (Federal Automotive Statistical Tool) system to facilitate the review and analysis of their own fleet data by agencies.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
▪ **Regulatory Support**	**0**	**198**	**114**

In FY 2007, continue tracking and analysis of energy legislation and revised EPAct 2005 Renewable Fuel goal.

Clean Cities.....	**0**	**0**	**4,393**

This program will continue to promote petroleum displacement strategies by working with local Clean Cities coalitions and their partners. Technologies include: alternative fuel vehicles, idling reduction devices in commercial trucks and buses, expanded use of non-petroleum fuel blends, and hybrid technologies. Through regional collaboration and small grants to local coalitions, the program will facilitate local coalition market development, education, and training; conduct peer review opportunities; and continue providing limited technical assistance teams to help address technical niche market issues raised by local Clean Cities coalitions. The program also will continue efforts to provide targeted niche market assistance, analyze market trends, and provide education and training to coalitions about market opportunities in airport, school bus, transit, and municipal fleets.

In support of the National Energy Policy and EPAct 1992 Section 405 to expand consumer education, and to address implementation barriers, the program will: identify and support opportunities to showcase commercially available AFVs, hybrids, idle-reduction technologies, fuel blends and highlight fuel economy and other petroleum reduction activities; publish case studies of successful niche markets for various petroleum reduction technologies; continue to build national and regional alliances to promote petroleum reduction strategies. Efforts to support development of the legislatively mandated Fuel Economy Guide and associated www.fueleconomy.gov website will continue.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

In FY 2005 and 2006, Clean Cities was funded in the Weatherization and Intergovernmental Program, under Gateway Deployment.

Testing and Evaluation.....	**2,465**	**2,474**	**3,534**

The primary goal of the Advanced Vehicle Testing Activity (AVTA) is to benchmark and validate the performance of passenger and commercial vehicles that feature one or more advanced technologies. These include: internal combustion engines burning advanced fuels, such as 100 percent hydrogen and hydrogen/compressed natural gas-blended fuels; hybrid electric, pure electric, and hydraulic drive systems; advanced batteries and engines; and advanced climate control, power electronic, and other ancillary systems.

By benchmarking the performance and capabilities of advanced technologies, the AVTA supports the development of industry and DOE technology targets. The testing results are also input to component, system, and vehicle models, as well as hardware-in-the-loop testing.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

The AVTA develops vehicle test procedures with input from industry and other stakeholders to accurately measure real-world vehicle performance. These test procedures are then applied to production and preproduction advanced technology vehicles on dynamometers and closed test tracks as well as in government, commercial, and industry fleets. The AVTA tests produce unbiased information about vehicles with advanced transportation technologies, which reduces the U.S. dependence on foreign oil, while improving the Nation's air quality. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **Vehicle Evaluation**	**2,416**	**2,425**	**3,484**

In FY 2007, expand the controlled, closed track baseline testing and real-world monitored fleet evaluations of advanced "plug-in" hybrid electric vehicles in cooperation with industry partners. Identify component and system performance and reliability weaknesses to be addressed through future technology R&D activities. Continue testing of first generation hydrogen-fueled internal combustion engine hybrid electric vehicles and initiate testing of second generation advanced hybrid electric vehicles, including hydraulic and ultra-capacitor equipped hybrids. Complete evaluation of first generation hydrogen-fueled internal combustion engine passenger vehicles and electric airport ground support equipment. Expand baseline performance and accelerated reliability testing of new hybrid electric vehicles. Expand data collection on fuel cell and advanced hybrid electric transit buses. Complete initial evaluations of advanced commercial truck idle-reduction devices. Initiate fleet evaluation of passenger fuel cell vehicles.

▪ **Infrastructure Testing**	**49**	**49**	**50**

In FY 2007, continue evaluation of vehicle refueling and recharging systems required for advanced "plug-in" hybrid electric vehicles and hydrogen-fueled vehicles.

Advanced Vehicle Competitions	**986**	**1,287**	**1,300**

Advanced Vehicle Competitions provide educational opportunities for university students to learn and use real-world engineering skills while demonstrating the performance of critical vehicle technologies identified by the Department of Energy and industry. In FY 2007, we will conduct the third year of the Challenge X competition in partnership with General Motors. Selected teams will be challenged to integrate advanced vehicle technologies and appropriate fuels to develop an approach that minimizes use of petroleum fuel. Many students who graduate from these vehicle competitions go on to take jobs in the auto industry where they bring with them an unprecedented appreciation and understanding of advanced automotive technologies. Initiate planning for a follow-on advanced vehicle competition. (FreedomCAR, $1,300,000)

Total, Technology Introduction	**4,944**	**6,250**	**11,031**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Legislative and Rulemaking	
▪ **State and Fuel Provider Fleet**	
No change	0
▪ **Private and Local Fleet**	
Activities are being reduced to increase other within-program priority R&D efforts. A more basic review of progress toward EPAct goals will be undertaken by in-house staff	-297
▪ **Fuel Petitions**	
Actions are being reduced to place greater priority on research and development activities. The use of external expertise to contribute to the effort will be reduced	-311
▪ **Federal Fleets**	
No significant change	+7
▪ **Regulatory Support**	
Reduce funding for tracking and analysis of energy legislation and revisions to the EPAct of 1992 Replacement Fuel goal reflects program streamlining of procedures, data acquisition and data storage	-84
Total, Legislative and Rulemaking	**-685**
Clean Cities	
In FY 2006, Clean Cities was funded in Weatherization and Intergovernmental Activities, in the Gateway Deployment subprogram. The change from comparable FY 2006 requested funding is -$1,510,000. This reflects reductions in technical assistance and outreach efforts for niche applications of "traditional" alternative-fuel vehicles (ethanol and natural gas) and an increase in promotion of near-term petroleum-displacement technologies such as anti-idling technologies for trucks and buses, non-petroleum fuel blends, and hybrid vehicle technologies	+4,393

	FY 2007 vs. FY 2006 ($000)
Testing and Evaluation	
▪ **Vehicle Evaluation**	
Evaluation of "plug-in" hybrids, performance and reliability testing of hybrids, and data collection on fuel cell and hybrid trains and buses are all expanded in cooperation with industry partners, while evaluation of hydrogen internal combustion engines and truck idle reduction devices are concluded. Data from baseline testing and field evaluations will be utilized to validate and enhance computer modeling tools being used in the Simulation and Validation activity to develop control strategies for these vehicles. The data will also be provided to the component technology researchers at DOE National Laboratories and within industry, to help identify necessary component advances and guide future R&D activities	+1,059
▪ **Infrastructure Testing**	
No significant change	+1
Total, Testing and Evaluation	**+1,060**
Advanced Vehicle Competitions	
No significant change	+13
Total Funding Change, Technology Introduction	**+4,781**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	1,877	2,475	0
Total, Technical/Program Management Support	1,877	2,475	0

Description

In the past, consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provided funding for Technical/Program Management Support. This included activities such as R&D feasibility studies; R&D option development and trade-off analyses; and technical, economic, and market evaluations of research. These activities provide important benefits directly to the VT Program described above and are therefore an integral part of the R&D program. Consistent with Energy and Water subcommittee standard practice, those functions are built into the individual program budgets starting in FY 2007.

Benefits

The analysis and technology assessment and planning necessary for good management of the R&D programs will be funded within the programs themselves, since it is an integral part of the Federal role of oversight of the R&D activities.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	**1,877**	**2,475**	**0**

Technical management activities, including strategic and technical planning; project and performance tracking; program reviews and evaluations, including R&D feasibility studies and trade-off analyses; peer reviews; data collection and publication; and market, economic, and other analyses are all part of the sound management of any R&D or technology deployment program. Consistent with Energy and Water subcommittee standard practice, funding for those activities will be taken from within the requested budgets for the individual technology and deployment programs starting in FY 2007.

Total, Technical/Program Management Support	**1,877**	**2,475**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
In FY 2007, Technical/Program Management Support activities are funded as needed within the preceding programmatic budget lines, consistent with Energy and Water standard practice	-2,475
Total Funding Change, Technical/Program Management Support	**-2,475**

Biennial Peer Reviews

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Biennial Peer Reviews	0	990	0
Total, Biennial Peer Reviews	0	990	0

Description

Biennial reviews of both the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership technical activities and their resource allocation will be conducted by an independent party such as the National Academy of Sciences/National Academy of Engineering, to evaluate the progress and direction of the partnerships. This continuous (biennial) activity supports the PMA, PART, and R&DIC processes. The reviews will include evaluation of progress toward achieving the technical and program goals supporting each partnership, as well as an assessment of the appropriateness of Federal investment in each of the activities. Based on the evaluation, resource availability, and other factors, the FreedomCAR and 21st Century Truck partners will consider new opportunities, make adjustments to program targets, and set goals as appropriate. FY 2007 is an alternate year in which Peer reviews are not held and thus no funding is requested.

Benefits

Collaboration with outside experts to gain their perspectives is extremely appropriate and productive in helping to assure that the program's research directions and priorities are properly aligned with the needs of auto manufacturers, equipment suppliers, energy companies, other Federal agencies, state agencies, consumers, and other stakeholders. Thus the program mission is supported by this subprogram through the greater assurance that the programs R&D investments are well selected and effectively managed.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Biennial Peer Reviews	**0**	**990**	**0**

Conduct biennial reviews of the FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership by an independent third party, such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. Reviews will include evaluation

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

of progress toward achieving the technical and program goals supporting each partnership, as well as an assessment of the appropriateness of Federal investment in each of the activities. The FreedomCAR review will address relevant elements of both the Vehicle Technologies Program and the Hydrogen Technology Program. Based on the evaluations, resource availability, and other factors, the partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate. Because reviews of both partnerships were held in FY 2006, there will be no review in FY 2007, in preparation for shifting to an alternate-year schedule. This shift will not only simplify the budgeting, but will also simplify the management of these important activities by having only one review in a given year. (FreedomCAR, $0; 21st Century Truck, $0.)

Total, Biennial Peer Reviews	**0**	**990**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The decrease is due to FY 2007 being an alternate year in which peer reviews are not held and thus no funding is requested.....	-990
Total Funding Change, Biennial Peer Reviews.....	**-990**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	0	20,295	0
Total, Congressionally Directed Activities	0	20,295	0

Description

In general, Congressionally Directed activities do not support program goals because such activities were not a result of the program's planning effort which is focused on overcoming technical barriers.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2006, there were 5 Congressionally Directed activities funded out of the Vehicle Technologies Program. The program does not request any funds to continue these projects: some do not further the achievement of DOE's goals at all, and those that may be characterized as partially contributing, represent less-than-optimal ways to support the program's goals. The following projects were directed by Congress to be included in this program:

Phase II Heavy Vehicle Hybrid Propulsion	**0**	**2,970**	**0**

This project continues ongoing Oshkosh – FCVT cost-shared technology development of a heavy hybrid (Class 8) refuse hauler.

National Hybrid Truck Manufacturing Program	**0**	**1,980**	**0**

This project proposes to: 1) provide technology development of an International Truck/Eaton Corporation hybrid electric lift truck, and 2) technology development of a hydraulic hybrid refuse hauler.

Vehicle Test Strip Equipment Demonstration	**0**	**1,485**	**0**

This project is expected to contribute to the development of more effective data for the evaluation of technology performance.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Oak Ridge National Lab Highway Transportation Technologies	**0**	**9,900**	**0**

The Oak Ridge National laboratory will undertake a broad program of research and development on materials development and computational modeling. Materials development efforts will focus on energy critical body, chassis, and engine systems on cars and heavy trucks. Computational modeling activities will address vehicle systems such as engines, electric drive systems, and body systems.

Mississippi State University CAVS Center	**0**	**3,960**	**0**

The Center for Advanced Vehicular Systems (CAVS) at the University of Mississippi will perform cradle to grave modeling of automotive and truck components to reduce weight and cost while improving performance and safety. In addition, the university will conduct multidisciplinary research on automotive design using the multi scale virtual manufacturing suite of tools.

Total, Congressionally Directed Activities	**0**	**20,295**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal..	-20,295
Total Funding Change, Congressionally Directed Activities	**-20,295**

Building Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Building Technologies					
Residential Buildings Integration	16,787	15,321	-153	15,168	19,700
Commercial Buildings Integration	5,125	3,100	-31	3,069	4,699
Emerging Technologies	31,124	33,389	-334	33,055	32,756
Technology Validation and Market Introduction	0	0	0	0	8,249
Equipment Standards and Analysis	10,147	10,256	-103	10,153	11,925
Oil Heat Research for Residential Buildings	493	1,000	-10	990	0
Technical/Program Management Support	1,479	1,500	-15	1,485	0
Congressionally Directed Activities	0	5,400	-54	5,346	0
Total, Building Technologies	65,155[b]	69,966	-700	69,266	77,329

Public Law Authorizations:
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (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 Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Supply Act" (1987)
P.L. 100-357, "National Appliance Energy Supply Amendments" (1988)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-190, "Energy Policy Act" (2005)

[a] Includes a rescission of $700,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $240,000 was transferred to the SBIR program and $69,000 was transferred to the STTR program.

Mission

The mission of the Building Technologies Program (BT) is to develop technologies, techniques and tools for making residential and commercial buildings more energy efficient, productive, and affordable. The portfolio of activities includes efforts to improve the energy efficiency of building components and equipment, and their effective integration using whole-building-system-design techniques, the development of building codes and equipment standards, and integration of renewable energy systems into building design and operation.

Benefits

The Building Technologies Program supports DOE's goal to improve energy security by developing reliable, affordable and environmentally sound technologies that significantly reduce the energy consumption and peak electrical demands of residential and commercial buildings, which account for about two thirds of the electric energy consumption in the Nation, thereby enhancing the reliability and efficiency of the Nation's energy supply infrastructure, and therefore reducing potential grid failures at periods of system peak demand.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Building Technologies Program supports the following DOE strategic and program goals:

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Building Technologies Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.04.00.00: Building Technologies. The Buildings Technologies Program goal is to develop cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.

Contribution to Program Goal 04.04.00.00 (Building Technologies)

The principal Building Technologies Program contributions to General Goal 4, Energy Security, are improving energy efficiency and incorporating productive power technologies into the whole building infrastructure. Key technology pathways that contribute to achievement of the goal include:

- Residential Buildings Integration R&D Activities: Provide the energy technologies and solutions that will catalyze 70 percent reduction in energy use of new prototype residential buildings that when combined with onsite energy technologies result in zero energy homes (ZEH)[a] by 2020 and when adapted, result in a reduction in energy use of existing homes. By 2010, develop, document and disseminate five technology packages that achieve an average of 40 to 50 percent reduction in whole house energy use. Performance indicators include the number of: subsystem technological solutions developed, researched, and evaluated; technology package research reports developed, researched, and evaluated against the Building America benchmark[b] for homes; builder best practices manuals developed and number of existing homes retrofitted to achieve 20 percent or more improvement in energy efficiency; project and demonstration homes developed in the Building America (BA) Program.

- Commercial Buildings Integration R&D Activities: By 2010, develop, document and disseminate 3 to 5 technology packages that can achieve 30 to 50 percent reduction in the purchased energy use in new, small commercial buildings relative to ASHRAE 90.1-2004. Performance indicators include the number of: technology packages developed, researched, and evaluated on their demonstrated potential to contribute to the target reduction of energy use in new buildings

- Emerging Technologies (ET) Activities: Accelerate the introduction of highly-efficient technologies and practices for both residential and commercial buildings. The emerging technologies activities support the BT goal through research and development of advanced lighting, building envelope, windows, space conditioning, water heating and appliance technologies. Without advanced components and subsystems developed in the Emerging Technologies activities, the goal of zero energy buildings will not be met. The performance indicators include the number of potentially market viable technologies demonstrated.

- Equipment Standards and Analysis: Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines that are technologically feasible, economically justified, and save significant energy. By 2010, issue 13 formal proposals, consistent with enacted law, for enhanced product standards and test procedures. Performance indicators include: product standards and test procedures proposed/issued; and analyses completed for labeling and ENERGY STAR® update and expansion to include new products.

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[a] The zero energy building (ZEB) (referred to as zero energy homes (ZEH) in the residential sector) research initiative is bringing a new concept to homebuilders across the United States. A zero energy home combines state-of-the-art, energy efficient construction and appliances with commercially available renewable energy systems such as solar water heating and solar electricity. This combination can result in a net zero energy consumption. A ZEH, like most houses, is connected to the utility grid, but can be designed and constructed to produce as much energy as it consumes on an annual basis. With its reduced energy needs and renewable energy systems, a ZEH can, over the course of a year, give back as much energy to the utility as it takes.

[b] Building America Benchmark, Version 3.1, November 2003, National Renewable Energy Laboratory

- Technology Validation and Market Introduction: Accelerates the adoption of clean, efficient, and domestic energy technologies through such activities as Rebuild America and ENERGY STAR®. By 2010, increase the market penetration of ENERGY STAR® labeled windows to 57 percent (41 percent, 2001 baseline), and maintain 30 percent market share for ENERGY STAR® appliances. ENERGY STAR® activities will work to remove technical, financial and institutional barriers to the widespread awareness, availability, and purchase of highly efficient appliances, compact fluorescent lighting products, and windows. Rebuild America activities will work to remove technical, financial and institutional barriers to the widespread awareness, availability and application of highly efficient commercial building design, construction, retrofit and operations practices.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.04.00.00, Building Technologies			
Residential Buildings Integration	16,787	15,168	19,700
Commercial Buildings Integration	5,125	3,069	4,699
Emerging Technologies	31,124	33,055	32,756
Equipment Standards and Analysis	10,147	10,153	11,925
Technology Validation and Market Introduction	0	0	8,249
Oil Heat Research for Residential Buildings	493	990	0
Technical/Program Management Support	1,479	1,485	0
Subtotal, Program Goal 04.04.00.00, Building Technologies	65,155	63,920	77,329
All Other			
Congressionally Directed Activities			
National Center on Energy Management and Building Technologies.	0	3,960	0
University of Louisville Sustainable Buildings Project	0	396	0
Carnegie Mellon University Advanced Building Testbed	0	990	0
Total, All Other	0	5,346	0
Total, General Goal 4, (Building Technologies)	65,155	69,266	77,329

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.04.00.00 (Building Technologies)					
Residential Buildings Integration					
Building America complete 1,700 homes in Fiscal Year 2002, bringing the total number of homes built through the program to more than 5,350. More homes were built than the original goal due to increased program success, increased program efficiency, increased builder participation, and reduced lead times to house completion. [MET GOAL]	Pursue six promising technical solutions considering regional and housing type differences targeting 40 percent reductions in residential space conditioning, hot water, and lighting loads. Based on Building America systems research results develop regional Building System Performance Packages for five climate zones describing "best practice" systems that reduce space conditioning energy use by 30 percent. [MET GOAL]	Initiate 5 design packages that provide promising technological solutions considering regional and housing type differences targeting 40 - 50 percent reductions in residential space conditioning loads, compared to IECC 2003, through Building America Consortia. Strategies to reduce the major loads, including energy used for hot water, lighting and clothes dryers were also investigated. [MET GOAL]	Complete the research for production-ready new residential buildings that are 30% more efficient than the whole-house Building America benchmark in 2 climate zones and document the results in Technology Package Research Reports. [MET]	Complete the research for production-ready new residential buildings that are 30% more efficient in 3 climate zones and 40% more efficient in one climate zone than the whole-house Building America benchmark and document the results in Technology Package Research Reports.	Document in Technology Package Research Reports research results for production ready new residential buildings that are 30% more efficient in 1 climate zone and 40% more efficient in 1 climate zone than the whole-house Building America benchmark.
Publish one proposal for upgrade to the Federal Residential Buildings codes. [NOT MET]			Analyze and develop code change proposals that are expected to result in a cost-effective improvement in energy efficiency in residential buildings of approximately 1-2 percent. [MET]		

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Commercial Buildings Integration					
The draft framework from the High Performance Building Roadmap was tested multiple times with actual building design projects in FY 2002. Draft guides for achieving low-energy commercial buildings were reviewed, and final guidelines were published in early FY 2003. [MET GOAL]	Facilitate a 10 percent increase in commercial building designs that have meaningful consideration of energy efficiency by developing improved design tools, including code compliance tools, and completing six researches assisted design case studies in cooperation with industry. [MET GOAL]		Complete assessments of controls technology, optimization methods and market opportunities, with substantial input from designers and building owners, to establish a framework for development of programmatic pathways to achieve 50 percent or better energy performance in significant numbers of buildings enabling development of design and/or technology packages for new commercial buildings. [MET]	Complete the development of one design technology package to achieve 30 percent or better energy savings, focusing on a single, high priority building type, such as small commercial retail or office buildings, based on the technical and market assessments completed in 2005.	Complete the development of one new design technology package for a second small to medium sized commercial building type to achieve 30 percent energy savings over ASHRAE 90.1-2004.
All supporting documents for commercial codes including the draft Notice of Proposed Rule are in the General Counsel's office of DOE for concurrence. Preliminary concurrence from various agencies and FEMP has been obtained. Federal code staff work has been completed; significant comment response and redesign and timing of review currently underway by general counsel may result in delay for publication by one quarter. [NOT MET]			Analyze and develop code change proposals that are expected to result in a cost-effective improvement in energy efficiency in commercial buildings of approximately 1-2 percent. [MET]		

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Emerging Technologies					
Seven research areas were completed. Specific research projects include: energy performance of insulated, unvented attics; development of low cost wood shear panels; energy impacts of ICS (Integral Collector Storage) solar domestic hot water preheat systems; evaluation of mixing performance of residential mechanical ventilation systems; development of high performance affordable housing; evaluation and mitigation of moisture problems in manufactured housing; evaluation of dehumidification systems for residential buildings; and evaluation of low energy buildings with onsite power generation systems. [MET GOAL]		Complete a solicitation and award five or more competitively based research awards for cost-shared research on technology (such as materials and light extraction) to contribute to the goal of 160 lumens/Watt (lm/W) and $11/Klm of white light from solid state devices with industry, National Laboratories, and universities. [MET GOAL]	Select five new competitively based research awards for cost-shared research on technology (such as optical materials and device structures) to achieve ≥65 lm/W white light from solid state devices with industry, National Laboratories, and universities. [MET]	Conduct cost-shared, competitively selected research on technology to achieve = 65 1m/W (in a laboratory device) of white light from solid state devices with industry, National Laboratories, and universities.	Achieve at least 72 lumens per Watt (in a laboratory device) of white light from solid state devices based on cost-shared research which is competitively selected.
WINDOW version 5.1 was released to Industry on October 2, 2002 at a NFRC meeting. A Simulation Training Manual and an improved optics database editor (allows for the formulation of advanced glazings including laminated glass) were also released with Windows. An improved heat transfer model, THERM 5.0, was also released. The suite of programs allows for heat transfer modeling of new designs that promote energy efficient product development at significantly lower cost than conventional prototype development. [MET GOAL]			Complete a prototype dynamic window that will have a Solar Heat Gain Coefficient (SHGC) in the range of 0.05 to 0.60 , while meeting American Society for Testing and Materials (ASTM) durability standards for cycling in a high temperature, high ultraviolet light environment. [MET]		

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Concluded field demonstrations of heat pump water heaters with utility partners. Data was collected from 16 units over a year. Data analysis was performed and a draft report was produced in June. [MET GOAL]	Complete investigation of 5 methods to increase the optimum selection of equipment components for air conditioning and heat pumps. [MET GOAL]		Complete a thermodynamic study of emerging refrigerants. Based on study results, make go/no-go decision on initiation of first stage development of a laboratory prototype, high efficiency residential 1-ton air-conditioning and heat pump unit that uses a novel approach to the vapor compression refrigeration cycle and has the potential for a Seasonal Energy Efficiency Ratio (SEER) of over 20. [MET]		
Equipment Standards and Analysis					
Two proposals for appliance standard upgrades have resulted in Final Rules. The Residential Central Air Conditioner and Heat Pump, and the Final Rule for Dishwasher Test Procedure for Non-Sensor type machines were issued in the Federal Register in May 2002. [MET GOAL]	Conduct 4 rulemakings to amend appliance standards and test procedures. [MET LESS THAN 80 percent OF GOAL]	Prepare for issuance up to four rules to amend appliance standards and test procedures for some of the following products: Residential Furnaces, Boilers, and Mobile Home Furnaces; Electrical Distribution Transformers; Commercial Unitary Air-Conditioners and Heat Pumps; and Residential Niche Product Air-Conditioners and Heat Pumps. [MET]	Complete analytical and regulatory steps necessary for DOE issuance of 3-4 rules, consistent with enacted law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. [MET]	Complete analytical and regulatory steps necessary for DOE issuance of 4 rules, consistent with enacted law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. Develop for DOE issuance notices of proposed rulemaking (NOPRs) regarding energy conservation standards for electric distribution transformers, commercial unitary air conditioners and heat pumps, and residential furnaces and boilers.	Final rules will be issued for 3-5 product categories, consistent with enacted law, to amend appliance standards and test procedures that are economically justified and will result in significant energy savings. This includes final rules for distribution transformers and residential furnaces and boilers.
Technology Validation and Market Introduction/Rebuild America					
Establish 40 new Rebuild America community partnerships and assisted these communities to retrofit 80 million square feet of floor space in K-12 school, colleges, public housing, and State and local governments.	Assist 450 Rebuild America community partnerships to upgrade 80 million square feet of floor space in K-12 schools, college, public housing, and State/local governments. [MET]	Assist over 500 new and existing Rebuild America community partnerships to upgrade 70 million square feet of floor space in K-12 schools, colleges, public housing, and State/local governments, reducing the average energy used in these buildings by 18 percent. [MET]	Help Rebuild America community partnerships to upgrade 60 million square feet of floor space in K-12 schools, colleges, public housing, and State/local governments, reducing the average energy used in these buildings by 18 percent. [MET]		

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Technology Validation and Market Introduction/ENERGY STAR®					
Recruit 500 additional retail stores, five addition manufacturers bringing the total number of stores marketing ENERGY STAR® appliances to 7,000.	Recruited 375 additional ENERGY STAR® partners including retail stores, utilities and manufacturers. [MET]	Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Add domestic hot water heaters to the program. Begin work on a Commercial Window Specification. Expand room air-conditioner program to include heating cycle. Continue outreach to non-English speaking communities and Weatherization activities. [NOT MET]	Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Complete draft Commercial Window specification. Begin update of Residential Window specification. Expand coordination with all gateway activities. [MET]	Increase market penetration of appliances (clothes washers, dishwashers, room air conditioners and refrigerators) to 38 to 42% (baseline 30% calendar year 2003), to 2 to 3% for Compact Fluorescent Lamps (baseline 2% calendar year 2003) and 40 to 45% for windows (baseline 40% calendar year 2004). Estimated energy savings will be 0.030 Quads and $657 million in consumer utility bill savings.	Increase market penetration of appliances to 30 to 32% (baseline 30% calendar year 2003), to 2.5 to 4% for CFL's (baseline 2% calendar year 2003) and 45 to 50% for windows (baseline 40% for calendar year 2003). Estimated energy savings will be 0.032 Quads and $671 million in consumer utility bill savings.
		Contributed proportionately to EERE's corporate goal of reducing corporate and program uncosted to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [Not MET: EERE actively accelerating costing of funds]	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline in 2004 ($33,417k) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Building Technologies Program will use various means and strategies, as described below, to achieve its program goals. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Department will implement the following means:

- The Residential Buildings Integration subprogram focuses on improving the efficiency of the approximately 1.5 to 2.0 million new homes built each year and the 100+ million existing homes, including multifamily units. These improvements are accomplished through research, development, demonstrations, and technology transfer strategies. This includes efforts to improve the energy efficiency of residential energy uses such as space heating and cooling, ventilation, water heating, lighting, and home appliances. It also includes support for the development of residential building codes and standards to enable application of whole building design techniques. These activities support efforts to develop strategies to integrate solar energy applications and other renewable technologies into buildings and the concept for zero energy buildings. Outputs from the subprogram include technology package research reports, which represent research results achieving a target level of performance. Builder Best Practices Manuals, tailored for specific climate regions, are derived from these reports;

- The Commercial Buildings Integration subprogram addresses energy savings opportunities in new and existing commercial buildings ($254 billion spent annually for new capital construction and $113 billion for renovation). This includes research, development and demonstration of whole building technologies, design methods and operational practices. Technology development efforts focus on cross-cutting, whole building technologies such as sensors and controls. This also includes efforts to improve commercial building energy codes and standards. These efforts support the net zero energy buildings goal not only by reducing building energy needs, but also by developing design methods and operating strategies which seamlessly incorporate solar and other renewable technologies into commercial buildings;

- The Emerging Technologies subprogram conducts R&D and technology transfer associated with energy-efficient products and technologies, for both residential and commercial buildings. These efforts address high-impact opportunities within the multitude of building components such as lighting, building envelope technologies including advanced windows and analysis tools and design strategies. Efficiency advances for this equipment will support the BT goal;

- The Equipment Standards and Analysis subprogram leads to improved efficiency of appliances and equipment by conducting analyses and developing standards that are technologically feasible and economically justified, under the Energy Policy and Conservation Act, as amended (EPCA). Analysis performed under this program will support related program activities such as ENERGY STAR,® to ensure a consistent methodology is used in setting efficiency levels for each related program; and

- Technology Validation and Market Introduction: Activities will be developed to accelerate the adoption of clean, efficient, and domestic energy technologies. The two major activities are: ENERGY STAR® and Rebuild America. ENERGY STAR® is a joint Department of Energy/Environmental Protection Agency (EPAct 2005) activity designed to identify and promote energy efficient products. Through its partnership with more than 7,000 private and public sector organizations, ENERGY STAR® delivers the technical information and tools that organizations and consumers need to choose energy-efficient solutions and best management practices. The Rebuild America Program element will be redesigned and aligned with the Commercial Building Integration research and development activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting. The redesigned activity will target decision-makers with national and regional market scope, such as multi-brand corporations in the retail, lodging, and restaurant market segments, as well as commercial property developers, owners and operators.

BT's challenge is to bring the appropriate strategies to bear to exploit the opportunities, while designing programs that give appropriate consideration to the marketplace and barriers to energy efficiency. To accomplish this, the Building Technologies Program will implement the following strategies:

- Focus the R&D portfolios to ensure that the most promising, revolutionary technologies and techniques are being explored, and align the Residential and Commercial Integration subprograms to a vision of zero net energy buildings, and appropriately exit those areas of technology research that are sufficiently mature or proved to the marketplace, and close efforts where investigations prove to be technically or economically infeasible ("off ramps");

- Use a "whole buildings" approach to energy efficiency that takes into account the complex and dynamic interactions between a building and its environment, among a building's energy systems, and between a building and its occupants. This approach has achieved energy savings of 30 percent beyond those obtainable by focusing solely on individual building components, such as energy-efficient windows, lighting, and water heaters;[a]

- Investing in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of photovoltaic on zero energy homes and buildings;

- Develop technologies and strategies to enable effective integration of energy efficiency and renewable energy technologies and practices;

- Increase minimum efficiency levels of buildings and equipment through codes, standards, and guidelines that are technologically feasible and economically justified. BT develops standards through a public process and submits codes proposals to International Energy Conservation Code (IECC) and American Society of Heating, Refrigeration and Air conditioning Engineers (ASHRAE);

[a] Building Science Corporation, Final Report: Lessons Learned from Building America Participation, February 1995 – December 2002, February 2003, NREL/SR-550-33100

- The management strategy for developing affordable net zero energy buildings requires a high level of coordination with other programs in the Office of Energy Efficiency and Renewable Energy. These include the Solar Energy Technology Program and the Distributed Energy Resources Program. In addition, the Biomass Program, Wind Energy Program, Geothermal Technologies Program, and Hydrogen Technology Program have important technologies to contribute. The Building Technologies Program also invests in technical program and market analysis and performance assessment in order to direct effective strategic planning; and

- Provide technical information to customers through deployment of cost-effective energy technologies, forming partnerships with private and public sector organizations. Rebuild America accelerates energy efficient improvements by targeting key decision-makers and influence leaders in the supporting financial, design-build, architectural, and engineering networks related to commercial buildings. ENERGY STAR® utilizes partnerships with more than 7,000 private and public sector organizations, delivering the technical information and tools that organizations and consumers need to choose energy-efficient solutions and best management practices.

These strategies will result in significant cost savings and a significant reduction in the consumption of energy, increase the substitution of clean and renewable fuels, and cost effectively reduce America's demand for energy, thus lowering carbon emissions and decreasing energy expenditures.

The following external factors could affect Building Technologies' ability to achieve it strategic goal:

- There are several factors that interfere with the private sector making R&D investments in energy efficient building technologies. These include a fragmented industry comprised of thousands of builders and manufacturers, none of which has the capacity to sustain research and development activities over multi-year periods.

- Another factor is the compartmentalization of the building professions, in which architects and designers, developers, construction companies, engineering firms, and energy services providers do not typically apply integrated strategies for siting, construction, operations, and maintenance.[a]

In carrying out the program's mission, Building Technologies performs the following collaborative activities:

- Partnerships and cost share arrangements with industry and other Federal agencies become critical management tools that can build a critical mass to address these barriers. ENERGY STAR® is a joint DOE and Environmental Protection Agency Program (EPAct 2005) with more than 4,000 retailers to label ENERGY STAR® qualified appliances and energy efficient products, while Rebuild America develops partnerships with numerous decision-makers, State and local governments.

- Partners with the Solar Energy Program to realize the goal of zero energy homes.

- Coordinates with The Office of Science in basic research required for solid state lighting technology advancement.

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[a] Scott Hassell, Anny Wong, Ari Houser, Debra Knopman, Mark Bernstein, RAND Corporation: *Building Better Homes: Government Strategies for Promoting Innovation in Housing, 2003.*

- The program's management strategy involves four key elements: a customer-focused, team-based organization for greater accountability and improved results; collaboratively developed technology roadmaps to provide for a more integrated, customer driven R&D portfolio implemented through systematic multi-year planning; greater competition in project solicitations to increase innovation and broaden research participation; and increased peer review to assure scientifically sound approaches.
- The program interacts regularly with industry to ensure relevance of research, including research and development workshops (e.g., biennial reviews in Solid State Lighting and windows research) and peer reviews.

Validation and Verification

To validate and verify program performance, the Building Technologies Program will conduct various internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. The table below summarizes validation and verification activities.

Data Sources: EIA Annual Energy Review (AER); Commercial Building Energy Consumption Survey (CBECS); Residential Energy Consumption Survey (RECS); and Annual Energy Outlook (AEO) ISTAR (ENERGY STAR® database). U.S. Department of Commerce (DOC) Current Industrial Reports (CIR). Various trade publications. Information collected directly from Building Technologies performers or partners.

Baselines: The following are key baselines used in the Building Technologies Program:

- New Residential Buildings: Energy use varies by climate region, based on the Building America Benchmark. The program will focus on creating design technology packages to reduce energy consumption from the Building America Benchmark. In 2003, 0 technology package research reports at 30/50/70 percent energy savings.
- New Commercial Buildings Energy Use Intensity: Varies by climate region and building type (ASHRAE 90.1-2004). The program will focus on creating design technology packages to reduce energy consumption by 30 and 50 percent for small commercial buildings (baseline 0 technology packages for 30 and 50 percent in 2005).
- Solid State Lighting (2002): 25 lumens/Watt efficacy (solid state lighting whitelight).
- Windows (2003): 0.33 to 0.75 U-values (varies by region).
- Residential Heating and Cooling (2003): Average total heating and cooling system energy use, defined by reported consumption in EIA for residential buildings and all existing buildings, and the Building America benchmark for new residential buildings, by climate region.
- New Residential Building Codes: 2003 International Energy Conservation

Code (IECC), International Code Council.

- New Commercial Building Codes: ASHRAE 90.1-2004.
- ENERGY STAR®: Federal appliance minimum standards and applicable national building codes (windows). ENERGY STAR® baseline is increased market share for ENERGY STAR® appliances to 29 percent by 2006 compared to 15 percent in 2001.

Frequency: Complete revalidation of assumptions and results can only take place every three to four years, due to the reporting cycle of two crucial publications: CBECS and RECS. However, updates of most of the baseline forecast and BT Program outputs will be undertaken annually.

Evaluation: In carrying out the program's mission, the Building Technologies Program uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal technical and management reviews of program and subprogram portfolios;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule, R&D Investment Criteria, President's Management Agenda and Program Assessment and Rating Tool (PART) reviews;
- Peer reviews as needed when evaluating go/no go decision points in each research area; and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: EIA and DOC data sources are publicly available. Trade publications are available on a subscription basis. BT Program output information is contained in various reports and memoranda.

Verification: Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market survey and product shipments.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. BT has incorporated feedback from OMB into its results based management strategy reflected in the FY 2007 Budget Request, and continues to improve performance along the lines suggested by the PART.

The Building Technologies Program was rated as Adequate in its PART for 2003 receiving good scores for Purpose (80) and Management (88), with a lower score for Planning (50). The program has undertaken a multi-year planning effort that focuses on the development of technical pathways and the integration of the systems and component research to achieve Zero Energy Buildings. The 2003 PART review of the Building Technologies Program contained a recommendation to continue supporting solid state lighting and reduce support for other technologies near commercialization. In response to this recommendation, DOE in the FY 2005 and FY 2007 budget request redirected $1.5M and $2M respectively, to solid state lighting from existing lighting R&D. Another PART recommendation suggested the development of adequate long-term and annual performance measures, and in 2004 the Building Technologies Program developed a multi-year program plan and annual operating plan that included these measures for FY 2005 with refinements and additional measures for FY 2006. The program continues to work with OMB to define meaningful annual performance measures.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. The Applied R&D programs in DOE have improved use of common baselines, assumptions and more consistent methods for generating their benefits estimates. But benefits estimates are not comparable across the entire applied R&D portfolio. DOE will continue to address this finding corporately.

Expected Program Outcomes

The Building Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce Environmental Protection Agency (EPA) criteria and other pollutants; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the BT goals would provide the potential to reduce conventional energy use even further, especially if warranted by future energy needs.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, oil savings, natural gas savings, and the reduced need for electricity capacity additions that result from the realization of Building Technologies Program goals are shown in the table below through 2050. In addition to the types of benefits quantified above, building efficiency and renewable technologies often provide non-energy benefits, such as improved lighting quality and building occupant productivity. The benefits estimates reported in this table exclude any expected acceleration in the deployment of these new technologies that may result from the unique field partnerships that provide the

basis for the Residential Building Integration R&D, or synergies with the ENERGY STAR® Home Program.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future energy prices, differ from the "baseline case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals.

The results shown in the long-term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Fundamental breakthroughs from basic science from coordinated programs between Building Technologies and the Office of Science may contribute significantly to the benefits. Estimated benefits that follow assume that individual technology plans and market assumptions obtain. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html.

FY 2007 GPRA Benefits Estimates for the Buildings Program[b]

Mid-Term Benefits[c,d]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	0.10	0.41	0.81	1.99
Energy expenditure savings (Billion 2003$)	1	8	17	17
Carbon emission reductions (MMTCE)	2	8	17	45
Oil savings (MBPD)	ns	0.2	0.09	0.04
Natural gas savings (Quads)	0.05	0.25	0.23	0.48
Total electric capacity displaced (GW)	ns	13	32	76

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

[b] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are met and funding continues at levels consistent with assumptions in the FY 2007 Budget.

[c] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case increase.

[d] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.

Long-Term Benefits[a]	2030	2040	2050
Primary nonrenewable energy savings (Quads)	2.62	4.95	5.39
Energy system net cost savings (Billion 2003$)	57	103	135
Carbon emission reductions (MMTCE)	56	117	124
Oil savings (MBPD)	0.16	0.31	0.48
Natural gas savings (Quads)	0.83	0.54	0.74
Total electric capacity displaced (GW)	67	103	118

[a] Long-term benefits were estimated utilizing the GPRA07 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Residential Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Residential Buildings Integration			
Research and Development: Building America	15,959	14,731	18,775
Residential Building Energy Codes	828	99	495
SBIR/STTR	--	338	430
Total, Residential Buildings Integration	16,787	15,168	19,700

Description

The long-term goal of the Residential Buildings Integration subprogram is to develop cost effective, production ready systems in five major climate zones that result in houses that produce as much energy as they use on an annual basis.

Benefits

In order to reach zero energy homes by 2020, integrated cost-effective whole-building strategies will be developed to enable residential buildings to use up to 70 percent less total energy than the Building America Benchmark and provide energy for the remaining 30 percent of energy requirements through the use of integrated onsite power systems.[a] Building America (BA) is a private/public partnership that conducts research on energy solutions for new and existing homes on a cost shared basis with major stakeholders in the homebuilding industry. The Building America Program combines the knowledge and resources of industry leaders with the U.S. Department of Energy's technical capabilities. Together, they act as a catalyst for energy efficient change in the home-building industry. Industry partners provide all costs for equipment, construction materials and construction labor used in research projects.

Building America is also developing energy efficiency and onsite/renewable power solutions, demonstrated on a production basis by building community subdivisions which will reduce whole-house energy use in new homes by an average of 50 percent by 2015 and 70 percent by 2020 compared to the Building America Benchmark[b] at zero or less net cash flow.[c]

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[a] Whole house energy savings for all residential end uses are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, Version 3.1, November 11, 2003, National Renewable Energy Laboratory). (www.buildingamerica.gov)

[b] Whole house energy savings are measured relative to the BA Research Benchmark Definition (Building America, Building America Research Benchmark Definition, December 29, 2004, National Renewable Energy Laboratory) which consists of the 2000 IECC requirements plus lighting, appliances and plug load energy levels (www.buildingamerica.gov)

[c] Net cash flow is the monthly mortgage payment for energy options minus the monthly utility bill cost savings. "Zero or less net cash flow" means that monthly utility bill cost savings are greater than the monthly mortgage payment for energy options. In other words, the increase in mortgage payment is offset by the energy savings.

To ensure meeting the performance goals, Building America has specified the following interim performance targets for completion of technology package research reports for each climate region, shown below.

The Energy Policy Act of 2005 (EPAct) and the consumer tax incentives it provides for residential energy efficiency could accelerate the current target dates. Increased demand from consumers for energy efficient products may improve participation by manufacturers and builders, thus improving the cost-effectiveness of advanced energy efficient technology.

Residential Integration Performance Targets by Climate Zone

Target (Energy Savings)	Marine	Hot Humid	Hot/Mixed Dry	Mixed Humid	Cold
30%	2006	2007	2005	2006	2005
40%	2008	2010	2007	2008	2009
50%	2011	2015	2012	2013	2014
70%[a]	2020	2020	2020	2020	2020

Building Energy Codes (Residential and Commercial)

The activities of the Building Codes and Standards element are established by legislation and the 3-year cycle for upgrading the model building energy codes and standards. Title III of the Energy Conservation and Production Act, as amended (ECPA) (42 USC 6831 et seq.), requires the Department of Energy to:

- Support the upgrading of model building energy codes (American Society of Heating Refrigerating and Air-Conditioning Engineers' (ASHRAE) Standard 90.1, for commercial buildings, and the International Code Council's (ICC) International Energy Conservation Code (IECC), for residential buildings). Review and assist in improving the technical basis, determining cost effectiveness, and technical feasibility of code measures and, based on ongoing research activities, recommend and seek adoption of feasible, cost effective measures.
- Review and upgrade the Federal building energy codes (10 CFR 434 and 435) with technically feasible, cost-effective code measures. DOE maintains Federal building energy codes as distinct from the voluntary sector building energy codes to reflect the unique financial perspective of the Federal sector and to address the role of the Federal sector in leading the private sector towards greater energy efficiency. 10 CFR 434 is the current Federal commercial standard and 10 CFR 435 (subpart C) is the current Federal residential standard.
- Publish a determination in the Federal Register as to whether each new edition of the model codes will improve the energy efficiency of buildings.

[a] The current Building America target year for completion is 2020. Climate zone target dates for the 70 percent level are dependent upon progress at lower target (energy savings) levels, and will be determined in a future planning cycle; some climate zones may be completed before 2020.

- Provide incentive funding and technical assistance to states to update, implement and enforce their code to meet or exceed the upgraded model codes that the Department of Energy has determined will improve the energy efficiency of buildings.

The model code organizations have established a 3-year upgrade cycle, receiving and deliberating on proposed amendments to the model codes and republishing a new edition of each model code every 3 years.

The Building Technologies (BT) Program is responsible for requirements 1 to 3, above, and for coordinating the overall codes effort. Weatherization and Intergovernmental Activities (WIP) was responsible for requirement 4 in FY 2006 and prior years. This last activity is being discontinued in FY 2007 because the States have developed sufficient expertise in this area.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Research and Development: Building America	**15,959**	**14,731**	**18,775**

The residential systems research, driven by the performance targets by climate zone and the financial constraint of zero or less net cash flow, is applied in three phases for each climate zone.[a] During the three phases, Building America acts as a national residential energy systems test bed where homes with different system options are designed, built and tested at three levels of system integration, including research houses, production prototype houses, and community scale housing. A summary of the three phases follows.

Phase 1 – System Evaluations: The Building America Consortia design, construct and test subsystems for whole house designs in research houses to evaluate how components perform. The focus of Phase 1 is to evaluate and field test prototype subsystems to determine the most reliable and cost effective solution for a given performance level and climate.

Phase 2 – Homes incorporating the successful subsystems from Phase 1 are designed and constructed by production builders working with the Building America Consortia to evaluate the ability to implement the systems on a production basis. The focus of Phase 2 research is to move the research prototype house and building practices to the point that they are production-ready, capable of being integrated with production construction techniques practiced by today's builders.

Phase 3 – The Building America Consortia provide technical support to builder partners to advance from the production prototypes to full production in a subdivision. The results are documented in a case study report. Several of these reports are distilled into a final research report that describes the design and construction practices needed to achieve a particular level of energy savings within each

[a] Building America deals with five climate zones in the U.S. — Marine, Hot Humid, Hot/Mixed Dry, Mixed Humid, and Cold. These climate zones require unique approaches to reach the 30-40-50 percent energy target savings.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

climate zone targeted by the program.

From the technology package research reports developed from Phase 3, "Best Practices" manuals are designed for builders, manufacturers, homeowners, realtors, educators, insurance companies, and mortgage providers. The Best Practices manuals present the research results in illustrated text that is targeted to a specific audience to make it easily assimilated, and that synthesize research findings into energy-efficient processes for the building industry.

The three system research stages currently take approximately three years. For more advanced energy efficiency levels at and above 50 percent whole house savings, the system research process is expected to take additional iterations of whole house testing before implementation in production ready homes.

In FY 2007, BT will continue research at the 40 percent efficiency level for three climate zones and will complete the research in 1 of the climate zones. BT will begin the second phase for 40 percent energy efficient homes in the mixed humid and marine climates.

The focus of the 50 percent systems research in 2007 will be finding ways to reduce the energy used by the hot water system, developing aesthetically pleasing low cost ways to light homes efficiently, developing strategies to reduce the plug load and continued field testing of lower cost efficient windows, methods of space heating and renewable power equipment.

Additionally, BT will invest in collaborative research with the Solar Energy Program to reduce barriers to the installation and operation of photovoltaic on zero energy homes and buildings. This research will be closely coordinated with the Office of Science which will provide critical input to achieving more aggressive goals. Some of the fundamental university-funded photovoltaic research previously performed by the photovoltaic program is being augmented by an accelerated Office of Science solar research effort. This research is crucial to addressing some of the fundamental technical problems associated with converse efficiency, reducing cost and improving reliability. Closely coordinated planning and research with the BT zero energy homes activity will lead to photovoltaic products that are easily integrated in new and existing building designs.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Residential Building Energy Codes	**828**	**99**	**495**

In FY 2007, DOE will provide determinations as required on new ASHRAE, IECC or IRC building codes, and update REScheck code compliance software to efficiency levels in the current residential codes. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**338**	**430**

In FY 2005, $0 and $13,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Residential Buildings Integration	**16,787**	**15,168**	**19,700**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Research and Development: Building America	
This increase will continue basic R&D to achieve the long term target of zero energy homes by 2020 and will provide for technology transfer and shared R&D	+4,044
Residential Building Energy Codes	
Funding will allow completion of the development of the Energy Conservation Standard for New Federal Residential and Multi-Family High-Rise Residential Buildings	+396
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of Program activities	+92
Total Funding Change, Residential Buildings Integration	**+4,532**

Commercial Buildings Integration

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Commercial Buildings Integration			
Research and Development	4,345	2,970	4,204
Commercial Building Energy Codes	780	99	495
Total, Commercial Buildings Integration	5,125	3,069	4,699

Description

In order to reach net zero energy buildings (ZEB) by 2025, DOE will develop integrated whole-building strategies to enable commercial buildings to be designed, constructed, and operated to use 60 to 70 percent less energy relative to ASHRAE Standard 90.1-2004. By 2010, the BT goal is to develop five cost-effective design technology packages using highly efficient component technologies, integrated controls, improved construction practices, streamlined commissioning, maintenance and operating procedures that will make new and existing commercial buildings durable, healthy and safe for occupants. These design technology packages will reduce energy use for new small commercial buildings by 30 percent, relative to conventional practice.

The long-term goal of the Commercial Buildings Integration subprogram is to develop cost-effective designs for commercial buildings such that they produce as much energy as they use on an annual basis. Research will focus on integrating energy efficient technologies to reduce the total energy use in commercial buildings by 60 to 70 percent by 2025. These improvements in energy efficiency, when coupled with research to integrate onsite renewable energy supply systems into commercial buildings will result in marketable net zero energy technology packages.

Benefits

The challenges inherent in designing and operating high performance and net zero energy buildings demand a number of breakthroughs, both in technology and in the fundamental knowledge of how to integrate and operate technology so as to optimize whole building performance. Systems integration and improved component technology (HVAC, lighting, windows, etc.) are required in order to achieve progressively higher levels of energy performance. Also required is a much richer understanding of the market itself, given the heterogeneity of the buildings sub sector, which varies widely across the dimensions of size, surface-to-volume ratio, vintage of construction, complexity of function, and energy use. This understanding is necessary to target the R&D to realize the largest opportunities to save energy in commercial buildings.

The commercial buildings integration activities are focused on small to medium-sized repeatable building designs such as strip malls, retail stores, office buildings, schools, etc. BT is focused on these buildings because there are greater opportunities for energy savings (developers of smaller commercial

buildings do not usually have engineering budgets sufficient to perform comprehensive energy analysis) and these buildings are replicated more times. BT will seek out opportunities to work with commercial companies that build numerous similar buildings and are favorably disposed to investments that yield 50 percent or more energy savings. There is a higher likelihood for the lessons learned in these interactions to be implemented by many building owners and managers.

DOE's principal technical approach will be development of design technology packages of system integrated design strategies and operational methodologies, which can be used by architects, engineers and others to design, build and operate commercial buildings in an integrated manner. The BT method validates the process with architects and engineers on actual buildings, encompassing numerous requirements for cost-effective technology, marketability, maintenance of real estate value, building durability and grid connection reliability. Such an approach is clearly targeted at new construction, because the opportunities for aggressive performance improvement are so much greater than in existing buildings, where many building parameters (orientation, envelope, etc.) are set in steel and concrete. However, this does not exclude the renovation and existing building market, as many of the strategies can be adapted and deployed in this sector. Research results will be transferred through close cooperation with the Rebuild America activity that is transferred to BTP in FY 2007. The draft design technology packages in FY 2007 will consist of one or two fully researched buildings in the medium, average energy intensity category. The performance targets are shown below.

EPAct 2005, and the building tax incentives it provides for commercial energy efficiency could accelerate the current target dates. Increased acceptance among commercial building owners of energy efficient products may improve participation by manufacturers and builders, thus improving the cost-effectiveness of advanced energy efficient technology.

Commercial Buildings Design Technology Packages Performance Targets

Characteristics	Units	Calendar Year			
		2004	2006	2007	2011
Whole Building Energy Use Small-Sized (less than 25,000 square feet) Buildings	% Energy Savings	0	30	30	50
Small Commercial Building Design Technology Packages	Number	0	1	1	3

Commercial Building Energy Codes

For a description of the activities under Commercial Building Energy Codes see the summary contained in Building Energy Codes in the Section on Residential Integration activity above.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Research and Development	**4,345**	**2,970**	**4,204**

In FY 2007, we will demonstrate the first package of cost-effective technologies for small to medium sized (less than 25,000 square feet) commercial buildings to reach 30 percent energy savings over ASHRAE 90.1-2004 and begin development on a design package for medium sized commercial buildings, also focusing on 30 percent improvement over ASHRAE 90.1-2004. This commercial building energy efficiency improvement package will describe the technologies, quantify the energy savings and costs and provide design, construction, and commissioning guidelines for implementation in at least several climate regions of the U.S. With the results of the system optimization methods and design strategies completed in FY 2005, we will target the gaps and determine the technology advancements required for routinely creating zero energy buildings within 20 years. Additionally, we will continue to identify potential partners to test the energy efficiency packages in other commercial building types that will result in 50 percent lower energy use in new construction.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Commercial Building Energy Codes	**780**	**99**	**495**

In FY 2007, DOE will provide determinations as required on new ASHRAE, IECC or IRC building codes, and update COMcheck code compliance software to efficiency levels in the current commercial codes. In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Total, Commercial Buildings Integration	**5,125**	**3,069**	**4,699**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Research and Development	
Additional Commercial Building Integration funding will support the development of design guides for (1 or 2) distinct market segments of small and medium size buildings. This increased activity will allow research activities to concentrate on higher risks associated with large, complex buildings at higher levels of whole building energy efficiency, as well as address market relevance	+1,234

	FY 2007 vs. FY 2006 ($000)
Commercial Building Energy Codes	
Funding will allow completion of the development of revised Federal buildings energy efficiency performance standards	+396
Total Funding Change, Commercial Buildings Integration	**+1,630**

Emerging Technologies

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Emerging Technologies			
Lighting R&D	13,799	19,301	19,283
Space Conditioning and Refrigeration R&D	4,846	2,817	2,845
Appliances and Emerging Technologies R&D	1,682	1,021	0
Building Envelope R&D	8,274	6,687	7,119
Analysis Tools and Design Strategies	2,523	2,396	2,684
SBIR/STTR	--	833	825
Total, Emerging Technologies	31,124	33,055	32,756

Description

The long-term goal of the Emerging Technologies subprogram is to develop cost effective advanced technologies, (e.g., lighting, windows, and space heating and cooling) for residential and commercial buildings. Research will focus on developing technologies to support the residential and commercial building goal to reduce the total energy use in buildings up to 70 percent. BT is actively analyzing technology advancement in these areas that will be required to reach the zero energy buildings goals and using this analysis to identify which technology pathways to fund. The improvement in component and system energy efficiency when coupled with research to integrate onsite renewable energy supply systems into the commercial and residential buildings will establish the technologies from which to package marketable net zero energy designs.

Specifically, we will focus on:

- Solid State Lighting (SSL), which has long term efficiencies that have the technical potential to approach 200 lm/W, compared to most conventional technologies maximum efficiencies in the 85 to 115 range.
- Heating and cooling systems with the technical potential to reduce annual HVAC energy consumption by 50 percent, and peak demand by 30 percent, aligned with advanced technology performance requirements of the Residential Integration activities.
- Advanced windows, which have the technical potential to move from a net energy loss to a net energy provider by incorporating advanced insulation materials and technologies that enable dynamic control of thermal and light transmittance performance.

Benefits

The Emerging Technologies subprogram improves energy security by supporting the technology development needs of the Residential Integration and Commercial Integration subprograms and the need for energy efficient replacement technologies in the existing building stock. The advancement of these technologies supports the appliance standards rulemakings by creating more efficient, cost-effective technology advancements.

Lighting Research and Development

Lighting Research and Development (R&D) is a critical element of the Building Technologies Program. Our goal is to achieve lighting technologies with double the efficacy of today's most efficient lighting sources, linear and compact fluorescents.[a] Our primary targets are solid state lighting devices and technologies that will produce white light with efficacies[b] in excess of 160 lumens per Watt in commercial products by 2025, with an interim target of 107 lumens per Watt projected for laboratory devices by 2012.

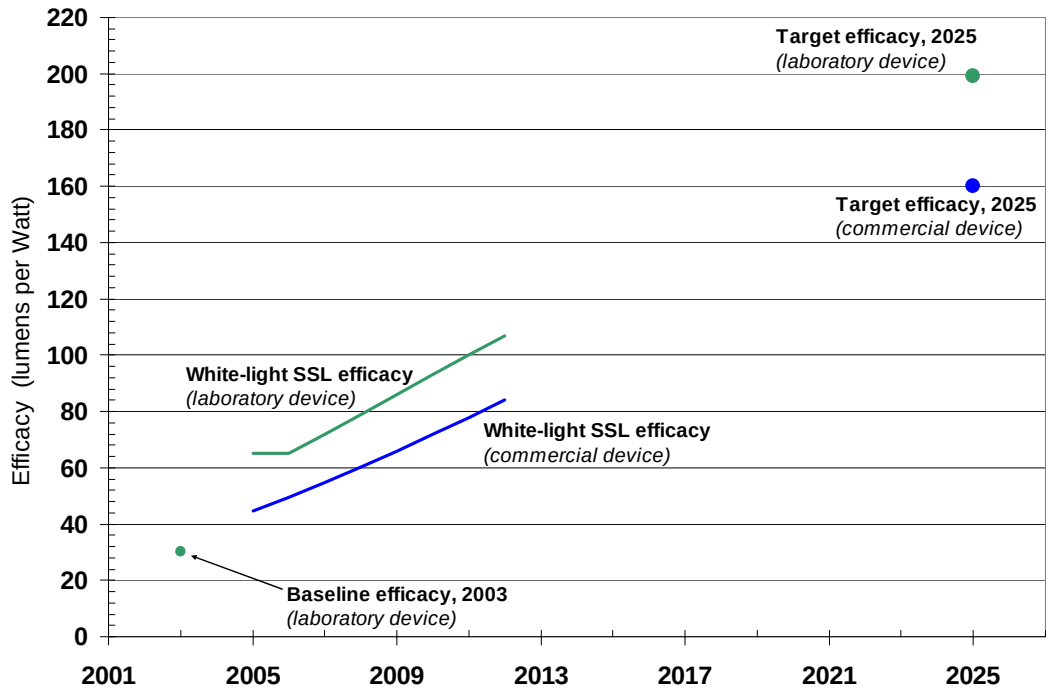
The Solid State Lighting (SSL) activity is evaluating both inorganic light emitting diodes (LEDs) and organic light emitting diodes (OLEDs). LEDs have a focused point of light and monochromatic LEDs are used in many of the newly installed traffic signals and brake lights on cars. OLEDs have a distributed light and are used in display technologies on cell phones and digital cameras, but ultimately could be used in innovative and unique lighting designs such as painted on and full wall surface lighting. To prepare these SSL technologies for the highly competitive general illumination market, research, development, demonstration, and commercial application activities will be performed, as also noted in EPAct 2005. The anticipated rate of performance improvement for LEDs is shown in the following diagram.

[a] Linear fluorescent lamp offer efficacies as high as 80 lumens per Watt. Compact fluorescent lamps, a derivative of this technology, are less efficient (approximately 60 lumens per Watt); however they still offer a four-fold improvement over traditional incandescent bulbs.

[b] For solid-state lighting technologies, the performance target is focused on the energy efficiency rating of the device. The unit of performance commonly used when discussing light sources and systems is lumens of light produced per Watt of energy consumed. The technical term for this metric is 'efficacy' measured in lumens per Watt. Several lighting products, including fluorescent lamps and incandescent reflector lamps, are regulated using an efficacy target. The efficacy projections for solid-state lighting are generated for laboratory devices because the Lighting R&D portfolio does not have direct influence over commercially offered products.

Efficacy Projection for White-Light SSL Laboratory Devices (Projections 2005 to 2012)

White-Light LED Efficacy Targets



This projection is translated into point values in the following table, with the five-year target milestones.

Point Values of Efficacy Projections for White-Light SSL Laboratory Devices

Characteristics	Units	Calendar Year								
		2003 (baseline)	2005	2006	2007	2008	2009	2010	2011	2012
Solid State Lighting Performance	Lumens / Watt	30	65	65	72	79	86	93	100	107

The SSL activity provides a focus on increased efficacy while the state of SSL development in industrial labs and the marketplace is formative and can be influenced. Manufacturers would likely not focus on efficacy but on the unique attributes of solid state lighting (e.g., durability, reliability, etc.) This emphasis on efficacy will strengthen and expand the base of U.S. intellectual property. Many foreign governments are supporting SSL R&D in an effort to expand their future markets for general illumination, yet most of the foreign products have lower efficacy than U.S. products.

DOE conducts its SSL R&D through strong industry partnerships that are already producing results such as innovations in chip design to produce photonic crystal LEDs that yield up to a 70 percent increase in power compared to regular LEDs. Industry enthusiasm and cost share on projects is high (>35 percent).

Space Conditioning and Refrigeration Research and Development

Space conditioning systems, which have transformed the 20th century by enabling us to become more productive and comfortable, will play a critical role in achieving BT's goal of zero energy buildings. Space conditioning equipment for residential and commercial buildings consumes approximately 38 percent of the total energy used in buildings and is the most important contributor to summer peak electricity demand.[a]

In the past, R&D and efficiency standards have focused on increasing the efficiency of the various individual units. Raising the minimum efficiency standard for residential unitary equipment from 10 to 13 SEER is one key example. New approaches are now needed to further advance HVAC system efficiency. Having focused substantial attention on improving equipment efficiency, it is now critical to ensure that optimal performance is actually achieved in the field.

Although the energy efficiency of HVAC equipment has increased substantially in recent years, new approaches, including radically new ideas, are needed to continue this trend. The dramatic reductions in HVAC energy consumption necessary to support the ZEB goals require a systems-oriented approach that characterizes each element of energy consumption, identifies alternatives, and determines the most cost-effective combination of options. Therefore, the first task in this effort will involve system characterizations, identification of necessary upgrades to analysis tools, and an assessment of cost and performance of alternative solutions.

Space Conditioning System Performance Goals

Characteristics	Units	Calendar Year		
		2004 Status	2007 Target	2010 Target
Annual HVAC Energy Consumption Reduction vs. Building America benchmark (demonstrated product)	%	Baseline	25	50

Building Envelope Research and Development

Thermal Insulation and Building Materials

The Building Envelope program element will contribute to Zero Energy Buildings by advancing a portfolio of new insulation and membrane materials, including exterior finishes, with both residential and commercial application. Although BT has not requested funding in thermal insulation for the past two years, recent planning analysis conducted by Building America has shown the need for new envelope materials.[b]

[a] US DOE Energy Efficiency and Renewable Energy, *2004 Buildings Energy Databook*, August 2004.
[b] Analysis of System Strategies Targeting Near-Term Building America Energy-Performance Goals for New Single-Family Homes, Anderson, Ren et al, November 2004, NREL/TP-550-36920

The table below lists the performance goals for the Thermal Insulation activities. All performance measurements are relative to historical baselines that have been set as the Building America regional baseline new construction. Achieving cost-effectiveness and durability are critical aspects of these targets.

Thermal Insulation and Materials Performance Goals

Characteristics	Units	Calendar Year		
		2004 Status	2007 Target	2010 Target
Advanced attic/roof system	R-Value	30	35	Dynamic annual performance equal to conventional R-45
Wall insulation	R-Value	10	Dynamic annual performance equal to conventional R-20[a]	Dynamic annual performance equal to conventional R-20[b]

Windows Technologies

Window performance will also be vital to reaching the residential and commercial buildings goals. Development of cost effective, highly efficient glazing and fenestration systems for all building types and all parts of the country will require a portfolio of technologies matched to those types and climatic conditions. The table below lists the performance measurement targets for the Windows element. All performance measurements are relative to historical baselines that have been set as the baseline new construction in 2003. The next generation of highly insulated and dynamic windows can become net energy producers in climates with heating loads and can dramatically reduce cooling loads to achieve ZEB.

[a] Interim target NOT subject to cost constraints and may not be in commercial production
[b] Subject to no additional operating cost, within the traditional 3.5-in. wall dimension, with acceptable durability characteristics

Windows Performance Goals

Characteristics	Units	Calendar Year				
		2003 Status	2007 Target	2010 Target	2015 Target	2020 Target
Dynamic Solar Control	Price/Sq Ft.	$85-100	$50	$20	$8	$5
	Size (Sq. Ft.)	8	16	20-25	25+	25+
	Visual Transmittance	60 to 4%	60 to 4%	65 to 3%	65 to 2%	65 to 2%
	Solar Heat Gain Coefficient	0.50 to 0.10	0.50 to 0.10	0.53 to 0.09	0.53 to 0.09	0.53 to 0.09
	Durability* (ASTM Tests)	Med	High	High	High	High
Highly Insulated Windows	U-Value	0.33-0.50	0.20-0.25	0.17	0.10	0.10
	Incremental Cost $/ft^2	IG Base cost: $3	5	5	4	3

*Represents component durability, system reliability will be address in future years < 20K cycles – Low; 20K – 50K Cycles – Medium; > 50K Cycles – High

Analysis Tools and Design Strategies

BT has established aggressive goals to create a new generation of residential and commercial building technologies by 2025 that will enable zero energy buildings. Similar technologies and design approaches will also be applied to improve the performance of existing buildings. These ZEB goals cannot be met alone through research to significantly improve the performance of components (e.g., windows, appliances, heating and cooling equipment, lighting). It also requires a revolutionary approach to building design and operation that can achieve 70-80 percent reductions in load coupled with careful integration with onsite renewable energy supplies as well as thermal and electrical storage.[a] This in turn requires new design strategies and powerful simulation tools that support evaluation of new ZEB demand-reduction and energy-supply technologies.

[a] Building energy performance, particularly in ZEB, is the result of interactions among many elements including climate (outdoor temperature, humidity, solar radiation and illumination), envelope heat and moisture transfer, internal heat gains, lighting power, HVAC equipment, controls, thermal and visual comfort, and energy cost—and these complex interactions cannot be understood and quantified without simulation tools. For example the effect of daylighting dimming controls on the electric lights with daylighting has several effects: lighting electricity use goes down as does the heat gain from lights. Lower heat from lights reduces cooling use (amount depends on cooling equipment efficiency) but in the winter it can significantly increase the heating energy. Thus the annual impact of daylighting on energy use requires detailed calculations that consider these interactions. In a series of field evaluation case study reports, NREL found that simulation tools were one of the essential elements for tuning the building design as well as the operating building performance [Torcellini, Judkoff and Crawley (2004)].

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Lighting R&D	**13,799**	**19,301**	**19,283**

The R&D agenda of the Solid State Lighting (SSL) activities are established through an annual consultative process with general lighting industry, compound semi-conductor industry, universities, research institution, national laboratories, trade organizations, other industry consortia, and the Next Generation Lighting Industry Alliance (DOE's competitively selected Solid State Lighting Partnership). The high priority tasks are competitively bid and awarded to entities whose proposals meet these priorities and the SSL portfolio's stated objectives. The Solid State Lighting activity classifies its projects into four R&D classes: LED Core Technology, LED Product Development, OLED Core Technology and OLED Product Development.[a] Tasks in Core Technology are truly innovative and groundbreaking, fill technology gaps, provide enabling knowledge or data, and represent a significant advancement in the SSL knowledge base. These Core Technology tasks are focused on gaining pre-competitive knowledge for future application to products, for use by other organizations. Product Development tasks are the systematic use of knowledge gained from basic and applied research to develop or improve commercially viable materials, devices, or systems. Technical activities are focused on a targeted market application with fully defined price, efficacy, and other performance parameters necessary for success of the proposed product. Product development encompasses the technical activities of product concept modeling through to the development of test models and field ready prototypes. Within each R&D class, there are active, detailed R&D agendas which contribute to the larger programmatic objective.

The SSL portfolio is presently funding six core priority R&D topics and four product development priority R&D topics (based on FY 2004 Solid State Lighting Workshop prioritized R&D topics). Each year, the R&D topics are reviewed for progress on currently funded projects, completion of topical areas, new topics to start, and advice from the Alliance and the research community. The agenda is reprioritized for upcoming solicitations.

[a] LEDs have a focused point of light and monochromatic LEDs are used in many of the newly installed traffic signals and brake lights on cars. OLEDs have a distributed light and are used in display technologies on cell phones and digital cameras, but ultimately could be used in innovative and unique lighting designs such as painted on and full wall surface lighting.

(dollars in thousands)

FY 2005	FY 2006	FY 2007

Solid State Lighting Research Topics

Topic	LEDs		OLEDs	
	Current R&D	Future R&D	Current R&D	Future R&D
CORE:	● UV emissions ● Power conversion efficiency ● Phosphors	● Semiconductor materials ● Device approaches, structures, and systems ● Substrates, buffers and wafers	● Materials ● Light extraction ● Novel device structures	● Materials – enabling ● Encapsulants and packaging ● Structures for quantum efficiency
PROD. DEVEL:	● Luminaire design and materials ● Electronics	● Optical coupling and modeling ● Manufactured materials ● Packaging ● Electronic development ● Thermal design	● Luminaire design and materials	● Materials – devices ● Devices – increase quantum efficiency ● Packaging ● Light extraction from devices

In FY 2007, the program will continue the Solid-State Lighting (SSL) research projects that have demonstrated progress. These projects resulted from the competitive solicitations in 2004 (awarded in FY 2005) to develop and deploy SSL products for general illumination. These projects are identified in the table under current R&D and include LED core topics (UV emissions, power conversion efficiency, and phosphors), LED product development topics (luminaire design and materials, and electronics), OLED core topics (materials, light extraction, and novel device structures), and OLED product development (luminaire design and materials). For LEDs, the additional research topic will be on substrates, buffers, and wafer research to lower defect density (improve light generation efficiency) and affect the cost of these widely used materials. For OLEDs, the additional research topic will be on encapsulants and packaging to invent new, low-cost methods to protect the organic system from the environment (mostly oxygen and water). Both research topics were given high priority rankings by the SSL Workshop in February 2005, but have not received, to date, direct emphasis in the solicitations. For further information on the SSL R&D Agenda, as formulated by and rank-prioritized by the research community see the SSL website (www.netl.gov/ssl/PDFs/DOE_SSL_Workshop_Report_Feb2005.pdf).

New awards will be made from a competitive solicitation conducted in FY 2006 focused on the

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

"future R&D" core and product development topic areas for LEDs and OLEDs. The new projects will continue advancements in device efficacy, durability, manufacturing, and cost needed to reach a commercially viable light meeting the 160 lumens per Watt goal.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Space Conditioning and Refrigeration R&D.....	**4,846**	**2,817**	**2,845**

In FY 2007, demonstrate through laboratory or field testing, the 2-3 design concepts (selected from initial prototypes in FY 2006) that have the long term potential to reduce annual HVAC energy consumption by 50 percent in new residential buildings, relative to Building America Benchmarks, with an estimated simple payback period of 3 years or less. The design concepts must also address other critical Building America needs such as humidity control, uniform comfort, and indoor air quality. The R&D projects will emphasize modest cost premiums, since very high efficiency equipment already exists, but has low market penetration due to high first cost.

The approaches considered include: airtight and well insulated ducts with insulation that does not get wet due to condensation; residential "economizing" using cool night air; advanced zoning approaches incorporating occupancy sensing and automated supply air control; providing real-time energy consumption feedback to occupants in order to change usage patterns; energy recovery ventilation; reducing of hot water distribution losses and reducing ventilation loads in commercial buildings through natural, hybrid, or demand control ventilation or air treatment that eliminates or drastically reduces outside air requirements. The potential for multi-function appliances to contribute to achieving the energy consumption reduction goals will also be evaluated.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Appliances and Emerging Technologies R&D	**1,682**	**1,021**	**0**

The Emerging technologies activity is eliminated as a stand alone effort in FY 2007 in order to better align technology transfer and market transition with core research activities in the Building Technologies Program.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Building Envelope R&D	**8,274**	**6,687**	**7,119**
▪ **Thermal Insulation and Building Materials**	**2,762**	**2,895**	**2,411**

An assessment of the advanced state of thermal insulation and building materials technologies, which are being demonstrated in the Residential Buildings Integration subprogram was undertaken in November 2004. The assessment revealed that more energy efficient, cost effective, and durable building materials and insulation is required to achieve the Building Technology Program's long range goal of developing zero energy buildings (ZEB) by 2025. Reducing energy losses through the building enclosure will contribute significantly to DOE's attainment of a practical ZEB.

In FY 2007, DOE will develop new envelope materials in response to needs identified in the Residential and Commercial Integration activities. Specifically, this research will include phase change materials and thermochromic surfaces that adjust to optimize building performance. The integration of these new materials have the technical potential to transform the performance of our Nation's predominant light weight wall construction building market to function with the equivalence of greater thermal mass and high R values, delivering greater energy savings and curtailing peak demand. The research in phase change insulation will produce a prototype product for experimental application in one or two whole building demonstrations, in conjunction with the Building America research activity. Also, initial material science characterization and development will be conducted for thermochromic (temperature responsive) devices that have the technical potential to meet market requirements for cost and performance and industry acceptance.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

▪ **Windows Technologies**	**5,512**	**3,792**	**4,708**

In FY 2007, DOE will continue competitive fundamental science research to develop the second generation of materials, chemical engineering applications, and advanced manufacturing processes that can offer "leap frog" reductions in cost for dynamic windows while maintaining a high level of reliability and durability with a broad range of optical properties. In FY 2005, the first generation prototype of a highly insulating, dynamic window was developed as a laboratory device. In FY 2007, second generation highly insulating, dynamic window, with improved durability, will be developed. The goal of the second generation prototypes will be to address technical problems/issues that arise from the testing of the original prototype, and to focus on increasing the size and durability of the product. The second generation of dynamic windows is targeted to enter the market in the 2010 to 2015 timeframe, but can only be successful if issues such as durability, size and performance can be resolved. Work will continue on the commercialization of affordable highly insulating windows that approach U values of 0.20. The lessons learned from the FY 2006 prototype of a highly insulated dynamic window will be applied

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

in future research on highly insulated dynamic windows.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Analysis Tools and Design Strategies	**2,523**	**2,396**	**2,684**

In FY 2007, BT will focus its research on developing, improving, verifying, and maintaining software packages for engineers, architects, and builders who design or retrofit buildings to be energy efficient and comfortable. BT will conduct research on and incorporate additions to EnergyPlus analysis and design tool to create new-generation whole-building energy simulation software that allows building designers, operators, owners, and researchers to evaluate technologies for improving the energy efficiency and comfort of buildings while reducing operating costs. BT will complete research on current technologies, systems, and controls and incorporate new modules in an EnergyPlus version which aims at development of and compliance with current and near-term building energy standards, focusing on the top 20-30 features, completing new capabilities for recent state-of-the-art fenestration, daylighting, insulation, HVAC equipment and systems, and renewable energy technologies such as air and water solar collector systems, material properties as a function of temperature and moisture, shading as a function of glare/illumination/sun position/heat gain, concentrating fiber optic solar lighting, under-floor air distribution, evaporative cooling, and thermal storage.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

SBIR/STTR	**--**	**833**	**825**

In FY 2005, $240,000 and $56,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Emerging Technologies	**31,124**	**33,055**	**32,756**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Lighting R&D	
No significant change	-18
Space Conditioning and Refrigeration R&D	
No significant change	+28
Appliances and Emerging Technologies R&D	
The Emerging technologies activity is eliminated as a stand alone effort in FY 2007 in order to better align technology transfer and market transition with core research activities in the Building Technologies Program. These activities will be integrated into complete technical pathways that demonstrate market relevance and include sustainable exit strategies, as required by the President's Management Agenda and articulated in the RDIC, that identify appropriate Federal roles in assuring research results are transferred effectively to private industry directly, through market intermediaries or through justified public-private partnerships	-1,021
Building Envelope R&D	
▪ **Thermal Insulation and Building Materials**	
The decrease reflects the completion of competitively awarded component research on advanced crawlspaces. Further testing and systems integration will continue under residential integration R&D activities	-484
▪ **Windows Technologies**	
The increase will support the goal of developing second generation highly insulating dynamic windows with improved durability	+916
Total, Building Envelope R&D	**+432**
Analysis Tools and Design Strategies	
The increase will support research on developing, improving, verifying and maintaining software packages to promote the design of energy efficient buildings	+288
SBIR/STTR	
No significant change	-8
Total Funding Change, Emerging Technologies	**-299**

Technology Validation and Market Introduction

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Validation and Market Introduction			
Rebuild America[a]	0	0	2,473
ENERGY STAR® [b]	0	0	5,776
Total, Technology Validation and Market Introduction	0	0	8,249

Description

The Technology Validation and Market Introduction element funds activities that accelerate the adoption of clean, efficient, and domestic energy technologies. The two major activities are: ENERGY STAR® and Rebuild America. Both have been transferred to BT in 2007 from Weatherization and Intergovernmental Activities. ENERGY STAR® is a joint Department of Energy/Environmental Protection Agency (EPAct 2005) activity designed to identify and promote energy efficient products. Through its partnership with more than 7,000 private and public sector organizations, ENERGY STAR® delivers the technical information and tools that organizations and consumers need to choose energy-efficient solutions and best management practices. The Rebuild America Program element will be redesigned and aligned with the Commercial Building Integration research and development activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting.

Benefits

Technology Validation and Market Introduction contributes to BT goals by providing information and technical assistance to improve efficiency in the building market sector. DOE ENERGY STAR® through its partnership with more than 7,000 private and public sector organizations has saved Americans over $9 billion. The program estimates that, to date, more than $3.3 billion of savings is directly attributable to the implementation of EERE-developed technology. As of the end of 2003, with a cumulative Federal investment of $72 million, Rebuild America partnerships have renovated more than 609 million square feet of floor space, saving building owners more than $141 million each year with a cumulative saving of $1.6 billion through private investment for energy-efficiency improvements in excess of $700 million.[c] Another 590 million square feet of projects have progressed beyond the planning stage.

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[a] Rebuild America was funded in Weatherization and Intergovernmental Activities in FY 2005 and FY 2006 under the heading of Gateway Deployment. Comparable funding for FY 2005 and 2006 was $8,641,000 and $3,769,000 respectively.
[b] ENERGY STAR® was funded in Weatherization and Intergovernmental Activities in FY 2005 and FY 2006 under the heading of Gateway Deployment. Comparable funding for FY 2005 and 2006 was $3,762,000 and $5,940,000 respectively.
[c] As reported by Rebuild Partnerships. Information available on website: http://rebuild.org.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Rebuild America	**0**	**0**	**2,473**

The Rebuild America Program element is transferred to the Building Technologies Program from Weatherization and Intergovernmental Activities. The Rebuild America Program element will be redesigned and aligned with the Commercial Building Integration research and development activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting. The redesigned activity will target decision-makers with national and regional market scope, such as multi-brand corporations in the retail, lodging, and restaurant market segments, as well as commercial property developers, owners and operators.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

ENERGY STAR®	**0**	**0**	**5,776**

The ENERGY STAR® Program element is transferred to the Building Technologies Program from Weatherization and Intergovernmental Activities. Comparable funding for FY 2005 and 2006 was $3,762,000 and $5,940,000 respectively. In accordance with EPAct 2005, ENERGY STAR® will continue to update criteria on selected products. In FY 2007, DOE will focus on raising efficiency targets to increase energy efficiency of the current appliance portfolio (e.g., clothes washers, dishwashers, room air conditioners and CFLs) to insure the label connotes top-level performance of managed products, and introduce new ENERGY STAR® products, as appropriate (e.g., photovoltaics, solid state lighting, and water heaters.) These activities, while increasing energy savings, may temporarily reduce market penetration. The Home Performance Program is creating a contractor base to perform whole house assessments which not only save energy but provide the added benefits of improved indoor air quality, health and safety. Also, DOE will work through national organizations to disseminate information about ENERGY STAR® throughout the U.S., create inter- and intra-state partnerships to promote ENERGY STAR® best practices and increase the number of ENERGY STAR® State Partners.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Total, Technology Validation and Market Introduction	**0**	**0**	**8,249**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Rebuild America	
The Rebuild America Program element is transferred to the Building Technologies Program from Weatherization and Intergovernmental Activities at a reduced funding level. Comparable funding for FY 2005 and 2006 was $8,641,000 and $3,769,000 respectively. The Rebuild America Program element will be redesigned and aligned with the Commercial Building Integration research and development activity to accelerate the adoption of advances in commercial building integrated design, software tools, practices and advanced controls, equipment and lighting, making it more market relevant.	+2,473
ENERGY STAR®	
The ENERGY STAR® Program element is transferred to the Building Technologies Program from Weatherization and Intergovernmental Activities. DOE will focus on completing the following activities: As appropriate, raise efficiency targets to increase energy efficiency of current appliance portfolio (e.g. clothes washers, dishwashers, room air conditioners and CFLs) to insure label connotes top-level performance of managed products, and introduce new ENERGY STAR® products, as appropriate, e.g., photovoltaics, solid state lighting, and water heaters thus increasing the public benefit	+5,776
Total Funding Change, Technology Validation and Market Introduction	**+8,249**

Equipment Standards and Analysis

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Equipment Standards and Analysis	10,147	10,153	11,925
Total, Equipment Standards and Analysis	10,147	10,153	11,925

Description

The goal of the Equipment Standards and Analysis subprogram is to develop minimum energy efficiency standards that are technologically feasible and economically justified. During FY 2005 and FY 2006, the Department has identified and implemented significant enhancements to implementation of rulemaking activities. The Department has made a commitment to clear the backlog of delayed actions that accumulated during prior years, while simultaneously implementing all new requirements of the Energy Policy Act of 2005. In FY 2007, the Department will continue to implement productivity enhancements that will allow multiple rulemaking activities to proceed simultaneously while maintaining the rigorous technical and economic analysis required by statue.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Equipment Standards and Analysis	**10,147**	**10,153**	**11,925**

During FY 2006, the Equipment Standards and Analysis subprogram will continue ongoing rule-makings and add new rule-making activities for the following 13 product categories that will continue in FY 2007:

- Residential Water Heaters
- Direct Heating Equipment
- Pool Heaters
- Ceiling Fan Light Kits
- Incandescent Reflector Lamps
- Fluorescent Lamps
- Incandescent General Service Lamps
- Residential Dishwashers
- Ranges and Ovens and Microwave Ovens (Electric and Gas)

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

- Dehumidifiers (Residential)
- Commercial Clothes Washers
- Refrigerated Bottle or Canned Beverage Vending Machines [EPAct 2005]
- Ice-Cream Freezers, Self-Contained Commercial Refrigerators, Freezers, and Refrigerator-Freezers without doors, and remote-condensing commercial refrigerators, freezers and refrigerator-freezers

The specific standards and test procedure activities listed above have been identified considering existing obligations, new legislative directives and input from a broad range of external stakeholders. In FY 2007 final rules will be issued for 3-5 products, including distribution transformers and residential furnaces and boilers. A complete schedule of activities, with dates for publication of proposed rulemakings and other milestones, can be found at http://www.eere.doe.gov/buildings/appliance_standards/2006_schedule_setting.html.

Activities in FY 2007 will also include responses to waiver requests from manufacturers and requests for input and recommendations to the Office of Hearings and Appeals. Resource planning becomes critical to minimize delays and availability conflicts of DOE staff and contractor support. Some resources may also be utilized to prepare for challenges such as new technologies utilized in appliances including compound use appliances, networked or interconnected appliances and even test procedure sensing devices that can give false readings of efficiency levels.

In addition, these funds may be used to support efforts such as peer reviews; data collection and dissemination; and technical, market, economic, and other analyses.

Total, Equipment Standards and Analysis	**10,147**	**10,153**	**11,925**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The increased funding request addresses the new requirements of EPACT 2005 and will also allow the Department to clear the backlog of rulemaking activities. In FY 2007 the program will complete action on rulemakings started in FY 2005 and prior years, and will continue work on the 13 product standards and test procedures initiated in FY 2006. The program will also meet OMB requirements for peer review.....	+1,772
Total Funding Change, Equipment Standards and Analysis	**+1,772**

Oil Heat Research for Residential Buildings

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Oil Heat Research for Residential Buildings	493	990	0
Total, Oil Heat Research for Residential Buildings	493	990	0

Description

The goal of the Oil Heat Research for Residential Buildings Integration subprogram has been to develop ultra-low emissions combustion technologies for oil-based fuels that could be used in residential building applications.

Benefits

Based on the completion of research to improve the environmental performance of oil combustion systems in FY 2005, no further activities will be performed in the Oil Heat Research for Residential Buildings Integration subprogram.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Oil Heat Research for Residential Buildings	**493**	**990**	**0**

Oil Heat Research is complete and results are transferred to private industry. No further Federal role is justified due to market forces driving down the number of oil heated homes by 35 percent from 1980 to 2000 (See Data from Census Bureau below) and limited remaining technical potential for improvement (NAECA Standard 78 AFUE, GAMA highest available 86 AFUE). DOE sees greater opportunity to assist oil heat consumers through commercially available high efficiency oil furnaces and ENERGY STAR® windows, lighting and appliances; duct sealing, adding recommended insulation and general weatherization.

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Total, Oil Heat Research for Residential Buildings.....	**493**	**990**	**0**

Data from Census – Total Household; Households Heating w/ Fuel Oil

Year	Total Households	Households Heated by Fuel Oil	Percent Households Heated by Fuel Oil
1980	88,410,627	14,768,118	16.7%
1990	91,947,410	11,243,727	12.2%
2000	105,480,101	9,457,850	9.0%

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funding is requested for Oil Heat Research because of increasingly diminishing market potential. Research has been completed and transferred to private industry	-990
Total Funding Change, Oil Heat Research for Residential Buildings.....	**-990**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	1,479	1,485	0
Total, Technical/Program Management Support	1,479	1,485	0

Description

The Technical/Program Management Support subprogram provides analytic support to aid the program to achieve its net zero energy building goals.

Benefits

This was accomplished by identifying research priorities through R&D feasibility studies and trade-off analyses. The Technical/Program Management Support subprogram focused on implementing a research and development evaluation process for successfully integrating component research with building system research.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	**1,479**	**1,485**	**0**
In FY 2007, technical program management support activities are funded as needed within the preceding programmatic budget lines, consistent with Energy and Water standard practice.			
Total, Technical/Program Management Support	**1,479**	**1,485**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Technical/Program Management funds are included in the budgets at the activity level ...	-1,485
Total Funding Change, Technical/Program Management Support	**-1,485**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	0	5,346	0
Total, Congressionally Directed Activities	0	5,346	0

Description

In general, congressionally directed activities do not support program goals because such activities were not a result of the program's planning effort which is focused on overcoming technical barriers.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

In FY 2006, there were 3 Congressionally Directed activities funded out of the Building Technologies Program. The program does not request any funds to continue these projects as they do not further the achievement of DOE's goals. The following projects were directed by Congress to be included in this program:

National Center on Energy Management and Building Technologies	**0**	**3,960**	**0**

The National Center for Energy Management and Building Technologies conducts activities to improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environmental quality, and security concerns in new and existing buildings. These activities include research, participating in standard setting, advancing technical training and professional education, and serving as a repository of information on economic, technical, and policy issues.

University of Louisville Sustainable Buildings Project	**0**	**396**	**0**

Project to improve the sustainability of local buildings and essential community applications through the use of solar heating, lighting, and photovoltaics.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Carnegie Mellon University Advanced Building Testbed	**0**	**990**	**0**
Supports a research facility to test the performance and interaction of advanced window, insulation, lighting and other building technologies.			
Total, Congressionally Directed Activities	**0**	**5,346**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal	-5,346
Total Funding Change, Congressionally Directed Activities	**-5,346**

Industrial Technologies

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Industrial Technologies					
Industries of the Future (Specific)	37,369	24,489	-244	24,245	17,001
Industries of the Future (Crosscutting)	32,262	29,147	-292	28,855	28,562
Technical/Program Management Support	3,740	3,793	-38	3,755	0
Total, Industrial Technologies	73,371[b]	57,429	-574	56,855	45,563

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act" (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act" (1989)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-190, “Energy Policy Act” (2005)

Mission

The mission of the Industrial Technologies Program (ITP) is to reduce the energy intensity of the U.S. industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficiency technologies and operating practices.

Benefits

ITP develops, manages, and implements a balanced portfolio of technology investments to address industry requirements throughout the technology development cycle. Research and development, particularly high-risk, high-return R&D, is conducted to target efficiency opportunities in manufacturing processes and crosscutting energy systems. Validation and verification of technology benefits through intermediate-term pilot and demonstration phases help emerging technologies gain commercialization and near-term adoption. Dissemination of energy-efficiency technologies and practices is accomplished through a variety of technology delivery mechanisms that will be the near-term focus of program efforts. These activities will help accelerate industry understanding, acceptance, and implementation of

[a] Includes a rescission of $574,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $1,281,000 was transferred to the SBIR program and $149,000 was transferred to the STTR program.

efficiency advances as industry starts reaping the benefits of proven technologies, system management decision tools, training, and strategic partnerships. These technology successes are the result of the "industry pull" designed into the Industrial Technologies Program. Reducing industrial energy intensity also contributes to environmental quality by promoting technologies and practices that minimize adverse environmental impact and promote sustainability during the production life cycle, yield improvement and resource conservation, and contribute to economic viability, international competitiveness, and to energy security by promoting technologies that increase independence from foreign energy sources. Given reduced program funding in response to corporate priorities, contributions to EERE portfolio benefits attributable to ITP R&D activities are expected to decrease.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Industrial Technologies Program supports the following goal:

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Industrial Technologies Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.60.00.00: Industrial Technologies. The Industrial Technologies Program goal is to partner with our most energy-intensive industries in strategic planning and specific RD&D to develop the technologies needed to use energy efficiently in their industrial processes and cost-effectively generate much of the energy they consume. The result of these activities will save feedstock and process energy, improve the environmental performance of industry, and help America's economic competitiveness.

Contribution to Program Goal 04.60.00.00 (Industrial Technologies)

The Industry of the Futures technology program's key contribution to energy security is through improving energy efficiency and directly reducing the demand for oil, natural gas, and electricity. Between 2002 and 2009, industrial technologies will contribute to a 7.2 percent reduction in energy intensity (Btu per unit of industrial output as compared to 2002) in the energy-intensive Industries of the Future (a potential savings of 0.7 Quads above projected baseline efficiency improvements); between 2004 and 2009, target industries and RD&D partners will commercialize over 10 energy-efficiency technologies developed through the ITP partnerships.

The production improvements and direct reduction in both total industrial energy use and the use of fossil fuels could contribute to the Administration goal of an 18 percent reduction between 2002 and 2012 in the greenhouse gas intensity, or total greenhouse gas emissions per unit of Gross Domestic Product, of the U.S. economy.

ITP voluntary partner program activities contribute directly to environmental benefits. According to an EIA report[a], the industrial end-use sector decreased its emissions of carbon dioxide from 2002 to 2003. Industrial production rose by 0.2 percent in 2003, while industrial emissions of carbon dioxide fell by 0.3 percent, for a total carbon intensity reduction of 0.5 percent. Overall, from 2002 to 2003, carbon dioxide emissions throughout the economy grew by 0.8 percent, or 45.5 million metric tons, attributable both to economic growth and a cold winter. In 2003, ITP estimates that technologies it developed and activities it undertook saved over 24 million metric tons of carbon dioxide, or 6.6 million metric tons of carbon equivalent.[b]

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.60.00.00, Industrial Technologies			
Industries of the Future (Specific)	37,369	24,245	17,001
Industries of the Future (Crosscutting)	32,262	28,855	28,562
Technical/Program Management Support	3,740	3,755	0
Total, Program Goal 04.60.00.00, Industrial Technologies	73,371	56,855	45,563
Total, General Goal 4 (Industrial Technologies)	73,371	56,855	45,563

[a] See EIA Report Emissions of Greenhouse Gasses in the United States 2003 at http://www.eia.doe.gov/oiaf/1605/cdrom/pdf/ggrpt/057303.pdf.
[b] See 2005 Impacts Report at http://www.pnl.gov/impacts/

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.60.00.00 (Industrial Technologies)					
Industries of the Future (Specific)					
Commercialize 10 new energy efficiency technologies in partnership with the most energy-intensive industries.	Commercialize 4 new technologies in partnership with the most energy-intensive industries. [MET: Exceeded, 5 technologies] Turn over 25 percent of projects in the RD&D portfolio. [MET]	Commercialize 4 new technologies in partnership with the most energy-intensive industries. [MET: Exceeded, 6 technologies]	Commercialize 3 new technologies in partnership with the most energy-intensive industries. [MET]	Commercialize 3 new technologies in partnership with the most energy-intensive industries.	Commercialize 3 new technologies in partnership with the most energy-intensive industries that improve energy efficiency of an industrial process or product by at least 10 percent.
Industries of the Future (Specific and Crosscutting)					
Complete 2 showcase demonstrations at industry sites, of advance energy efficiency technologies.	Help industry save more than 180 trillion Btu of energy worth at least $720 million (assumes average energy prices of $4.00 a million Btu). [MET]				
Assist industry in saving more than 265 million Btu of energy, worth more than $1.6 million. Complete 20 new Allied Partnerships with energy intensive companies, trade organizations, and other groups.					
Industries of the Future (Crosscutting)					
Continue support for Industrial Assessment Centers operating at 26 participating university that will conduct over 600 combined energy waste, and productivity assessment days of service to manufacturing clients.	6,200 energy-intensive U.S. plants that will apply EERE technologies and services averaging up to a 15 percent improvement in energy productivity per plant. [MET: Exceeded, 6400 plants]	An additional 600 (leading to a cumulative 6,800) energy intensive U.S. plants will apply EERE technologies and services averaging a 5 percent improvement in energy productivity per plant. [MET: Exceeded, 9,987 cumulative plants]	An additional 200 (leading to a cumulative 7,000) energy intensive U.S. plants will apply EERE technologies and services. [MET]	An additional 200 (leading to a cumulative 8,600) energy intensive U.S. plants will apply EERE technologies and services contributing to the goal of a 20% reduction in energy intensity from 2002 levels by 2020.	An estimated 100 trillion Btus saved by an additional 800 energy intensive U.S. plants applying EERE technologies and services

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (2003) until the target range is met. [MET]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($40,741K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The Industrial Technologies Program uses various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the success of planned investments, means and strategies, and to addressing external factors.

The Industrial Technologies Program implements the following means:

- ITP invests in pre-competitive and high-risk RD&D that individual companies are unable to undertake without Government support. These industry and departmental investments in applied research and pre-commercialization technology represented the greatest opportunities to save energy and improve environmental performance in a cost-effective manner.
- ITP implements its research and technology development program through cost-shared projects with multiple industrial and academic partners. Sharing project costs (industrial partners typically contribute 50 percent) leverages public investment with private resources, increases access to scientific capabilities, increases industry commitment to achieving R&D success, shortens the technology development and commercialization cycle, and facilitates technology delivery. ITP activities include both industry-specific R&D and technology development applicable to multiple industries.

The Industrial Technologies Program implements the following strategies:

- The Management Strategy focuses on addressing energy losses that when remedied will reduce the energy requirements of industry while stimulating economic productivity and growth.
- ITP invests in next-generation manufacturing concepts that will produce dramatic energy and environmental benefits providing large public benefits. The development of Transformational Technologies typically requires high-risk, high-return R&D which one industry cannot typically do, such as an entirely new processing route to achieve much lower energy use than current processes. Examples of Transformational Technologies are the nano-manufacturing applications and industrial fuels and feedstock economic efficiency research to be begun in FY 2007 to support national manufacturing priorities. These efforts are expected to yield substantial energy, environmental, and economic benefits.

These means and strategies could result in significant cost savings and a significant reduction in the consumption of energy across fuel types — increasing the substitution of clean fuels and power — cost effectively reducing American's demand for energy, lowering carbon emissions, and decreasing energy expenditures. These energy and emissions savings come from a portion of EERE's portfolio of diverse technologies, a portfolio that must continuously be refined to accelerate and expand contributions to critical national objectives and most efficiently and effectively address the complex requirements for simultaneously improving national energy security, providing for a cleaner environment, and ensuring continued economic growth and development.

The following external factors could affect ITP's ability to achieve its goals:

- Rates of market growth/technology adoption;
- Industry profit margins;

- Capital investment requirements;
- Foreign competition;
- Energy supply markets and prices;
- Safety and environmental regulations;
- Costs and adoption of technologies;
- Labor and material costs; and
- Environmental policies at the national and state level, including Federal efforts to reduce carbon and criteria emissions that might affect the choice of energy sources.

In carrying out the program's mission, Industrial Technologies Program (ITP) performs the following collaborative activities:

- The *National Energy Policy*[a] encourages energy efficiency programs that are modeled as public-private partnerships. The Industrial Technologies Program has used this partnership model for the past nine years to bring together the strengths of business and Government to improve energy efficiency. These partnerships also help to disseminate and share best energy management practices in factories throughout the United States.
- ITP works with DOE's Basic Energy Sciences and Fossil Energy Programs to coordinate research in such areas as nanotechnology and mining, respectively.
- ITP coordinates with other Federal agencies, including the National Aeronautics and Space Administration, the National Science Foundation, the National Institute of Standards and Technology, EPA, and the Departments of Defense, Commerce, Agriculture, and Interior to organize research efforts in common areas.
- On manufacturing technology issues, ITP collaborates through the National Science and Technology Council inter-agency working group on manufacturing (IWG) with many of the participating agencies.

Validation and Verification

To validate and verify program performance, the Industrial Technologies Program will report and manage its performance plan directly and conduct internal and external reviews and audits. These programmatic activities are subject to continuing review by, for example, the Congress, the General Accountability Office, the Department's Inspector General, the U.S. Environmental Protection Agency, and state environmental agencies. ITP will also undertake analyses to address Government Performance and Results Act (GPRA) and the President's Management Agenda (PMA) requirements, including the Performance Assessment Rating Tool (PART) and the R&D Investment Criteria (RDIC).

The table below summarizes validation and verification activities. Progress toward annual performance targets and results are also tracked on a quarterly basis through the DOE management system, Joule.

Data Sources:	Energy intensity is calculated from the Energy Information Administration's (EIA's) Annual Energy Outlook, Manufacturing Energy Consumption Survey (MECS) and Department of Commerce data. The number of technologies and their energy savings

[a] See National Energy Policy report of the National Energy Policy Development Group (May 2001), P. 4-12.

are ascertained through interviews with technology developers and suppliers. Energy savings for the technical assistance programs are estimated based upon past reported participant data. Project financial data is tracked through the EERE Corporate Planning System.

Evaluation: In carrying out the program's mission, the Industrial Technologies Program uses several forms of evaluation to assess progress and to promote program improvement.

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review of the Industrial Technologies Program;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of benefits for the Government Performance and Results Act (GPRA).

Baselines: The following are the key baselines used in ITP:

- Industrial energy intensity (2002) 14,000 Btu/$1996 value of shipments of energy intensive industry output.
- The baseline for the cumulative count of new commercialized technologies that achieve 10 percent improvement in energy efficiency is zero in 2003 cumulative count.

Frequency: EIA/MECS collects energy intensity data once every 4 years, and ITP makes annual estimates based upon data from annual Department of Commerce surveys. ITP collects data on energy savings and technologies commercialized annually. The EERE Corporate Planning System tracks project awards and expenditures continually.

Data Storage: Energy intensity information is contained in EIA's computer database. Data on energy savings and technologies commercialized are stored in ITP's Impacts Database and are available on the internet at: http://www.pnl.gov/impacts/. Data on the counts and impacts of plants contacted is collected by Lawrence Berkeley National Laboratory and Oak Ridge National Laboratory.

Verification: ITP uses prospective and retrospective peer reviews to evaluate project performance and to adjust support. To verify program performance and results, ITP tracks all technologies commercialized (and the extent of their use) by industry through an

analysis of program impacts conducted by Pacific Northwest National Laboratory. ITP also provides EIA quality control and outside peer review of the Manufacturing Energy Consumption Survey. Industry representatives review data on energy savings and technologies commercialized. ITP has conducted reviews of the impacts of several technical programs and assistance programs have also been reviewed several times.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Industrial Technologies Program received its first OMB PART review in 2005. The PART review included ratings of 80% for program purpose, 90% for planning, 91% for management and 50% for program results and accountability with an overall rating of Adequate. The program will address the findings and recommendations in the PART and expects to improve its score in the next assessment. These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles**.**

Expected Program Outcomes

Over the past 30 years, industry has shown a remarkable ability to improve energy efficiency, greatly increasing economic output without a corresponding increase in energy use. The Industrial Technologies Program estimates that, in 2003, it directly contributed to industrial energy savings of over 352 trillion Btu[a] in energy savings worth over $2.7 billion.[b] From the ITP activity's inception in 1977 through 2002, ITP helped develop more than 180 commercialized industrial technologies. Cumulative tracked energy savings over that period are estimated to be almost 4 Quads.

Yet an expanding economy will increase industrial energy demand. In its Annual Energy Outlook 2005, the Energy Information Administration projects industrial energy use will grow by almost 23 percent from 2003 to 2025, even with assumed efficiency gains and an economic shift to less energy-intensive industries. Reducing energy intensity – the amount of energy used to produce a given amount of industrial product – is the key to increasing energy efficiency in industry without impeding economic growth. Because there are significant gaps between current energy use and the practical minimum energy use for most industrial processes, the industrial sector will continue to offer excellent opportunities to improve energy efficiency in the United States over the next 25 years.

If energy use per unit of output in the ITP partner industries continued at 2002 levels, these industries would be using about 20 Quads by 2008. However, by that time, partner industries are expected to reduce their energy use by 0.9 Quads through business-as-usual efficiency improvements (EIA projection of 0.75 percent annually), and, concurrently, activities originally sponsored by the Industrial Technologies Program are projected to help these industries lower energy use by another 0.6 Quads.

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[a] See 2005 Impacts report at http://www.pnl.gov/impacts/

[b] Constant 2003 dollar values for energy savings shown in this budget are based upon Energy Information Administration data from the Annual Energy Outlook 2005 (AEO 2005). Average industrial energy prices per million Btu were $6.39 in 2002, $7.78 in 2003, and a forecast of $8.73 for 2004. Source: based on AEO 2005, Table 3, available at www.eia.doe.gov/oiaf/aeo/pdf/aeo_base.pdf.

Performance Indicators	Historic			Planned				
	2002	2003	2004	2005	2006	2007	2008	2009
Annual number of technologies commercialized (after 2006, that achieve 10% improvement in energy efficiency)								
Target	6	4	4	3	3	3	3	3
Actual	10	5	6					
Annual energy savings from Industrial Program activities in partnership with industry (trillion Btu)								
Target		290	220	220	180	180	180	
Actual	293	352						
Number of new Allied Partners								
Target	20	20	20	20	10	10	0	0
Actual	20	20	21					
Cumulative number of energy-intensive plants impacted by the program								
Target	5,000	6,200	6,800	12,000	12,800	13,600	14,400	14,400
Actual	5,200	6,400	9,987					
Number of internet information page views (million)								
Target	5.0	6.0	6.2	6.4	6.6	6.4	6.4	0
Actual	5.3	6.0	6.3					
Percentage change in energy intensity from 2002								
Target		-1.2	-2.4	-3.7	-4.8	-6.0	-7.2	-7.2
Actual		-1.6	-3.7	-4.3 Est.				

FY 2007 GPRA Benefits Estimates for the Industrial Technologies Program[a]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)..	0.16	0.72	1.68	2.39
Energy Expenditure Savings (Billion 2003$)……..	2.2	4.5	22.9	22.3
Carbon Emission Reductions (MMTCE)…….	3.4	13.9	31.4	49.4
Oil Savings (MPPD)……	0.00	0.05	0.26	0.08
Natural Gas Savings (Quads)……	0.07	0.31	0.65	0.85

[a] The benefits estimates for the Industrial Technologies Program are derived largely via off-line analysis tools, and not with the full integration with the integrated energy model.

Industries of the Future (Specific)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Industries of the Future (Specific)			
Forest and Paper Products Industry	6,103	3,560	2,878
Steel Industry	5,489	3,625	3,613
Aluminum Industry	5,390	3,085	2,265
Metal Casting Industry	3,862	2,406	982
Glass Industry	2,511	1,696	0
Chemicals Industry	9,943	7,481	6,787
Mining Industry	3,394	1,022	0
Supporting Industries	677	691	0
SBIR/STTR	--	679	476
Total, Industries of the Future (Specific)	37,369	24,245	17,001

Description

The Industries of the Future (Specific) sub-program supports cost-shared research, development, and demonstration (RD&D) of advanced technologies to reduce the energy intensity while improving the environmental performance of America's energy-intensive and waste-intensive industries. To provide the best value and optimum use of public investments, this activity focuses on a few basic energy-intensive industries that can achieve the highest returns on Federal investments. In the process of closing out the glass, mining and supporting industries activities, less productive efforts will be terminated first.

Benefits

Key domestic industries will employ partner co-developed and tested industrial efficiency technologies that reduce their energy consumption and improve their competitive position preserving domestic economic benefits while reducing cost, saving energy and improving environmental performance.

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Forest and Paper Products Industry	**6,103**	**3,560**	**2,878**

In FY 2007, the key activity plans to perform mechanical and process tests for technologies that will reduce water and energy usage in the papermaking process. Additional research will investigate avenues for the reduction of natural gas use through transformational technologies.

Continue to support the American Forest & Paper Association and other industry organizations to improve their member companies' energy efficiency and environmental performance through the industry's Agenda 2020. The collaborative activities will include cost-shared R&D as well as the utilization of new improved energy technologies, industrial energy efficiency tools and energy management best practices.

Steel Industry	**5,489**	**3,625**	**3,613**

In FY 2007, the focus will be on processes that both reduce the use of natural gas and improve energy efficiency in iron and steelmaking. Continue work initiated in FY 2005 for cokeless ironmaking and for developing transformational technology for next generation steelmaking. Funding will be primarily used to continue research initiated in previous years.

Continue to support the American Iron and Steel Institute, the Steel Manufacturers' Association, and other industry organizations to improve their member companies' energy efficiency and environmental performance. The collaborative activities will include the continuation of cost-shared R&D as well as the utilization of new improved energy technologies, industrial energy efficiency tools, and energy management best practices.

Aluminum Industry	**5,390**	**3,085**	**2,265**

In FY 2007, key activities will be in the areas of isothermal melting of aluminum, spray rolling of aluminum strip, and hot rolling scrap reduction. Primary smelting research will be discontinued as the industry continues to move off-shore.

Metal Casting Industry	**3,862**	**2,406**	**982**

In FY 2007, this key activity will be scaled down to focus on advanced melting and efficient net shape manufacturing processes. ITP-developed metal casting models will be made publicly available.

Glass Industry	**2,511**	**1,696**	**0**

Close out of this activity will include the transfer of research and development results and findings to the industry and the public sector.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Chemicals Industry	**9,943**	**7,481**	**6,787**

In FY 2007, planned activities include the completion of demonstration testing of the following projects: In situ Sensors, Energy-efficient Natural Gas Liquid (NGL) Removal Process, the Production and Separation of Fermentation Derived Acetic Acid project, the Dimpled Tube Technology for Process Heaters, and Process Optimization Tools for Solution Crystallization.

Continue work initiated in FY 2005 to develop transformational technologies for hybrid distillation and microchannel reactor technologies and investigate research avenues for the reduction of natural gas use through transformational technologies.

Mining Industry	**3,394**	**1,022**	**0**

Close out of this activity will include the transfer of the remainder of the research and development results and findings to the industry and the public sector.

Supporting Industries	**677**	**691**	**0**

Close out of this activity will include the transfer of research and development results and findings to the industry and the public sector.

SBIR/STTR	**--**	**679**	**476**

In FY 2005, $807,081 and $0 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Specific)	**37,369**	**24,245**	**17,001**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Forest and Paper Products Industry	
This activity will be scaled down in FY 2007 to focus on water- and natural gas-reducing technologies, consistent with R&D Investment Criteria on incorporating "off-ramps"	-682
Steel Industry	
No significant change	-12

	FY 2007 vs. FY 2006 ($000)
Aluminum Industry	
The activity in primary smelting research will be discontinued in FY 2007, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology	-820
Metal Casting Industry	
In FY 2007, this activity will be scaled down to focus on advanced melting and efficient net shape manufacturing processes, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology	-1,424
Glass Industry	
This activity will be closed out and research and development results transferred to industry and the private sector, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology	-1,696
Chemicals Industry	
This activity will be scaled down in FY 2007 as demonstration testing is completed for several projects, and the expected commercialization consistent with R&D Investment Criteria on incorporating "off-ramps"	-694
Mining Industry	
This activity will be closed out and research and development results transferred to industry and the private sector, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology	-1,022
Supporting Industries	
This activity will be closed out and research and development results transferred to industry and the private sector, consistent with R&D Investment Criteria on incorporating "off-ramps" and the expected commercialization of the technology	-691
SBIR/STTR	
Changes in the SBIR/STTR funding are a direct result of changes in the funding of program activities	-203
Total Funding Change, Industries of the Future (Specific)	**-7,244**

Industries of the Future (Crosscutting)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Industries of the Future (Crosscutting)			
Industrial Materials of the Future	9,642	11,033	9,847
Combustion	1,544	0	2,357
Robotics	1,972	0	0
Sensors and Automation	994	3,061	3,051
Industrial Technical Assistance			
Industrial Assessment Centers	6,904	6,435	4,035
Best Practices	8,206	7,920	8,833
Total, Industrial Technical Assistance	15,110	14,355	12,868
Congressionally Directed Activities	3,000	0	0
SBIR/STTR	--	406	439
Total, Industries of the Future (Crosscutting)	32,262	28,855	28,562

Description

The Industries of the Future (Crosscutting) activities works with industrial partners and suppliers to conduct cost-shared RD&D on technologies that have potential applications across many partner industries. For FY 2007, there will be an emphasis on two new areas, using the convening power of government to form working groups for future industrial cooperation in the areas of Transforming Manufacturing Technologies and Industrial Fuels and Feedstock Flexibility. Three primary areas of focus that offered past major improvements in energy efficiency and emissions reduction are: (1) *advanced industrial materials* that can transform manufacturing processes, reduce energy use, lower emissions, increase component life, improve product quality, optimize process operating conditions, and reduce downtime; (2) *high-efficiency, clean combustion* technologies; and (3) *advanced sensors and automation* that can increase process efficiency and productivity even in high temperature and harsh environments. Through its technical assistance activities, ITP also developed and provided the tools, technical assistance, and research needed by industry to expedite the adoption of energy-efficient and clean manufacturing technologies.

Benefits

Crosscutting IOF technologies have provided the means for development of broad benefit and enabling technologies that were not within practical developmental reach of an individual industry. These technologies continue to be developed and deployed across industries providing economic, energy and environmental benefits nationally.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Industrial Materials of the Future	**9,642**	**11,033**	**9,847**

In FY 2007, complete software development for the prediction of localized corrosion. Complete development of ultrananocrystaline diamond coatings for rotating pump and seal surfaces. Work will continue on the development of transformational advanced materials solutions such as film thermoelectrics, for energy loss recovery, refractories for industrial systems, and materials solutions for corrosion and wear. Research activities on national priorities such as nano-manufacturing will be increased. Funding will be ended for the M-PLUS Program to allow for funding of higher priority activities in accordance with the RDIC guidelines.

Combustion	**1,544**	**0**	**2,357**

In FY 2007, Development of Computational Fluid Dynamics-based design tool deferred from FY 2005 will be completed. Continue work initiated in FY 2005 for a transformational superboiler.

Robotics	**1,972**	**0**	**0**

FY 2006 research efforts in this area will be combined with the activities in the Sensors and Automation area.

Sensors and Automation	**994**	**3,061**	**3,051**

In FY 2007, evaluate networked industrial wireless sensor systems in industrial environments; develop a machine vision-based steel surface quality sensor; and continue robotics R&D activities in the areas of gas-fired thermal treatment processes and general improvement in manufacturing line productivity.

Industrial Technical Assistance	**15,110**	**14,355**	**12,868**
▪ **Industrial Assessment Centers**	**6,904**	**6,435**	**4,035**

Through the end of 2003, over 13,300 audits have been completed, training over 2,150 students, with an estimated cumulative energy savings of nearly 1 quadrillion Btu. An average of about 600 audits is expected to be conducted per year through FY 2006, with about 350 conducted in FY 2007.

This activity is being scaled down substantially starting in FY 2007 in order to focus more resources on higher priority activities.

▪ **Best Practices**	**8,206**	**7,920**	**8,833**

In FY 2007, complete 4 plant-wide assessments and complete 30 training sessions on energy-efficiency software.

Continue technical assistance to plant sites, enabling their use of industrial process application tools relevant to energy feedstock selection and switching, motor, pump, process heating, steam

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

and compressed air systems emphasizing system-level improvements. In collaboration with industry, develop new software tools and update existing tools, as necessary.

Continue efforts to replicate plant-wide assessment results from prior awards in industrial facilities with similar process lines. Allied Partnerships will be used to facilitate delivery and replication of the entire Best Practices portfolio. Conduct 200 energy savings assessments to reduce manufacturing plant natural gas consumption in support of the Secretary of Energy's "Easy Ways to Save Energy" campaign.

Congressionally Directed Activities	**3,000**	**0**	**0**

Congressionally directed activities for this subprogram included $1,000,000 for the Metals Processing Laboratory Users Facility at Oak Ridge, Tennessee, and $2,000,000 for R&D in the area of robotics to replace repetitive manufacturing tasks. The robotics R&D activities have been incorporated into the Sensors and Automation activity, with an FY 2007 focus in the areas of gas-fired thermal treatment processes and general improvement in manufacturing line productivity. Funding will be ended for the M-PLUS Program to allow for funding of higher priority activities in accordance with the RDIC guidelines.

SBIR/STTR	**--**	**406**	**439**

In FY 2005, $473,919 and $149,000 were transferred to the SBIR and STTR programs respectively. The FY 2006 and FY 2007 amounts shown are estimated requirements for the continuation of the SBIR and STTR program.

Total, Industries of the Future (Crosscutting)	**32,262**	**28,855**	**28,562**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Industrial Materials of the Future	
Funding will be ended for the M-PLUS Program to allow for funding of higher priority activities in accordance with the RDIC guidelines	-1,186
Combustion	
The increase will accelerate development and demonstration for a transformational super boiler while maintaining adequate funding levels for existing projects making substantive progress towards their milestones. This focus on long-term potentially high pay-off activities is consistent with RDIC guidance	+2,357

	FY 2007 vs. FY 2006 ($000)
Sensors and Automation	
No significant change	-10
Industrial Technical Assistance	
▪ **Industrial Assessment Centers**	
This activity is being scaled down in order to focus more resources on higher priority activities. (It is expected that the University centers that have been implementing this program will be transitioned over time to state or other Federal support.) In this initial ramp-down phase, qualification guidelines for participants will be substantially tightened	-2,400
▪ **Best Practices**	
Program activities will be expanded to support assessments that are considered high priority among ITP activities	+913
Total, Industrial Technical Assistance	**-1,487**
SBIR/STTR	
No significant change	+33
Total Funding Change, Industries of the Future (Crosscutting)	**-293**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	3,740	3,755	0
Total, Technical/Program Management Support.....	3,740	3,755	0

Description

In the past, consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provided funding for Technical/Program Management Support. This included activities such as strategic and operating plans; evaluation of the impact of new legislation on R&D Programs; identification and application of performance methodologies (including GPRA); data collection to assess Program and project performance, efficiency and impacts on accomplishing the mission; and technical, economic, and market evaluations of research. These activities provide important benefits directly to ITP and are therefore an integral part of the R&D program. Those functions are built into the individual program budgets starting in FY 2007.

Benefits

The analysis and technology assessment and planning necessary for good management of the R&D programs will be funded within the programs themselves, since they are an integral part of the Federal role of oversight of the R&D activities.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support.....	**3,740**	**3,755**	**0**

Technical management activities, including strategic and technical planning; project and performance tracking; program reviews and evaluations, including R&D feasibility studies and trade-off analyses; peer reviews; data collection and publication; and market, economic, and other analyses are all part of the sound management of any R&D or technology deployment program. Consistent with Energy and Water committee standard practice, funding for those activities will be provided from within the requested budgets for the Industrial Technologies starting in FY 2007.

Total, Technical/Program Management Support.....	**3,740**	**3,755**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Technical/Program Management funds are included in the budgets at the activity level	-3,755
Total Funding Change, Technical/Program Management Support	**-3,755**

Distributed Energy Resources

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation[a]	FY 2006 Adjustments	FY 2006 Current Appropriation	FY 2007 Request
Distributed Energy Resources					
Distributed Generation Technology Development	38,410	0	0	0	0
End-Use System Integration and Interface	20,136	0	0	0	0
Technical/Program Management Support	523	0	0	0	0
Total, Distributed Energy Resources	59,069[b]	0	0	0	0

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (1975)
P.L. 94-385, "Energy Supply and Production Act" (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-190, "Energy Policy Act" (2005)

Mission

To provide localities with greater electric reliability, energy security, and economic development opportunities through Local Energy Networks that are designed for fuel flexibility, efficient use of electric and thermal energy, public health and safety, and consistency with future grid architecture(s), environmental requirements, and the transition to the hydrogen economy.

Benefits

The DER Program supports DOE's mission of advancing the national, economic, and energy security of the United States. The program helps protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy systems.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The DER Program supports the following goal:

[a] As directed in the FY 2006 Appropriation, the DER Program is transferred to Office of Electricity Delivery and Energy Reliability (OE).
[b] In FY 2005, $1,203,000 was transferred to the SBIR program and $144,000 was transferred to the STTR program.

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The DER Program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.59.00.00: Distributed Energy Resources. The DER Program goal is to develop a diverse array of cost competitive integrated distributed generation and thermal energy technologies and facilitate market adoption in homes, businesses, industry, communities, and electricity companies, increasing the efficiency of electricity generation, delivery, and use, improving electricity reliability, and reducing environmental impacts.

Contribution to Program Goal 04.59.00.00: (Distributed Energy Resources)

As directed by congress, the DER Program has transferred its activities to the Office of Electricity Delivery and Energy Reliability (OE).

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.59.00.00, Distributed Energy Resources			
Distributed Generation Technology Development	38,410	0	0
End-Use System Integration and Interface.....	20,136	0	0
Technical/Program Management Support.....	523	0	0
Total, Program Goal 04.59.00.00, Distributed Energy Resources.....	59,069	0	0
Total, General Goal 4 (Distributed Energy Resources).....	59,069	0	0

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.59.00.00 (Distributed Energy Resources)					
Distributed Generation Technology Development					
	Complete 4,000 hour field test of ceramic composite shroud components to demonstrate performance and emission benefits to a gas turbine. [MET]	Complete final design and initiate field testing of low emission technology with less than 7 ppm NO_x. [MET]	Demonstrate NO_x emission levels of 0.25 lbs/MWh from a turbine combustion system. [MET]	Program activities have been transferred to the OE, as directed by Congress.	NA
	Complete the 12 Beta field test units of high efficiency natural gas-fired heat pump (60 percent better than pulse combustion furnace) and install at field test sites hosted by major U.S. Gas Utilities. [MET]	Complete and demonstrate heating coefficient of performance of 1.4 for commercial introduction of a thermally activated system (approximately 40 percent more efficient than a conventional heating system). [MET]			
	Contract with three companies to support research on demonstrating a 5 percent increase in efficiency for an advanced microturbine. [MET]				
		Demonstrate 6 percentage point increase in efficiency for an advanced reciprocating engine. [MET]			
End-Use Systems Integration and Interface					
Demonstrate a microturbine package (highly efficient for reducing peak loads) at a university site.		Complete final design and initiate field testing and evaluation of a complete, fully functional integrated CHP system consisting of a turbine, absorption chiller and control system. [MET]	Complete a case study on a CHP installation that uses heat from a microturbine to provide plate tank heating and sludge drying at an industrial facility, contributing to the PART long-term measure of developing a 70 percent efficient CHP integrated system. [MET]	NA	NA
			Complete and document two DER/CHP demonstration projects within the high tech industry, contributing to the	NA	NA

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
			PART long-term measure of developing a 70 percent efficient CHP integrated system. [MET]		
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,257K) until the target range is met. [NOT MET]	NA	NA

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The DER Program has incorporated feedback from OMB into the FY 2007 Budget Request and has taken or will take the necessary steps to continue to improve performance. The details of this progress are discussed in the OE funding request.

The 2003 PART review included strong ratings for purpose (80%), planning (80%), and management (100%). These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles. The PART recommended that the program develop performance measures to account for outreach activities and that the program focus R&D funding on systems integration while decreasing emphasis on component technology R&D that is within industry's capability. In response to the recommendations from the PART review, the DER Program is developing a measure to account for outreach activities and has increased its funding for system integration efforts, particularly in the Distributed Energy System Applications Integration activity.

The PART also recommended that the program participate in the development of a consistent framework for the Department to analyze the costs and benefits of its R&D investments, and apply this guidance to the development of the budget. Benefit estimates are not yet comparable across the entire applied R&D portfolio. DOE will continue to address this finding corporately.

Distributed Generation Technology Development

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Distributed Generation Technology Development			
Industrial Gas Turbines	2,958	0	0
Microturbines	6,168	0	0
Advanced Reciprocating Engines	13,088	0	0
Technology Based – Advanced Materials and Sensors	8,959	0	0
Fuel Combustion (formerly Fuel Flexibility)	739	0	0
Thermal Energy Technologies (formerly Thermally Activated Technologies)	6,498	0	0
SBIR/STTR	--	0	0
Total, Distributed Generation Technology Development	38,410	0	0

Description

The mission of the Distributed Generation Technology Development Subprogram is to improve the energy and environmental performance of distributed technologies so that the Nation can have more energy choices to achieve a more flexible and smarter energy system. By Congressional direction, this activity is transferred to OE in FY 2006.

Benefits

This subprogram provides the high-risk R&D on technology development such as combustion, materials, system design, thermal recovery and failure analysis to develop the next generation high-efficiency, low emission technologies for industrial gas turbines, microturbines, and reciprocating engines as well as thermally activated technologies. The following tables are indicators of progress the program has planned and accomplished.

Historic and Planned Results (verified by rig or prototype engine testing)

(Percent/Low Heating Value)

Efficiency	Historic 2001	Historic 2002	Historic 2003	Historic 2004	Planned 2005	Planned 2006	Planned 2007	
Microturbines								
Target	28	--	33	33	35	--	--	
Actual	28	--	33	34	--	--	--	--
Reciprocating Engines								
Target	38	--	39	42	44	44	44	
Actual	38	39	39	43	--	--	--	--

(lb/MWh)

Emissions	Historic 2001	Historic 2002	Historic 2003	Historic 2004	Planned 2005	Planned 2006	Planned 2007	
Industrial Turbines								
Target	0.35	0.35	0.35	0.25	--	0.18	0.18	
Actual	0.35	0.35	0.35	0.30	--	--	--	--
Microturbines								
Target	0.70	0.70	0.40	0.40	0.30	0.30	0.30	
Actual	0.70	0.50	0.40	0.30	--	--	--	--
Reciprocating Engines								
Target	3.10	3.10	3.10	3.10	1.50	1.50	1.50	
Actual	3.10	3.10	3.10	1.60	--	--	--	--

Detailed Justification

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Industrial Gas Turbines	**2,958**	**0**	**0**

Industrial gas turbines are used in many industrial and commercial applications ranging from 1MW to 20MW. A key effort in the Industrial Gas Turbine research has been to enhance the efficiency and environmental performance of gas turbines for applications up to 20MW. The focus of this effort is to advance materials research, such as composite ceramics and associated environmental barrier coatings, which will improve performance and durability and advance low emissions combustion

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

technologies. By Congressional direction, this activity is transferred to OE in FY 2006.

Microturbines	**6,168**	**0**	**0**

Microturbines are a type of combustion turbine for use in distributed energy generation applications. Microturbines produce 25 to 500 kW of energy and can be located on sites with limited space for power production. By Congressional direction, this activity is transferred to OE in FY 2006.

Advanced Reciprocating Engines	**13,088**	**0**	**0**

Gas-fired reciprocating engines offer a wide range of power generation at an economical cost over other technologies. With their operating flexibility, reciprocating engines can be used for many purposes, such as local power grid and substation support, peak-shaving, remote power, on-site generation, combined cooling, heating, and power (CHP) applications, high-density electric loads, standby power, and as mechanical drives used for compressors and pumps in industrial, commercial, institutional, and residential applications. By Congressional direction, this activity is transferred to OE in FY 2006.

Technology Based – Advanced Materials and Sensors.....	**8,959**	**0**	**0**

Operation and maintenance of power generation is critical to the reliability and availability of these systems. Advanced materials, coatings and sensors are some of the key enabling technologies for heat exchangers (recuperation), compression/expansion systems (combustor liners, spark plugs), operation and environmental control of stationary industrial gas turbines, microturbines and reciprocating engines to improve the efficiency and reduce emissions. Engineered ceramics, such as ceramic matrix composites offer all of the advantages of ceramics-resistant to heat, corrosion, erosion, and chemical activity-while adding strength and thermal shock resistance that conventional ceramics do not demonstrate. By Congressional direction, this activity is transferred to OE in FY 2006.

Fuel Combustion (formerly Fuel Flexibility)	**739**	**0**	**0**

In an effort to address distributed energy generators concerns about the composition of natural gas, the stability of the combustion process, and the future availability and price volatility of natural gas, the program had undertaken fuel combustion research. By Congressional direction, this activity is transferred to OE in FY 2006.

Thermal Energy Technologies (formerly Thermally Activated Technologies)	**6,498**	**0**	**0**

Thermal Energy Technologies use the recoverable heat from gas-fired systems and rejected/waste heat from industrial processes or electricity generation. The technologies provide important components to achieving high overall efficiencies. The program has completed major activities in the development of advanced chillers. By Congressional direction, this activity is transferred to OE in FY

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
2006.			
SBIR/STTR	**--**	**0**	**0**
In FY 2005, $768,000 and $144,000 were transferred to the SBIR and STTR programs respectively.			
Total, Distributed Generation Technology Development	**38,410**	**0**	**0**

End-Use System Integration and Interface

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
End-Use System Integration and Interface			
Distributed Energy Systems Applications Integration			
Distributed Energy Systems Applications Integration	7,573	0	0
Congressionally Directed Activity, Distributed Energy Systems Applications Integration	986	0	0
Total, Distributed Energy Systems Applications Integration	8,559	0	0
Cooling, Heating and Power (CHP) Integration	11,577	0	0
SBIR/STTR	--	0	0
Total, End-Use System Integration and Interface	20,136	0	0

Description

Distributed energy devices provide utilities and consumers with more choices and control over how their energy needs are met, and are essential for more openly competitive electricity and natural gas markets to flourish. The focus of the End-Use Integration and Interface activities is to develop highly-efficient integrated energy systems that can be replicated across end-use sectors which will help demonstrate a R&D objective or address a technical barrier. By Congressional direction, this activity is transferred to OE in FY 2006.

Benefits

This subprogram develops the knowledge base and technologies necessary to integrate energy systems efficiently in end-use applications. The focus is on heat/mass transfer, air/fluid flows, optimizing performance, adaptive controls for building load management, and sensors/communications technologies for use with building energy systems. The following tables are indicators of the progress the program had achieved toward its goal of creating successful integrated system demonstrations:

Historic and Planned Results

	Historic				Planned			
Cumulative # Successful Demonstration	2001	2002	2003	2004	2005	2006	2007	
Target	0	0	0	0	1	1	2	
Actual	0	0	1	1				

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Distributed Energy Systems Applications Integration	**8,559**	**0**	**0**
▪ **Distributed Energy Systems Applications Integration**	**7,573**	**0**	**0**

This activity facilitates acceptance of distributed energy resources (DER) in end-use sectors by forming partnerships with industry consortiums in the light industrial, supermarkets, hospitality, education and healthcare sectors. These industries represent a high potential for use of DER due to the high reliability and power quality requirements and related large cooling loads. By Congressional direction, this activity is transferred to OE in FY 2006.

▪ **Congressionally Directed, Distributed Energy Systems Application Integration/National Accounts Energy Alliance**	**986**	**0**	**0**

National Accounts Energy Alliance

Cooling, Heating and Power (CHP) Integration	**11,577**	**0**	**0**

The Cooling, Heating and Power Integration (CHP) Program integrates power producing prime movers that generate heat and utilize it for domestic hot water, steam, and/or thermally activated technologies that drive absorption chillers and/or desiccant units. These systems will reduce energy costs and emissions by using energy resources more efficiently. In conventional conversion of fuel to electricity, over two-thirds of the energy input is discarded as heat to the environment and not used for productive purposes. By Congressional direction, this activity is transferred to OE in FY 2006.

SBIR/STTR	**--**	**0**	**0**

In FY 2005, $435,000 and $0 were transferred to the SBIR and STTR programs respectively.

Total, End-Use System Integration and Interface	**20,136**	**0**	**0**

Technical/Program Management Support

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	523	0	0
Total, Technical/Program Management Support.....	523	0	0

Description

The addition of distributed energy resources as a power choice is a complex issue. This task forms the technical foundation that guides the DER research activities to ensure relevance to the market. By Congressional direction, this activity is transferred to OE in FY 2006.

Benefits

The Technical/Program Management Subprogram (TPMS) provided the analysis framework and technical support to meet the requirements of Department's planning process, Congress, GPRA, and PART (planning, management and purpose). Program management will be focused on completing existing activities, and therefore planning support will not be necessary.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support	**523**	**0**	**0**
No activity.			
Total, Technical/Program Management Support	**523**	**0**	**0**

Federal Energy Management Program

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Federal Energy Management Program					
Project Financing	7,133	6,827	-68	6,759	5,935
Technical Guidance and Assistance	8,160	7,720	-78	7,642	6,519
Planning, Reporting and Evaluation	2,638	2,600	-26	2,574	2,473
Departmental Energy Management	1,951	2,019	-20	1,999	1,979
Total, Federal Energy Management Program	19,882	19,166	-192	18,974	16,906

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91 "DOE Organization Act" (1977)
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 100-615, "Federal Energy Management Improvement Act" (1988)
P.L. 102-486, "Energy Policy Act" (1992)
P.L. 109-190, "Energy Policy Act" (2005)

Mission

The mission of the Federal Energy Management Program (FEMP) is to promote energy security, environmental stewardship and cost reduction through energy efficiency and water conservation, report progress toward the Executive Order goals at Federal sites and support energy management activities of the Department of Energy.

Benefits

FEMP supports the mission of the Office of Energy Efficiency and Renewable Energy (EERE) by improving the energy efficiency and productivity of Federal Government buildings and by bringing clean, innovative, energy-efficient and renewable technologies to Federal facilities. FEMP supports DOE's goal of improving energy security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy to Federal facilities. These activities fulfill the statutory requirements of the National Energy Conservation Policy Act (NECPA); provisions under the Energy

[a] Includes a rescission of $192,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.

Policy Act of 1992 (EPAct); Executive Order 13123 (Efficient Energy Management) and the Energy Policy Act of 2005.

FEMP's mission contributes to several national energy and environmental priorities. The President's National Energy Policy calls for America to modernize conservation efforts, increase energy supplies, "accelerate the protection and improvement of the environment, and increase our Nation's energy security." It directs heads of executive departments and agencies to "take appropriate actions to conserve energy use at their facilities to the maximum extent consistent with the effective discharge of public responsibilities." Furthermore, FEMP carries out a number of responsibilities mandated by the Energy Policy Act of 2005, including the development of standards and guidance to help agencies meet new energy efficiency and renewable energy targets. FEMP also assists agencies in meeting the goals set forth in that legislation.

As of 2004 (the year with the latest available data), FEMP has assisted Federal agencies in reducing energy intensity in Federal buildings by 26 percent using 1985 as a baseline. While there is a trend in reducing energy intensity over time (see graph in the Expected Program Outcomes section entitled "Building Energy Intensity"), a great many factors combine to affect Federal agency energy consumption in any one year over time. Throughout its program history, FEMP has had a significant effect on reducing Federal energy intensity, as do other factors including new Federal building construction; military base closures and greater use of the existing building stock.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates of the Federal Energy Management Program are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. FEMP supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

FEMP has program goals that contribute to General Goal 4 in the "goal cascade":

Program Goal 04.13.00.00: Federal Energy Management Program. The Federal Energy Management Program goal is to provide technical and financial assistance to Federal agencies and thereby lead the Nation by example in the use of energy efficiency and renewable energy. Through the Federal Government's own actions, FEMP's target is to facilitate energy efficiency and renewable energy investments in FY 2007 that will result in lifecycle energy savings of 17.1 trillion Btus. Renewable energy investments are accounted for in this target as displaced conventional energy usage. This target includes only those investments at Federal agencies that can be quantified and directly related to FEMP activities.

These energy savings will help agencies reach the goals set by Executive Order and legislation. In addition to these FEMP-assisted efforts, agencies make additional energy savings investments without direct FEMP assistance and are expected to continue to do so. Federal agencies will need to make significant investments beyond the projects assisted by FEMP to meet the goals set forth by Executive Order 13123 and the Energy Policy Act of 2005 as summarized below:

- Executive Order 13123 establishes that the goal for all Federal agencies is to reduce energy intensity in Federal buildings by 35 percent by 2010 (relative to the 1985 baseline level of 138,610 Btu per gross square foot).
- The Energy Policy of 2005 sets forth the following goals for Federal agencies (including the Department of Energy):
    - Reduce energy consumption per square foot by 20 percent by 2015 compared to the baseline year of FY 2003 at a rate of 2 percent per year.
    - Ensure that at least 3 percent of Federal electricity consumption be generated by renewables in the years FY 2007 through FY 2009; 5 percent in the years FY 2010 through FY 2012; and 7.5 percent in FY 2013 and each fiscal year thereafter.

DOE has already achieved the Executive Order 13123 2010 goal to reduce the energy intensity in its standard buildings. The baseline (1985) energy intensity in standard buildings was 473,126 Btu per square foot, whereas the energy intensity in 2003 was 236,680 Btu per square foot, showing a 50 percent reduction in energy intensity in that time period. Contributing factors to this reduction include DOE energy efficiency retrofit projects, changes in mission and other operational changes in facilities, improved operation and maintenance, construction of new facilities (which are generally more energy efficient than older building stock) and retrofit projects at DOE facilities that were not administered primarily for energy efficiency, but nonetheless saved a substantial amount of energy.

To meet the Energy Policy Act of 2005 goals, the Department will need to fund energy projects through operation and maintenance funds under the stewardship and oversight of the cognizant program Secretarial Office, as well as through alternatively financed projects as appropriate. FEMP will continue to offer assistance to DOE sites, just as FEMP assists other agencies with alternative financing and technical assistance projects.

Contribution to Program Goal 4.13.00.00

FEMP employs a variety of approaches to assist agencies in realizing energy, environmental and cost savings potentials, including: direct technical assistance, and assistance in accessing alternative private sector funding. Success occurs when FEMP and its agency and private sector partners enable Federal energy managers to make better energy management choices that result in a more efficient, effective and energy secure government.

FEMP coordinates DOE energy management activities by establishing Departmental policy and guidance and reporting on progress toward Departmental and Executive Order goals. E.O. 13123 and DOE Order 430.2A have established goals for DOE in the areas of energy efficiency, renewable energy, greenhouse gas emissions, water management and energy audits.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.13.00.00, Departmental Energy Management Program/Federal Energy Management Program			
Project Financing	7,133	6,759	5,935
Technical Guidance and Assistance	8,160	7,642	6,519
Planning Reporting and Evaluation	2,638	2,574	2,473
Departmental Energy Management	1,921	1,999	1,979
Subtotal, Program Goal 04.13.00.00, Departmental Energy Management Program/Federal Energy Management Program	19,852	18,974	16,906
All Other			
National Center on Energy Management and Building Technologies	30	0	0
Total, General Goal 4 (Departmental Energy Management Program/Federal Energy Management Program)	19,882	18,974	16,906

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.13.00.00 (Departmental Energy Management Program/Federal Energy Management Program)					
Project Financing/Technical Guidance and Assistance/Departmental Energy Management					
					Complete ESPC and UESC contract awards, fund DOE retrofit projects and provide technical assistance that will result in lifecycle Btu savings of 17.1 trillion.
Project Financing					
Achieve $30 million in private sector investment through Super ESPCs. [MET: $97 million in private sector investment]	Achieve between $80 and $120 million in private sector Energy Savings Performance Contract (ESPC) investment. [MET: $252 million in private sector investment]	Achieve between $35 and $55 million in private sector investment through Super ESPCs, contributing to national energy security. [NOT MET: Program not authorized]	Will achieve between $80 and $120 million in private sector investment through Super ESPCs which will result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer. [MET]	Will achieve between $80 and $120 million in private sector investment through Super ESPCs and/or UESCs which we expect to result in about a 0.2 percent annual reduction in energy intensity. These projects are cost-effective resulting in a positive net present value gain for the tax payer.	
Technical Guidance and Assistance					
	Provide technical and design assistance for 40 energy efficiency, renewable energy, and water conservation projects; 10 will be large-scale distributed energy resources and combined heat and power projects. Report results achieved through the end of FY 2001. [MET: 53 energy efficiency and renewable projects]	Provide technical and design assistance for 60 energy efficiency, renewable energy, Operations and Management (O&M), distributed Energy Resource (DER)/Combined Heat and Power (CHP), and water conservation projects. [MET: 66 energy efficiency and renewable projects]	Will provide technical and design assistance for 60 Federal projects which include energy efficiency, renewable energy, O&M, Distributed Energy Resources, Combined Heat and Power, SAVEnergy Audits, ALERTS and water conservation projects. These projects are cost-effective, because the technologies applied have been shown to be cost-effective by the supporting EERE programs. [MET]	Provide technical and design assistance for 27 Federal projects (e.g., energy efficiency, renewable energy, Operations and Maintenance, Distributed Energy Resources, Combined Heat and Power, Assessment of Load and Energy Reduction Techniques (ALERTS) and water conservation projects) which are expected to result in energy savings of about 60 billion Btus.	

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Provide over 60 energy assessments including ALERTS, SAVEnergy Audits, industrial facility assessments, and operation and maintenance assessments that identified energy and cost saving opportunities.	Complete at least 35 energy assessments including SAVEnergy Audits, industrial facility assessments and operation and maintenance assessments to identify energy and cost saving opportunities. [MET: 50 energy assessments]				
Train 6,200 Federal energy personnel in best practices supporting National Energy Policy education goals.	Train 4,000 Federal energy personnel in best practices supporting National Energy Policy education goals. [MET: 6700 personnel trained]	Train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals. [MET: 4,450 personnel trained]	Will train 4,000 Federal energy attendees in energy management best practices supporting National Energy Policy education goals.		
Publish initial listing of products that use minimal standby power by December 31, 2001, in accordance with E.O. 13221. [MET]	Integrate information on standby power into Defense Logistics Agency and General Services Administration's product schedules in accordance with E.O. 13221. [MET]				
Departmental Energy Management					
	Complete the selection process for between 4 and 12 energy projects that will reduce the annual energy use in DOE facilities by 15 billion Btus. [MET: 14 projects selected for a reduction of 29 billion Btus.]	Complete the selection for funding of 4 to13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment. [MET: 11 projects selected for a reduction of 35 billion Btus.]	Complete the selection for funding of 4 to 13 energy efficiency projects through a competitive selection process that chooses those projects with the greatest return on investment.	Complete the selection for funding of 3 energy retrofit projects that will provide the required dollar savings to achieve a 20 percent return on the investment of the DEMP funding. These projects will save over 12 billion Btus per year.	

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing annual program uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funds.]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the FEMP/DEMP Program FY 2004 end of year adjusted uncosted baseline ($11,266K) until the target range is met. [NOT MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

FEMP will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources and information, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

FEMP helps Federal agencies take advantage of energy management opportunities in building construction, renovation, retrofit, operations and maintenance; energy consuming product and equipment procurement; and utility service acquisition and utility load management.

FEMP will implement the following means:

- Developing policy and guidance to achieve Executive Order and legislative requirements;
- Directing project analysis and engineering services at Federal sites;
- Providing energy savings performance contracting mechanisms and oversight for the Federal sites;
- Evaluating the potential of new, innovative technologies for use in the Federal sector;
- Reporting progress with respect to energy conservation at the Federal agencies; and
- Providing oversight and approval of DOE utility contracts and support utility rate interventions.

FEMP will implement the following strategies:

- Identify high impact opportunities across Federal agencies for energy efficiency improvements and to increase the use of renewable energy;
- Identify opportunities for widespread use of energy efficient and renewable energy technologies in the Federal sector and deploy these technologies through coordinated procurement, alternative financing, or other means; and
- Recommend strategies for improved security for critical energy needs at Federal facilities.

These strategies will result in significant cost savings and a significant reduction in energy use at Federal facilities.

The following external factors could affect FEMP's ability to achieve its strategic goal:

- Mission changes at Federal sites that would change building usage;
- Availability of energy management personnel at Federal sites; and
- Energy price increases that could help focus attention on energy conservation.

The following collaborations help FEMP achieve its goals:

- FEMP collaborates with agency leadership as well as energy and facility managers from other Federal agencies, as well as state and industry partners, to identify key opportunities for enhancing energy efficiency and the use of renewable energy at Federal facilities; and
- FEMP helps DOE Program Offices develop energy performance plans with their respective "landlord" sites in order to achieve energy management goals and measure progress.

Validation and Verification

To validate and verify programs, FEMP conducts ongoing internal reviews of its program activities each year. In addition, external peer reviews are conducted. FEMP provides a report to Congress every year on the progress of Federal agencies on reaching their energy efficiency and renewable energy goals.

Data Sources: Agencies submit annual reports documenting energy use, cost, gross square footage, and exempt facilities. The reports are supplemented by FEMP's tracking and reporting and are submitted each year to Congress.

Baselines: The baseline for the energy efficiency goal of the Energy Policy Act of 2005 is the FY 2003 energy intensity of standard and energy intensive Federal buildings -- 115,170 Btu per square foot. The baseline for Executive Order 13123 for standard buildings is the 1985 energy intensity of 138,610 Btu/square foot. The baseline for measure of new (since 1992) renewable energy sources as a percentage of Federal facility electricity use is 15% in 2000.

Frequency: Annual.

Evaluation: In carrying out the program's mission, the Federal Energy Management Program uses several forms of evaluation to assess progress and to promote program improvement:

- Technology validation and operational field measurement, as appropriate;
- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal program reviews;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate;
- Quarterly and annual assessment of program and management results-based performance through Joule (the DOE quarterly performance progress review of budget targets), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly) and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage:	FEMP maintains a database of reported information. Agencies maintain their own, more detailed data.
Verification:	External audits are conducted each year. Reporting anomalies are identified and resolved during the annual reporting cycle.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The Federal Energy Management Program participated in its first PART review in 2005. This PART review included ratings of 100% for program purpose, 100% for planning, 86% for management and 50% for program results and accountability with an overall rating of Moderately Effective. These ratings reflect the commitment of EERE program management at all levels to the basic management and planning principles of the President's Management Agenda, including the criteria scored in the PART and the implementation of the EERE reorganization employing those principles. The program has begun to take steps to address the PART findings and recommendations.

Expected Program Outcomes

FEMP pursues its mission through integrated activities designed to improve the energy efficiency of, and renewable energy usage by, the Federal Government. We expect these improvements to reduce the energy intensity at Federal facilities; lower their energy bills; reduce EPA criteria and other pollutants in the regions where agency operations are located; and enhance energy security by increasing the flexibility of local energy demand.

Estimates of annual non-renewable energy savings, energy expenditure savings, and carbon emission reductions that result from the realization of FEMP's goals are shown in the table below through 2025. The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005.[a] In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. The external factors such as unexpected changes in the price of electricity or natural gas or other factors identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals.

The table below provides a summary of the benefits estimates required by the Government Performance and Results Act (GPRA). The table provides a useful picture is provided of the potential change in

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

national benefits over time if the technology, infrastructure and markets evolve as expected. These estimates assume that individual technology plans are achieved and market assumptions prevail. Final documentation for the GPRA estimation is expected to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html.

FY 2007 GPRA benefits Estimates for FEMP[a]

Mid-term benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	0.01	0.01	0.02	0.02
Energy expenditure savings (Billion 2003$)	0.1	0.1	0.2	0.2
Carbon emission reductions (MMTCE)	0.2	0.2	0.3	0.4

In addition to the benefits quantified here, improved Federal energy management increases the ability of the Federal Government to manage its energy loads during emergencies and facilitates coordination of Federal energy use with local authorities in the event of local energy supply constraints or emergencies.

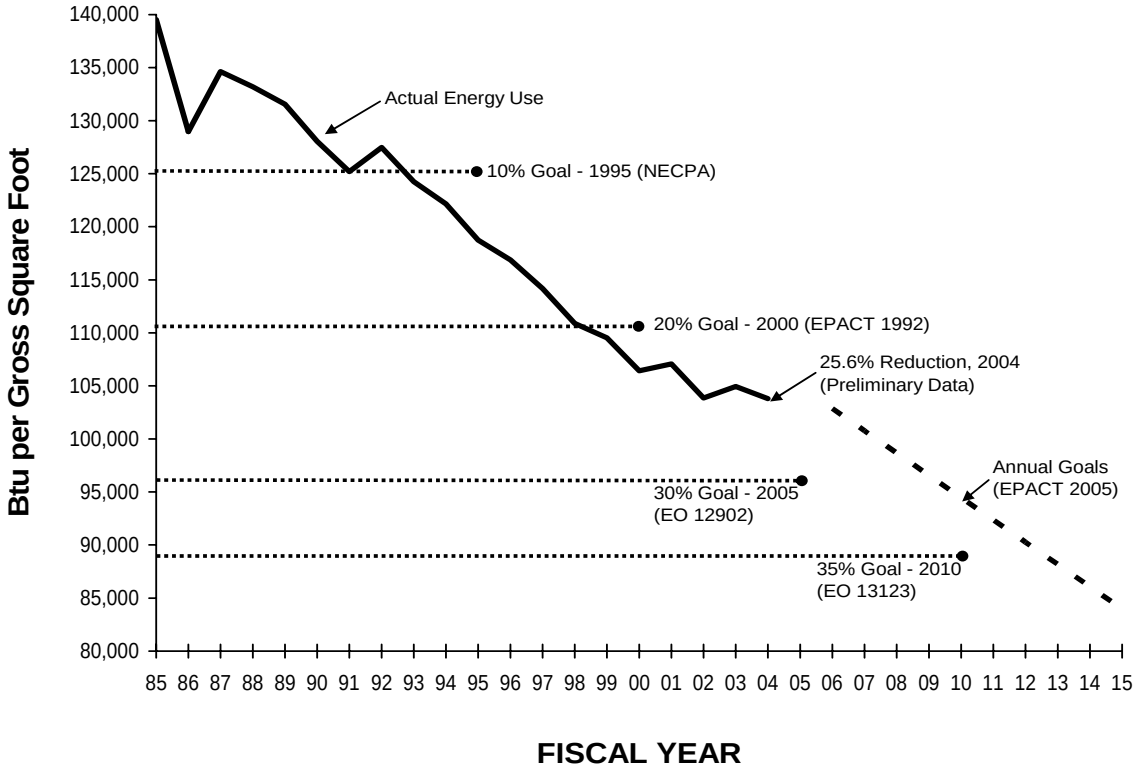
The EPAct 2005 goal calls for a 2 percent reduction in Federal building energy intensity each year between 2006 through 2015 measured against a 2003 baseline. The following figure shows the goals from two Executive Orders and three pieces of legislation along with the actual energy intensity over time for Federal agencies for standard buildings. Although the figure illustrates energy intensity objectives for standard buildings, the annual goals from the Energy Policy Act of 2005 include both standard and energy intensive buildings. Previous goals established in NECPA, EPAct 1992, EO 12902 and EO 13123 were measured against a 1985 baseline. More information regarding these goals can be found on FEMP's website: www.eere.energy.gov/femp.

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the Program's technical targets are achieved and funding continues at levels consistent with assumptions in the FY 2007 Budget.

[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.

[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits. FEMP savings are initially estimated outside of the integrated energy models and therefore, although the values are small, they are reported numerically.

Standard Building Energy Intensity



Project Financing

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Project Financing	7,133	6,759	5,935
Total, Project Financing	7,133	6,759	5,935

Description

FEMP developed its alternative financing programs to help Federal agencies access private sector financing to fund needed energy improvements. It provides guidance, documentation and individual project assistance to Federal agencies which utilize Energy Savings Performance Contracts (ESPCs), public benefit funds, and Utility Energy Service Contracts (UESCs) to finance energy saving improvements. These funds pay for energy improvements at Federal facilities that are in need of significant energy system retrofits. Projects include all types of energy improvements including lighting upgrades, new heating and ventilation systems, and improved control systems.

Benefits

These alternative financing mechanisms for energy efficiency and renewable energy projects have and will continue to vastly improve the energy efficiency of Federal facilities. These projects save on the energy bills of Federal facilities and are implemented at no net cost to the taxpayer. By providing a means for Federal agencies to utilize renewable energy and energy efficiency technologies, these financing mechanisms help reduce the emissions associated with power usage at Federal facilities and promotes the use of clean alternatives to conventional technologies. The investment of millions of dollars through alternative financing vehicles helps to support the energy efficiency and renewable technology industries.

FEMP has set a target to facilitate energy investments of between $90 and $130 million that will result in lifecycle Btu savings of 12.1 trillion from FEMP project financing activities in FY 2007. This savings is equivalent to displacing the energy use of about 8,700 households.

In FY 2005, the legal authority for implementing energy savings performance contracts (ESPCs) was reinstated through FY 2006. The Energy Policy Act of 2005 extends this authority through 2016.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Project Financing	**7,133**	**6,759**	**5,935**

Federal agency use of ESPC was authorized by Congress to provide an alternative to direct appropriations for the funding of energy-efficient improvements in Federal facilities. Under the ESPC legislation, agencies can take advantage of private sector financing and expertise with little or no upfront cost to the government. The government pays back the industry – including interest at private sector rates – through energy cost savings over the life of the projects. Typical contract terms are greater than 15 years.

The Department of Energy is responsible for ESPC oversight and reporting. FEMP will continue to improve its ESPC Program to ensure maximum benefits are achieved for the Federal Government by focusing on project facilitation, financing, reporting and competition. A recent GAO report entitled *Energy Savings Performance Contracts Offer Benefits, but Vigilance Is Needed to Protect Government Interests* (GAO-05-340) confirmed that these areas are key in protecting the Government's financial interests over the long term.

Activities in FY 2007 will continue to implement recommendations by the GAO report to protect the Government's financial interests. Competitively awarded project facilitators will continue to provide ESPC and UESC oversight including identifying and screening projects, preparing delivery orders and evaluating proposals. They will provide technical, contracting and information expertise for issues such as interest rates, competitive financing, and utility rates to support the negotiation process. National Laboratory expertise will continue to be utilized in FY 2007, although FEMP will be undertaking a process of reducing Laboratory involvement and relying more on expertise that is competitively awarded or obtained through other means. ESPC and UESC projects will continue to focus on energy-efficient improvements, renewable energy technologies, alternative fuel (biomass/landfill), combined heat and power, and reduced water consumption technologies.

Reporting and monitoring of contract performance will be expanded to ensure data integrity and provide the Federal Government with improved means of quantifying benefits. This will include focusing on measurement and verification methodologies and practices related to quantifying ESPCs and UESCs benefits. The ESPC project database will be merged with the UESC database to collect project information and long-term costs and benefits directly tied to projects facilitated by the program. The National Laboratories will assist in monitoring and verification of ESPC and UESC benefits.

Training information will move from the classroom to web-based training. Advanced level training will be provided if requested by a Federal agency, jointly conducted and co-sponsored with that agency, using competitively awarded educators. Analytical activities will continue in support of reporting requirements for project metrics, milestones and program plans to implement improvements in the ESPC and UESC activities.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

Activities supporting the use of state-provided public benefit funds for Federal facilities will continue. Specifically, a website will be supported to identify the public benefits funds available for Federal sites and technical experts at the project management center will assist Federal agencies applying for public benefit funds.

The FY 2007 target for implementing Super ESPC delivery orders is to facilitate energy investments of between $90 and $130 million that will result in lifecycle Btu savings of 12.1 trillion (which corresponds to the energy use of about 8,700 households).

Technical and financial analysis assistance provided for the ESPC and UESC projects is expected to result in Federal agency reimbursements of about $800,000 in FY 2007. Reimbursements were $160,000 in FY 2004, $528,000 in FY 2005, and are projected to be $700,000 in FY 2006.

Total, Project Financing	**7,133**	**6,759**	**5,935**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The decrease in funding is due to streamlining the assistance provided for project financing through means such as the transfer of project facilitation from the National Laboratories to competitive contractors. Training information will move from the classroom to web-based training. Advanced level training will be provided only if requested by a Federal agency, jointly conducted and co-sponsored with that agency, using competitively awarded educators	-824
Total Funding Change, Project Financing.....	**-824**

Technical Guidance and Assistance

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical Guidance and Assistance			
Direct Technical Assistance	6,286	5,722	6,519
Training and Information	1,874	1,920	0
Total, Technical Guidance and Assistance	8,160	7,642	6,519

Description

Technical Guidance and Assistance helps agencies take advantage of innovative technologies, tools and technical guidance in the Federal sector. FEMP assists Federal energy managers in their efforts to identify, design, and implement new construction and facility improvement projects. FEMP provides unbiased, expert technical assistance in areas such as audits for buildings and industrial facilities, peak load management; and new technology deployment, including combined heat and power and distributed energy technologies. FEMP also provides analytic software tools to help agencies choose the most effective energy and water project investments. In addition, FEMP helps agencies acquire the most energy efficient and water conserving products by continuing to update its specifications for highly energy efficient products and providing them to the General Services Administration and Defense Logistics Agency as required by the "federal purchase requirement" set forth in the Energy Policy Act of 2005.

Benefits

Technical Guidance and Assistance supports FEMP's mission by helping agencies implement projects and practices that reduce energy bills, improve air quality, and promote the use of water conservation, energy efficiency and renewable energy. FEMP's direct project assistance provides the information and means that agencies need to determine cost-saving and energy-saving practices appropriate to their needs as they design new buildings and renovate existing ones. Because FEMP focuses its technical assistance on EERE's energy efficiency and renewable technologies, the deployment and acceptance of these technologies is accelerated in the Federal sector.

FEMP's goal is to provide technical assistance for 64 projects that will result in lifecycle Btu savings of 4.7 trillion from FEMP technical assistance activities that include energy efficiency, renewable energy, O&M, Distributed Energy Resources, Combined Heat and Power, ALERTS and water conservation projects. This savings is equivalent to displacing the energy use of about 3,400 households.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Direct Technical Assistance.....	**6,286**	**5,722**	**6,519**

As driven by the Office of Management and Budget's Energy Scorecard, FEMP's technical assistance activities will continue to support cost-effective investments in energy efficiency and renewable energy technologies. Direct technical assistance will continue to provide analytical support and expert assistance to Federal agencies. The program will shift from individual assistance on operation and maintenance (O&M), life cycle costing analysis, sustainability, and audits and metering at different facilities to a more integrated holistic model that focuses on fewer projects which would allow better documentation and verification of savings. National Laboratory technical assistance will be utilized in areas where competitively selected private sector experts are not available and to provide unbiased technical review.

Activities will continue in demonstrating the most promising technologies for reducing energy consumption that can be replicated in the Federal sector and are life cycle cost effective. Current areas of focus include (but are not limited to) lighting and renewable energy and Combined Heat and Power (CHP) technologies for energy security. Analysis and engineering will be provided on a competitive basis. In-depth technology installation reviews will be completed at each site. Analytical review of new technologies will assess the technical potential for replication in the Federal sector, energy savings potential and cost. Federal Technology Alerts, and web-based technical case studies and guidance documents, which provide summary information on candidate energy-saving technologies, will continue to be developed. With the passage of the Energy Policy Act of 2005, FEMP is responsible for carrying out a number of activities, including developing product specifications and issuing guidance on metering, new construction, and other energy related building topics. FEMP will continue to update its specifications for highly energy efficient products and provide them to the General Services Administration and Defense Logistics Agency as required by the "federal purchase requirement" set forth in the Energy Policy Act of 2005.

Training information will move from the classroom to web-based training. Advanced level training will be provided if requested by a Federal agency, jointly conducted and co-sponsored with that agency, using competitively awarded educators.

Guidance documents and analytical assistance will continue to be provided in the area of renewable energy credit purchases and bulk procurements. FEMP's Assessment of Load and Energy Reduction Techniques activities will continue if necessary based on energy market dynamics (e.g., rolling blackouts or large scale outages). Additional analysis and guidance documents will be developed to educate decision makers on regulatory, market, economic and environmental benefits or impacts to the Federal sector.

Tools will continue to be developed that support the Federal sector including energy management

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

programs that analyze energy/water consumption and provide analysis on energy efficient products. The FEDS software projects have been completed.

Training and Information	**1,874**	**1,920**	**0**

Activities in this area will be discontinued in FY 2007.

Prior to FY 2007, this subprogram included the provision of technical information, tools and technical information. In addition, program activities included general training, publication of revised or new product energy efficiency recommendations and the coordination of energy efficiency criteria with the EPA/DOE ENERGY STAR® Program.

Technology transfer activities will be conducted under the Direct Technical Assistance area.

Total, Technical Guidance and Assistance	**8,160**	**7,642**	**6,519**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Direct Technical Assistance	
The increased funding in this area is due to an increased emphasis on technology transfer activities and analysis	+797
Training and Information	
FEMP has eliminated most general training and outreach activities following its success with web-based training and information dissemination. Adequate general training and information is available through other agencies, the private sector and FEMP's website. Technology transfer activities will be conducted under the Direct Technical Assistance area	-1,920
Total Funding Change, Technical Guidance and Assistance	**-1,123**

Planning, Reporting and Evaluation

Funding Schedule by Activity

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
Planning, Reporting and Evaluation	2,638	2,574	2,473
Total, Planning, Reporting and Evaluation	2,638	2,574	2,473

Description

The Energy Policy Act of 2005 and Executive Order 13123 require the Department to collect, verify and report on progress by the Federal agencies (including the Department of Energy) toward the goals that address energy efficiency in standard buildings, industrial and commercial space, petroleum reduction and water conservation. FEMP will collect and publish data for the Annual Report to Congress and respond to inquiries to help ensure accuracy in reporting and analysis of trends.

Benefits

Through planning, reporting and evaluation, FEMP meets the reporting requirements set forth by Congress and Executive Order. Also, the effectiveness of its programs is analyzed such that planning the design of energy efficiency programs will be coordinated and centralized in the Federal Sector. In this way the program's investments lead to the greatest possible reductions in energy costs, improvements in air quality, and promotion of water conservation, energy efficiency and renewable energy technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Planning, Reporting and Evaluation		**2,574**	**2,473**

The Energy Policy Act of 2005, Executive Order 13123 and the National Energy Conservation Policy Act require the Department of Energy (DOE) to collect, verify and report to Congress on the progress by the Federal agencies, including DOE, toward the Federal energy management goals of reducing energy intensity in buildings, reducing petroleum usage and conservation of water. Data collection, verification and reporting continue to be centralized for the Federal agencies at FEMP with the assistance of technical experts for preparing analysis and verification of data. This also includes maintaining the Department of Energy's facilities information and developing annual plans and reports. Information will be made available on Federal progress toward the legislative and Executive

Order goals on the FEMP website and technical updates to web-based materials will continue for the Federal sector.

Technical analysis will continue as required to respond to analytical reporting requirements involved with the Government Performance and Results Act (GPRA), the Program Assessment and Rating Tool (PART), multi-year planning and peer reviews. Analysis and information activities will continue to educate Federal facility managers about the potential energy, economic, and environmental benefits of technologies and programs. Program assistance will continue in preparing and updating the Federal sector plans for meeting the legislative and Executive Order goals as well as recognizing progress through Presidential and Federal awards program. Support will also be provided for the Federal Energy Management Advisory Committee and other interagency committees.

Total, Planning, Reporting and Evaluation	**2,638**	**2,574**	**2,473**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The decrease is due to streamlining information dissemination activities	-101
Total Funding Change, Planning, Reporting and Evaluation	-101

Departmental Energy Management

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Departmental Energy Management			
Energy Management Project Support	1,455	1,491	1,979
Energy Management Model Program Development	466	508	0
Congressionally Directed, National Center for Energy Management and Building Technologies	30	0	0
Total, Departmental Energy Management	1,951	1,999	1,979

Description

The Departmental Energy Management Program provides direct funding and leveraged cost sharing for energy retrofit projects and new energy technologies at DOE facilities to increase the energy efficiency of DOE facilities and reduce future utility and maintenance costs. Project proposals are evaluated based on cost-effectiveness, energy savings, and return-on-investment. These activities will help DOE meet the goals of the Energy Policy Act of 2005 and DOE Order 430.2A.

Benefits

DEMP supports the mission of the Office of Energy Efficiency and Renewable Energy by improving the energy efficiency and productivity of DOE buildings. DEMP supports DOE's goals by protecting our national and economic security by promoting a diverse supply of reliable, affordable, and environmentally sound energy to DOE facilities.

In prior years, because no data was collected from DOE facilities on their investments in energy efficiency directly or indirectly through infrastructure projects, the only funding reported for DOE in the Annual Report to the Congress on energy efficiency was the funding provided by the Departmental Energy Management Program. FEMP plans to request that DOE facilities and laboratories provide information on the funding spent on all energy efficiency projects and activities. FEMP will provide guidelines on what investments or the parts thereof can be classified and reported as energy efficiency investments.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Energy Management Project Support	**1,455**	**1,491**	**1,979**

DEMP will provide support through direct funding and leveraged cost-sharing at various DOE facilities for energy projects to increase the energy efficiency of DOE facilities and reduce future utility and maintenance costs. Leveraged cost sharing includes funding from the private sector and/or other DOE expenses funded activities at DOE sites. Funding will be provided to multiple projects which are identified through a DOE wide competition and selected to both maximize return on investment and demonstrate leadership in implementing emerging energy savings technologies.

Program support will also be provided for technical analysis undertaken to address the inputs used for planning, reporting and evaluation of DEMP activities.

Energy Management Model Program Development	**466**	**508**	**0**

No funding is requested for this subprogram in FY 2007.

Prior to FY 2007, the program ran a solicitation for projects which was sent to DOE facilities with set criteria for ranking projects. DOE sites could have requested DEMP funding under Model Programs to accomplish the following in DOE owned buildings: to accelerate the implementation of the Executive Order 13123; to evaluate new approaches for reducing energy; to expand the use of private sector financing for saving energy; and to identify future cost effective energy efficiency retrofit projects.

In FY 2007, information on these model program pilot projects will be available on the EERE website.

Congressionally Directed, National Center for Energy Management and Building Technologies	**30**	**0**	**0**

In FY 2005, activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.

Total, Departmental Energy Management	**1,951**	**1,999**	**1,979**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Energy Management Project Support	
The increase will be used to augment the scope of the retrofit projects that assist the Department of Energy in meeting its goal of reducing energy intensity in buildings.....	+488
Energy Management Model Program Development	
Funding for Model Program Development is redirected to Energy Management Project Support that provides direct funding for energy retrofit projects and new energy technologies at DOE facilities	-508
Congressionally Directed, National Center for Energy Management and Building Technologies	
No funding requested in FY 2006 or FY 2007	0
Total Funding Change, Departmental Energy Management.....	**-20**

Facilities and Infrastructure

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Facilities and Infrastructure – National Renewable Energy Laboratory	11,389	26,315	-263	26,052	5,935
Total, Facilities and Infrastructure – National Renewable Energy Laboratory	11,389	26,315	-263	26,052	5,935

Public Law Authorizations:

P.L. 95-91, Department of Energy Organization Act (1977)

Maintenance and Repair

The total maintenance request contributes to the facility management benchmark of 2 percent of Resource Property Value investment for maintenance of facilities and infrastructure, with the balance supplied from indirect funds. A number of projects are planned to maintain the efficiency of laboratory operations at the National Renewable Energy Laboratory (NREL). Projects are identified as a result of condition assessment surveys that are conducted periodically. Projects are also scheduled due to age and predicted service life of specific critical systems and components. In FY 2007, maintenance includes starting electrical distribution and equipment replacement at several sites and other projects, and replacement of air compressors.

Mission

This Facilities and Infrastructure budget funds capital investments to support a vibrant world-class research and development program at major participant DOE laboratory sites. Included are funding requests for projects and equipment that are of general benefit to all research activities at NREL.

Beginning in FY 2005, the cost of conducting External Independent Reviews (EIRs) for Capital Asset Projects greater than $5 million within the Facilities and Infrastructure Program, have been funded by this program. Examples of EIRs include conducting Performance Baseline EIRs prior to Critical Decision-2 (CD-2) to verify the accuracy of cost and schedule baseline estimates and conducting Construction/Execution Readiness EIRs, which are done for all Major System projects prior to CD-3. These funds, which are managed by the Office of Engineering and Construction Management, are

[a] Includes a rescission of $263,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.

exclusively used for EIRs directly related to these projects funded within Facilities and Infrastructure. Beginning in FY 2007, the EIR business line will be financed via the Working Capital Fund to achieve parity on how EIRs are funded and to standardize the administration of these critical activities.

Benefits

The National Renewable Energy Laboratory is a central part of the Office of Energy Efficiency and Renewable Energy's (EERE) programs. It provides in-house research, user facilities, and analysis for programs within the EERE budget, and in some instances manages external R&D contracts and grants. It also performs the same function for research in the Office of Electricity Delivery and Energy Reliability. NREL is home to 1,100 researchers, engineers, analysts, and administrative staff, plus visiting professionals, graduate students, and interns on a 632-acre split campus in Golden, Colorado, occupying 289,000 square feet in 4 large research buildings (with another to set to begin construction), a dozen or so smaller facilities totaling about 80,000 square feet, and 296,000 square feet of research and administrative leased space in neighboring office buildings.

Maintaining state-of-the-art research facilities at NREL permits the EERE programs to advance the basic materials technologies, biosciences, aerodynamics, systems analysis, and structural engineering that underpin the advancements made by our R&D programs. This concentration of expertise also makes NREL a central player in EERE's deployment efforts.

National Renewable Energy Laboratory

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Renewable Energy Laboratory			
Operation and Maintenance	4,762	5,742	5,935
Congressionally Directed, Research Support Buildings	0	9,900	0
Construction: NREL Science and Technology Facility	6,627	10,410	0
Total, National Renewable Energy Laboratory	11,389	26,052	5,935

Description

Within Operation and Maintenance, Plant and Capital Equipment (P&CE) funds serve to address: (1) upgrades and capital replacements in NREL's facilities, such as roof and road upgrades and replacements; (2) small new facility needs; and (3) the ability to provide better operational efficiencies and maintain first-rate lab and user-facility capabilities by replacing general use laboratory and administrative equipment. The increase of P&CE funding is for equipment replacements and upgrades.

Funding to begin construction of the 71,000 square foot Science and Technology Facility was provided in FY 2004, and funds to finish completion of the construction are included for FY 2006. Although not requested, Congress provided funds for Research Support Building(s) in FY 2006.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Operation and Maintenance	**4,762**	**5,742**	**5,935**

These funds provide for general infrastructure upgrades and facility system replacements that address NREL's general facility and equipment capital needs. This does not include technology-specific capital equipment funded by individual program budgets. The funding provides for facility upgrades and small construction projects that improve or enhance general use facilities and general use research and support equipment replacement.

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
▪ **Plant and Capital Equipment**	**4,762**	**5,742**	**5,935**
• **Plant Projects**	**1,556**	**3,790**	**3,957**

The Plant Projects request supports annual investments to renovate and extend the capabilities of the buildings and infrastructure already in place at NREL sites. These projects apply to both the South Table Mountain (STM) and National Wind Technology Center (20 miles away) locations in Golden, CO. Projects may include safety and security improvements; replacements of roofs and other building components; upgrades to utilities and heating ventilation and air conditioning systems; energy efficiency improvements; reconfigurations of existing buildings to accommodate changes or growth in R&D programs or research support needs; upgrades of site-wide utility systems, telecommunications and computer networks; road and parking improvements; and walkways, landscaping, water management, water treatment, and other site improvements to enhance the sustainability, cohesiveness, and pedestrian nature of the site.

• **Capital Equipment**	**2,381**	**1,952**	**1,978**

NREL's current capital portfolio is currently more than 60 percent depreciated. The amount proposed for FY 2007 will fund replacements that are planned. EERE is developing a recapitalization strategy to determine the optimal rate of reinvestment for future years.

This equipment includes upgrades, replacements, and additions to NREL's information technology systems and NREL's multi-program scientific instrumentation, to replace equipment that is no longer reliable or serviceable, to meet changing research needs, and to keep these instruments near state-of-the-art in capability.

▪ **Congressionally Directed, National Center for Energy Management and Building Technologies**	**825**	**0**	**0**

Activities funded under this Congressionally directed project addressed HVAC research needs and helped to improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings.

Congressionally Directed, Research Support Buildings	**0**	**9,900**	**0**

Congress appropriated $10 million (subject to the 1 percent rescission) for the design and construction of research support facilities at the National Renewable Energy Laboratory. Funding is not requested in FY 2007.

Construction: NREL Science and Technology Facility	**6,627**	**10,410**	**0**

FY 2006 funding finishes construction of the Science and Technology Facility (S&TF) at NREL, which began in FY 2004. The S&TF will allow the NREL Photovoltaics Program and other activities to address complex processing and system manufacturing problems that are common to all thin-film and

(dollars in thousands)

FY 2005	FY 2006	FY 2007

nanostructure energy technologies and that are beyond the capability of the industry to solve. The lab will institute a transformational research approach that will lower manufacturing costs and reduce time-to-market of next-generation thin-film and nanostructure technologies.

The S&TF will provide nine advanced material synthesis and general support laboratories, a unique process development and integration laboratory, and office space for 55 researchers. The S&TF has been designed to be a showcase facility for energy savings and sustainability in an R&D laboratory, with a goal of achieving a "Gold" LEED rating, and will be designed and built to incorporate all ES&H requirements for the intended research activities. The S&TF will be linked with the existing Solar Energy Research Facility.

The FY 2006 funding request represented a $1.5 million increase in the Total Estimated Cost (TEC) of the project. Significantly higher building construction escalation than was originally estimated has occurred in the past year due to market conditions accelerating construction material (metals, cement, wood, plastics, etc.) costs.

Total, National Renewable Energy Laboratory	**11,389**	**26,052**	**5,935**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Operation and Maintenance	
▪ **Plant and Capital Equipment**	
• **Plant Projects**	
Provide for maintenance, renovations, and upgrades (e.g., security, HVAC, etc.) to the buildings and infrastructure at NREL. Provides changes to existing laboratory space to accommodate research experiments and testing equipment. Provide roads, parking area, and utilities to southern facility sights. Provide fan loft and exhaust fans for the Field Test Laboratory Building (FTLB).....	+167
• **Capital Equipment**	
No significant change.....	+26
Total, Plant and Capital Equipment.....	**+193**
Total, Operation and Maintenance	**+193**

	FY 2007 vs. FY 2006 ($000)
Congressionally Directed, Research Support Buildings	
Funding for this congressionally directed activity is not requested in FY 2007	-9,900
Construction: NREL Science and Technology Facility	
Complete construction according to current schedule and revised TEC	-10,410
Total, Funding Change, National Renewable Energy Laboratory.....	**-20,117**

02-NREL-001, Science and Technology Facility, National Renewable Energy Laboratory, Golden, Colorado

1. Significant Changes

This project has had $105,000 removed from the budget request due to FY 2006 rescission/reduction requirements; it is anticipated that this can be accommodated within existing project contingency reserves, and therefore there is no additional budget requested for FY 2007.

Project estimated costing was replaced with actual costing. Out-year estimated costing was reevaluated and modified to mitigate funding risks due to extended continuing resolutions in FY 2005. Program capital equipment was reprioritized to allow purchase of long lead items during FY 2005 and estimated costs were revised.

2. Design, Construction, and D&D Schedule

(fiscal quarter)

	Preliminary Design start	Final Design Complete	Physical Construction Start	Physical Construction Complete	D&D Offsetting Facilities Start	D&D Offsetting Facilities Complete
FY 2002	1Q 2002	4Q 2002	--	--	--	--
FY 2003	1Q 2002	3Q 2003	--	--	--	--
FY 2004	--	--	--	--	--	--
FY 2005	4Q 2002	4Q 2003	1Q 2005	1Q 2007	*	*
FY 2006	4Q 2002	4Q 2003	1Q 2005	1Q 2007	*	*
FY 2007	4Q 2002	4Q 2003	1Q 2005	1Q 2007	*	*

* Note: The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement, cited under House Report 107-258.

3. Baseline and Validation Status

(dollars in thousands)

	TEC	OPC, except D&D Costs	Offsetting D&D Costs	Total Project Costs	Validated Performance Baseline	Preliminary Estimate
FY 2002	800	395	--	1,195	1,195	--
FY 2003	1,600	420	--	2,020	2,020	--
FY 2004	--	--	--	--	--	--
FY 2005	21,190	7,196	*	28,386	28,386	*
FY 2006	22,637	7,196	*	29,833	29,833	*

* Note: The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement. General appropriations rescissions in FY 2005 ($53K) and FY 2006 ($105K) have reduced the available TEC by $158K.

4. Project Description, Justification, and Scope

This project provides for the design, engineering and construction of a new facility for the National Renewable Energy Laboratory (NREL) in Golden, Colorado. This is the fourth inclusion of the capital construction budget request for this project, the Science and Technology Facility (S&TF).

The Science and Technology Facility, as designed, is a 71,000 sf. two story building with a third story mechanical penthouse. The laboratory block is 300 ft. long and varies between 60 ft. and 115 ft. wide on the two floors with a ceiling height of 18 ft. The office block is 165 ft. long and 75 ft. feet wide with a sloping roof structure that is 14 ft. tall at its highest point. The laboratories are constructed using structural concrete slabs with steel framing and are designed for H-5 (International Building Code - Semiconductor Fabrication Facilities Using Hazardous Production Materials) occupancy due to the use of hazardous production materials (HPM). The office section is constructed using slab-on-grade concrete floors with structural steel framing. The ventilation system for the laboratories is a variable air volume single pass system. The laboratories are similar in use to semiconductor fabrication facilities and have HPM and specialty gases distributed throughout with a toxic gas monitoring system. The facility has complete fire detection and suppression systems including standpipe configurations. The facility will be fully commissioned as a prerequisite for U.S. Green Building Council LEED™ certification. The LEED™ goal for the building is certification at the Gold level. (Gold certification is the second highest out of 4 possible certifications for new commercial construction, major renovations and high-rise residential buildings. Gold certification requires the attainment of 39 to 51 out of a possible 72 points for sustainable siting, energy and water efficiency, sustainable design in materials and resources, indoor environmental quality, and innovation.) Laboratory utility systems include compressed air, nitrogen, hydrogen, argon, and silane gas. Standard equipment for the facility includes office landscape furniture and laboratory casework and fume hoods.

Improvements to the land and utility connections for this project include roads, sidewalks, fire/potable water, sewer, electrical and natural gas utilities, and landscaping/water management. This project will also install equipment in the central plant of the existing Solar Energy Research Facility to support heating and cooling water requirements in the S&TF.

The purpose of the S&TF is to provide a facility to expand the research capabilities to enable DOE to achieve its strategic goals, as outlined in the National Energy Policy (NEP). The S&TF will do this by addressing complex processing and system manufacturing problems that are common to all hydrogen production and storage, fuel cells, advanced solid-state lighting, thin-film energy coatings/devices, electrochromics, photovoltaics, and related thin-film and nanostructure energy technologies. These processing and system manufacturing issues are beyond the capability of industry to economically resolve.

The expected results of constructing the S&TF include the following:

- The S&TF is designed to provide the capability to accelerate renewable energy technology advancement through performance-based R&D programs and public-private partnerships involving

solar technologies, hydrogen technologies, fuel cell components, and distributed energy technologies.

- The research that can only be accomplished in the S&TF will fill a critical knowledge gap that will help accelerate the introduction of new thin-film and nanostructure technologies and lower their cost.
- The S&TF will provide for a transformational research capability and approach that does not exist in the United States at this time. When fully outfitted and commissioned, the S&TF will combine process integration, diagnostics, and simulation with the fundamental and applied research and development that is currently conducted in the adjacent NREL Solar Energy Research Facility in ways that have not been done before.
- The S&TF has been designed to support the technology roadmaps and multiyear plans for photovoltaics, hydrogen, and buildings industries. In photovoltaics, for instance, the National Research Council has said, "The Solar Photovoltaics Program should give top priority to the development of sound manufacturing technologies for thin-film modules. Much more attention should be paid to moving the technology from the laboratory through integrated pilot-scale experiments to commercial-scale design." The Process Development and Integration Laboratory (PDIL) that the S&TF makes possible will directly address that concern.
- The research and development conducted in the S&TF will provide vital process information that is needed by US industry in the highly competitive international marketplace. This will enable the United States to maintain a leadership position in the international marketplace for near-term and next-generation thin-film and nanostructure technologies.
- The S&TF is designed to promote energy efficiency by providing the facilities in support of the development of new advances in solid-state lighting, building-integrated photovoltaics, thin-film energy coatings/devices, electrochromic films for smart windows and related building technologies, and superconducting wires, tapes, and materials (NEP pp. 4-11, 4-12, 6-17, 7-17).
- The S&TF design will demonstrate dramatic energy savings for National Laboratory facilities.
- The S&TF is designed to provide the research and development capability for improving the environment by reducing pollutants from today's electric power generators (NEP p. 3-14).

With the construction of the Science and Technology Facility at NREL and the process improvement knowledge that will be gained, EERE estimates that the time from laboratory to marketplace can be significantly shortened for these technologies. U.S. industry will have a totally new capability to aid them in competing in the international energy marketplace. The additional laboratory space and new capabilities of the Science and Technology Facility will greatly facilitate the successful accomplishment of DOE missions in photovoltaics, hydrogen, solar, buildings, solid-state lighting, thin-film energy coatings/devices, electrochromics, and nanotechnologies. The program impact is broad because the current Solar Energy Research Facility (SERF) at NREL and the proposed S&TF have been designed to be an integrated set of research facilities, enhancing the value from research currently conducted in the existing SERF. Achieving DOE goals for advancing renewable energy technologies based on thin-film and nanostructure technologies will require expanded laboratory facilities such as those in the STF, and the facility will help U.S. manufacturers to continue to be world technology leaders.

Programmatic impacts include:

Solar. U.S. industry has clearly indicated that the capabilities of the unique Process Development and Integration Laboratory in the S&TF are critical for competing with foreign firms. European firms have now become aware of the value of this integrated process research approach and they have started prototype operations at their university partners to begin their own work. This facility also supports the fundamental work for next-generation PV products. Timely construction of the Science and Technology Facility will provide U.S. research and industry with a competitive edge internationally.

Hydrogen. When the S&TF is constructed, hydrogen production research (photoelectrochemical and photovoltaic electrolysis) will gain valuable research space in the SERF, specially designed for toxic materials and explosive gases, to better conduct and expand hydrogen production research. Hydrogen storage research will also gain valuable space. The S&TF itself will also provide unique capabilities in engineering research for both hydrogen production and hydrogen storage technologies that cannot be done without the facility.

Buildings, Solid-State Lighting, Nanotechnologies**.** The S&TF will enable scale-up and process R&D on all thin-film technologies, including electrochromic films for smart windows, photovoltaic films integrated into architectural glass, and other thin-film technologies for the reduction of energy use in buildings; next generation solid-state lighting; nanostructure solar cells using quantum dots; and nanotubes for the storage of hydrogen.

A Life Cycle Cost Analysis (LCCA) has been completed to determine if needs can be met by modifying existing facilities. Six different options, including leasing and renovating commercial space and renovating abandoned government buildings, have been considered; however, life cycle cost analysis indicates these options to be less cost effective. There are currently no facilities in either the public or private sector that allow for the accelerated development and deployment of hydrogen and renewable energy technologies proposed for the S&TF. The recommended alternative with the greatest cost benefit is to construct the S&TF at NREL adjacent to the existing Solar Energy Research Facility.

Facility operating costs are included in Item 7, Related Annual Funding Requirements, shown below.

<u>Compliance with Project Management Order</u>

- Critical Decision – 0: Approve Mission Need – NA[a]
- Critical Decision – 1: Approve Preliminary Baseline Range – 6/10/2002
- Critical Decision – 2: Approve Performance Baseline – 9/16/2003
- External Independent Review Final Report – 8/8/2003
- Critical Decision – 3: Approve Start of Construction – 12/12/2003
- Critical Decision – 4: Approve Start of Operations – 2Q FY 2007

[a] Mission Need validated and approved prior to establishment of DOE 413.3.

5. Financial Schedule

(dollars in thousands)

	Appropriations	Obligations	Costs
Design/Construction by Fiscal Year			
Design			
2002	800	800	255
2003	770	770	1,118
Total, Design (PED)	1,570	1,570	1,373
Construction			
2004[a,c]	3,925[b]	3,925	211
2005[c]	6,627	6,627	6,109
2006	10,515	10,515	13,365
2007	0	0	1,579
Total, Construction	21,067	21,067	21,264
Total, TEC[d]	22,637	22,637	22,637

6. Details of Project Cost Estimate

Total Estimated Costs

(dollars in thousands)

	Current Estimate ($000)	Previous Estimate ($000)
Preliminary and Final Design	1,498	1,498
Construction Phase		
Site Preparation	1,803	1,803

[a] The financial schedule for FY 2004, FY 2005, and FY 2006 has been modified to reflect the appropriation of $3,925,000 to start construction of this project in FY 2004 instead of FY 2005. Out-year requests have been adjusted to reflect a $1,500,000 increase in the TEC due to inflation escalation and current market conditions.
[b] The FY 2004 appropriation shown here includes a reduction/rescission of $23,000 in accordance with the 0.59 percent across-the-board reduction contained in the FY 2004 Omnibus Appropriations Bill.
[c] Project estimated costing was replaced with actual costing and out-year estimated costing was reevaluated and modified to mitigate funding risks due to extended continuing resolutions in FY 2005.
[d] General appropriations rescissions in FY 2005 ($53K) and FY06 ($105K) have reduced the available TEC by $158K.

	Current Estimate ($000)	Previous Estimate ($000)
	(dollars in thousands)	
Equipment	761	761
All other construction	17,614[a]	17,614
Contingency	961	1,014
Total, Construction	21,139	21,192
Total, TEC	22,637	22,690

Other Project Costs

	Current Estimate ($000)	Previous Estimate ($000)
	(dollars in thousands)	
Cost Element		
Conceptual Planning[b]	380	380
NEPA documentation costs[c]	20	20
ES&H costs[d]	20	20
Experimental equipment (Process Development and Integration Lab)[e]	6,500	6,500
Other Project-Related costs[f]	276	276
Start-up	0	0
Offsetting D&D Phase[g]		
D&D for removal of the offsetting facility	--	--
Other D&D to comply with "one-for-one" requirements	--	--
D&D contingency	--	--

[a] $72,000 of the FY 2003 PED funding is allocated for partial Design Inspection services.
[b] The final Conceptual Design Report was completed in February of 2002 to support the Critical Decision (CD) 1 approval.
[c] Preparation of the National Environmental Policy Act (NEPA) documentation for the proposed facility was completed as part of the update of the existing Environmental Assessment (EA) for the NREL South Table Mountain Site. This EA was completed and a Finding of No Significant Impact (FONSI) determination was signed in July of 2003.
[d] ES&H costs represent the cost of preparing the Hazard Analysis Report and the Fire Hazard Analysis for the proposed facility
[e] Eleven items of scientific equipment, purchased by the Solar Energy Program, will be installed following building construction and acceptance utilizing program capital funds to be allocated in FY 2005, 2006, and 2007.
[f] Other Project-Related costs include building commissioning, integrated project team support, and independent assessment of construction progress.
[g] Note: The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement.

	Current Estimate ($000)	Previous Estimate ($000)
Total, D&D	--	--
Contingency for OPC other than D&D	0	0
Total, OPC	7,196	7,196

7. Schedule of Project Costs

(dollars in thousands)

	Prior Years	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Outyears	Total
TEC (Design)[a, a]	1,498	0	0	0	0	0	0	1,498
TEC (Construction)	19,560	1,579	0	0	0	0	0	21,139
OPC Other than D&D[b]	4,434	2,762	0	0	0	0	0	7,196
Offsetting D&D Costs	*	*	*	*	*	*	*	*
Total, Project Costs	380	270	1,190	221	7,209	16,222	4,341	29,833

8. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter)	2Q 2007
Expected Useful Life (number of years)	50
Expected Future start of D&D for new construction (fiscal quarter)	*

* Note: The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement.

[a] Preliminary design was completed in December of 2002. Final design was completed in September of 2003.
[b] Includes footnotes 6 thru 10 above.

(Related Funding Requirements)

(dollars in thousands)

	Annual Costs		Life cycle costs[a]	
	Current estimate	Prior Estimate	Current estimate	Prior Estimate
Operations	316[b]	316	1,768[c]	1,768
Maintenance	341[d]	341	371	371
Total, Related Funding	657	657	2,139	2,139

9. Required D&D Information

The DOE Golden Field Office is working with the HQ Program Office (EERE) and other DOE sites to identify square footage offsets that NREL can use to comply with the "one-for-one" requirement.

Name(s) and site location(s) of existing facility(s) to be replaced: TBD

D&D Information Being Requested	Square Feet
Area of new construction	71,347
Area of existing facility(ies) being replaced	0
Area of any additional space that will require D&D to meet the "one-for-one" requirement	71,347

10. Acquisition Approach (formerly Method of Performance)

Design and inspection are being performed under a negotiated fixed price, design to budget, subcontract awarded on the basis of competitive bidding and best value selection. Construction is being performed under a negotiated fixed price contract awarded on the basis of competitive bidding and best value selection. All subcontracts will be managed by the M&O Contractor with oversight by the Department of Energy.

[a] Life cycle costs based on the most recent approved Exhibit 300, July 2004.
[b] Utility costs are based on the energy analysis completed during Final Design for the proposed facility.
[c] Utility costs for STF from Final Daylighting Report dated May 30, 2003 (71,000 gsf STF = $249,894/year); includes capital replacement costs, domestic hot water heating (in year 17), and hot water heating system, air handling/cooling equipment, and roof (in year 22).
[d] Maintenance costs reflect historical site costs including custodial costs for the proposed facility.

Weatherization and Intergovernmental Activities

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Weatherization and Intergovernmental Activities					
Weatherization Assistance Program Grants	228,160	245,000	-2,450	242,550	164,198
State Energy Program Grants	44,176	36,000	-360	35,640	49,457
State Energy Activities	2,320	500	-5	495	0
Gateway Deployment	33,930	25,657	-257	25,400	0
International Renewable Energy Program	6,449	3,910	-39	3,871	2,473
Tribal Energy Activities	5,457	4,000	-40	3,960	3,957
Renewable Energy Production Incentive	4,960	5,000	-50	4,950	4,946
Total, Weatherization and Intergovernmental Activities	325,452[b]	320,067	-3,201	316,866	225,031

Public Law Authorizations:

P.L. 94-163, “Energy Policy and Conservation Act” (EPCA) (1975)
P.L. 94-385, “Energy Supply and Production Act” (ECPA) (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 Supply Policy Act” (NECPA) (1978)
P.L. 95-620, “Power Plant and Industrial Fuel Use Act" (1978)
P.L. 96-294, “Energy Security Act” (1980)
P.L. 100-12, “National Appliance Energy Supply Act" (1987)
P.L. 100-615, “Federal Energy Management Improvement Act" (1988)
P.L. 102-486, “Energy Policy Act of 1992"
P.L. 109-190, “Energy Policy Act” (2005)

[a] Includes a rescission of $3,201,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.
[b] In FY 2005, $411,000 was transferred to the SBIR program and $8,000 was transferred to the STTR program.

Mission

The mission of the Weatherization and Intergovernmental Program (WIP) is to develop, promote, and accelerate the adoption of energy efficiency, renewable energy, and oil displacement technologies and practices by a wide range of stakeholders. These include state and local governments, weatherization agencies, communities, companies, fleet managers, building code officials, and Native American tribal Governments.

Benefits

The Weatherization and Intergovernmental Program contributes directly to DOE's Energy Strategic Goal 4 by addressing the President's National Energy Policy (NEP) recommendations for market transfer of clean energy technologies and energy efficient products. The program also addresses the NEP call for reducing demand for fuels and energy and modernizing the deployment and public use of conservation technologies and practices. Weatherization Assistance Program Grants provide services that can make energy affordable for low-income households by reducing demand. The State Energy Program Grants assist States in developing emergency energy plans and in fostering clean, reliable, and diverse energy supplies. Lower WIP benefits reflect activities transferred and/or discontinued in the Gateway Subprogram, State Energy Program Grants, State Energy Assistance, and a reduction in the request for Weatherization Assistance Program Grants. The benefit calculations for activities transferred will be included in appropriate program benefit estimates, e.g., Rebuild America included in Building Technologies Program. The Tribal Energy Program helps foster diverse supplies of reliable, affordable and environmentally-sound energy through the market transfer of clean energy technologies. The NEP also calls for the promotion of market-based solutions to environmental concerns and the export of U.S. clean energy technologies.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and the environment) plus seven general goals that tie to the strategic goals. The Weatherization and Intergovernmental Program supports the following strategy and general goals:

Energy Strategic Goal

Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Weatherization and Intergovernmental Program has three program goals which contribute to General Goal 4 in the "goal cascade":

Contribution to Program Goal 04.09.00.00 (Weatherization)

Program Goal 04.09.00.00: (Weatherization). The goal of Weatherization Assistance Program Grants is to increase the energy efficiency of dwellings occupied by low-income Americans, thereby reducing their energy costs. DOE works directly with States and certain Native American tribes that contract with local governmental or non-profit agencies to deliver weatherization services.

Weatherization Assistance Program Grants contribute to General Goal 4 by providing cost-effective energy efficiency improvements to low-income households through the weatherization of 64,084 low-income homes with DOE funds in FY 2007. Priority is given to the elderly, persons with disabilities, families with children, and households that spend a disproportionate amount of their income on energy bills (utility bills consume an average of about 13 percent of household income for low income families, compared to 3.5 percent or less for all other Americans).[a]

Contribution to Program Goal 04.10.00.00 (State Energy Program)

Program Goal 04.10.00.00: (State Energy Program). The State Energy Program (SEP) goal is to strengthen and support the capabilities of States to promote energy efficiency and adopt renewable energy technologies, helping the Nation achieve a stronger economy, a cleaner environment and greater energy security.

The State Energy Program contributes to General Goal 4 by supporting States' promotion of energy efficiency and renewable energy technologies. The State Energy Program, among other activities, funds the development and maintenance of energy emergency planning at the state and local levels, a critical security benefit. SEP also assists States in developing strategic planning and logic modeling to target individual state energy priorities and increase energy security through diversification.

Contribution to Program Goal 04.11.00.00 (Intergovernmental Activities)

Program Goal 04.11.00.00: (Intergovernmental Activities). The goal of Intergovernmental Activities is to fund activities that facilitate the movement of energy efficiency and renewable energy products into the marketplace, namely promoting and incentivizing the use of these technologies in local communities with local customers.

The Intergovernmental Activities contribute to General Goal 4 by providing high leveraged technical assistance in targeted communities that accelerates the adoption of clean cost-effective EERE technologies. These activities benefit the public by improving energy productivity, reducing demand, and lessening the burden of energy costs on the disadvantaged. This will lead to the installation of 1000 MW of renewable generation globally by 2015 and 100 MW of generation in Indian country by 2010. Additionally, it is estimated that REPI qualified facilities will generate 16 billion KWh by 2010.

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[a] Data source: DOE EIA Residential Energy Consumption Survey (RECS).

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
General Goal 4, Energy Security			
Program Goal 04.09.00.00, Weatherization	228,160	241,956	164,198
Program Goal 04.10.00.00, State Energy Programs (State Energy Program Grants)	44,176	35,640	49,457
Program Goal 04.10.00.00, State Energy Programs (State Energy Activities)	2,320	495	0
Program Goal 04.11.00.00, Intergovernmental Activities			
Gateway Deployment	33,930	25,400	0
International Renewable Energy Program	4,464	406	2,473
Tribal Energy Activities	3,473	2,970	3,957
Renewable Energy Production Incentive	4,960	4,950	4,946
Total, Program Goal 04.11.00.00, Weatherization and Intergovernmental Activities	46,827	33,726	11,376
Subtotal, Program Goals 04.09.00.00, Weatherization, 04.10.00.00, State Energy Programs, and 04.11.00.00, Weatherization and Intergovernmental Activities	321,483	311,817	225,031
All Other			
Congressionally Directed, Weatherization Assistance Grants, Office of International Energy Market Development	0	594	0
Congressionally Directed, International Renewable Energy Program, International Utility Electricity Partnership, IUEP	1,984	3,465	0
Congressionally Directed, Tribal Energy Activities, Council of Renewable Energy Resource Tribes, CERT	992	990	0
Congressionally Directed, Pyramid Lake Paiute Tribe Renewable Energy Park	992	0	0
Congressionally Directed, National Center on Energy Management and Building Technologies	1	0	0
Total, All Other	3,969	5,049	0
Total, General Goal 4 (Weatherization and Intergovernmental Activities)	325,452	316,866	225,031

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Program Goal 04.11.00.00 (Intergovernmental Activities)					
International Renewable Energy					
		International Renewable Energy will strengthen and broaden activities supporting priority agreements, e.g., expanded the harmonization of standards to additional countries, ramped up implementation of the Energy Efficiency and Village Energy initiatives. Continue to work with APEC and NAEWG. [MET]	Provide technical analysis and reviews, data access, training and project support for 7 international clean energy projects which includes: developing 2 components for GIS tools to analyze U.S. EERE technology export markets; provide phase 1 technical assistance to secure access for EERE technologies to build 1,000 MW of generation globally over 10 years. [MET]		
Tribal Energy					
		Tribal Energy will conduct 6 technical and policy development workshops. [MET]	Tribal Energy will provide direct technical assistance to tribal nations including: 4 development workshops, 2-3 economic development projects, 8-10 "first steps" efforts, and 6-10 feasibility studies, working toward the goal of 100 MW of generation in Indian country by 2010. [PARTIALLY MET]		
Program Goal 04.09.00.00 (Weatherization)					
Weatherization Assistance Grants					
Weatherize 105,000 homes, with DOE funds.	Award $223 million in FY 2003 funds through 53 Weatherization Program grants, including all 50 States, to enable the direct Weatherization of 93,000 homes. This will bring the cumulative number of homes weatherized to over 52 million. [MET: 93,750 homes weatherized]	Weatherize 94,450 homes, with DOE funds. [MET]	Weatherize 92,500 homes, with DOE funds, and support the weatherization of approximately 100,000 additional homes with leveraged funds. [MET]	Weatherize 97,300 homes, with DOE funds.	Weatherize 64,084 homes with DOE funds.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
		Cumulative total of 2.8 million homes will be weatherized with DOE funds. [MET] Cumulative total of 5.4 million homes will be weatherized with DOE and leveraged funds. [MET]	Program will update the energy savings benefit-cost ratio and savings per DOE dollar invested as part of a national evaluation of the program. This will allow the program to track an annual performance efficiency of Btus per Federal dollar invested. [MET]	The program will complete planning for and initiate implementation of the new comprehensive national evaluation of the Weatherization Assistance Program. The evaluation is a multi-year task that will provide new, accurate baselines for average energy savings, benefit cost ratios, and Btu energy savings per Federal dollar expended.	
Program Goal 04.10.00.00 (State Energy Program Grants)					
State Energy Program Grants					
	.	Achieve an annual energy savings of 52,406,930 source Btu and $317,772,960 in annual energy cost savings by awarding $43,952,000 in grants to States and Territories. [MET]	Achieve an annual energy savings of 10,250,000 source Btus and $64,780.000 in annual energy cost savings with DOE funds. Achieve an annual energy savings 36,695,000 source Btus and $231,912.400 in annual energy cost savings with leveraged funds. [MET] Program will update Btu to dollar calculation derived from 2003 metrics study to establish new baseline. [MET]	Achieve an average annual energy savings of 8-10 trillion source Btus (an estimated $50-60 million in annual energy cost savings) with DOE funds. Achieve an additional average energy savings of 26-30 trillion source Btus (an estimated $190-$200 million in annual energy cost savings) from leveraged funds.	Achieve an average annual energy savings of 12-14 trillion source Btus (an estimated $72-78 million in annual energy cost savings) with DOE funds.
Program Goal 04.11.00.00 (Intergovernmental Activities)					
Gateway Deployment/Rebuild America					
Establish 40 new Rebuild America community partnerships and assisted these communities to retrofit 80 million square feet of floor space in K-12 school, colleges, public housing, and state/local governments.	Assist 450 *Rebuild America* community partnerships to upgrade 80 million square feet of floor space in K-12 schools, college, public housing, and state/local governments. [MET]	Assist over 500 new and existing *Rebuild America* community partnerships to upgrade 70 million square feet of floor space in K-12 schools, colleges, public housing, and state/local governments, reducing the average energy used in these buildings by 18 percent. [MET]	Help *Rebuild America* community partnerships to upgrade 60 million square feet of floor space in K-12 schools, colleges, public housing, and state/local governments, reducing the average energy used in these buildings by 18 percent. [MET]		Activity transferred to Building Technology Program.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
Gateway Deployment/Energy Efficiency Information and Outreach					
Gateway Deployment/Building Codes Training and Assistance					
		Provide technical assistance to States resulting in 4 States adopting upgraded 2001 and 2003 model commercial or residential building energy codes. [MET] Train 2,000 architects, engineers, builders and code officials to implement the above codes and upgraded 2004 model commercial code. [MET]	Provide technical assistance to States resulting in 4 States adopting upgraded 2001 and 2003 model commercial or residential building energy codes. [MET]		Activity transferred to Building Technology Program.
Gateway Deployment/Clean Cities					
Achieve 135,000 alternative fuel vehicles in operation in Clean Cities.	Achieve a total of 135,000 alternative fuel vehicles (AFV's) in operation in Clean Cities which will displace 180 million gallons of gasoline and diesel a year. [MET].	Clean Cities will conduct 7 major workshops, award $6 million in special project funding, and report a total of 180,000 number of alternative fuel vehicles in operation in clean cities. Achieving these outcomes will result in an estimated displacement of 153 million gallons of petroleum based fuels. [NOT MET]	Clean Cities will conduct 7 major workshops, award $4 million in special project funding for alt fuel, anti-idling, and hybrid technology, and provide technical support to coalitions. Program will report a total number of 198,000 alternative fuel vehicles in operation in clean cities. Achieving these outcomes will result in an estimated displacement of 168 million gallons of petroleum based fuels and 70 new ethanol fueling stations. [MET]		Activity transferred to FreedomCAR Program.
Gateway Deployment/ENERGY STAR®					
Recruit 500 additional retail stores, five addition manufacturers bringing the total number of stores marketing ENERGY STAR® appliances to 7,000.	Recruited 375 additional ENERGY STAR® partners including retail stores, utilities and manufacturers. [MET]	Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Add domestic hot water heaters to the program. Begin work on a Commercial Window Specification. Expand room air-conditioner program to include	Recruit 500 additional retail stores, 5 additional utilities and 10 additional manufacturers. Complete draft Commercial Window specification. Begin update of Residential Window specification. Expand coordination with all gateway	Increase market penetration of appliances (clothes washers, dishwashers, room air conditioners and refrigerators) to 38 to 42% (baseline 30% calendar year 2003), to 2 to 3% for Compact Fluorescent Lamps (baseline 2% calendar year 2003) and 40 to 45% for	Activity transferred to Building Technology Program.

FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Results	FY 2006 Targets	FY 2007 Targets
		heating cycle. Continue outreach to non-English speaking communities and Weatherization activities. [NOT MET]	activities. [PARTIALLY MET]	windows (baseline 40% calendar year 2004). Estimated energy savings will be 0.030 Quads and $657 million consumer utility bill savings.	
Gateway Deployment/NICE[3]					
		Continue program closeout initiated in FY 2003. [MET]			
Gateway Deployment/Inventions and Innovations					
Gateway Deployment/International Market Development					
		No activities.			
		Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003) until the target range is met. [NOT MET: EERE actively accelerating costing of funding]	Contribute proportionately to EERE's corporate goal of reducing corporate and program adjusted uncosted obligated balances to a range of 20-25 percent by reducing program annual adjusted uncosteds by 10 percent in 2005 relative to the program FY 2004 end of year adjusted uncosted baseline ($21,257K) until the target range is met. [MET]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent. [a]	Maintain total administrative overhead costs (defined as program direction and program support excluding earmarks) in relation to total program costs of less than 12 percent.

[a] Baseline for administrative overhead rate currently being validated.

Means and Strategies

The functions of the Weatherization and Intergovernmental Program have been realigned, whereby they directly impact a specific technology (e.g., Rebuild America to Building Technologies and Clean Cities to the FreedomCAR and Vehicle Technologies Program). Formula grant programs were centralized to the EERE PMC (Weatherization and SEP). This refocusing of deployment activities reinforces the systems approach to technology development and provides new leadership for state grant activities.

The Weatherization and Intergovernmental Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve program goals. Collaborations are integral to the planned investments, means and strategies, and will provide avenues to address external factors.

Collaboration with States, agencies, and a variety of customers is integral to the investments, means and strategies planned.

WIP will implement the following means:

- Weatherization Assistance Program Grants (WAP) will provide formula grants to States, which in turn, provide grants to Community Action Agencies to reduce the energy costs of low-income households by installing cost-effective energy efficiency improvements while ensuring the health and safety of the people served. Priority is given to the elderly, persons with disabilities, families with children, and households that spend a disproportionate amount of their income on energy bills (utility bills make up 13 percent of household expenses for low income families, compared to 3.5 percent or less for all other Americans);

- The State Energy Program (SEP) will provide formula grants to States, enabling state governments to target their own high priority energy needs and expand clean energy choices for their citizens and businesses. Activities will promote technology policies and projects that increase building, transportation, and industrial efficiency, reduce dependence on foreign oil, and increase use of renewable energy;

- The International Renewable Energy Program will consolidate its international efforts into a more focused program, whereby efforts are concentrated in a few countries that hold strategic opportunities. It will provide technical analysis for senior Administration officials in support of discussions with foreign governments regarding energy efficiency and renewable energy management, policies, and use;

- The Tribal Energy Activity supports and manages technical and financial assistance projects to promote energy, environmental, and economic development policy objectives for Native Americans. This primarily involves the development of energy efficiency and renewable energy resources on Tribal lands. Projects include resource assessments and development plans for energy efficient and renewable energy technologies. Technical assistance helps Native American Tribes and Tribal Colleges develop culturally compatible energy and economic development plans and strategies

reflecting Tribal priorities. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning; and

- The Renewable Energy Production Incentive (REPI) encourages the acquisition of renewable generation systems that use solar, wind, geothermal or biomass technologies by state and local governments and non-profit electric cooperatives by providing financial incentive payments for their electric production.

WIP will implement the following strategies:

- The Weatherization Assistance Program will utilize a cost-effective combination of energy-saving measures selected for each home based on a comprehensive audit. This activity will provide state formula grants in FY 2007 to weatherize approximately 64,084 low-income homes. Ninety percent of the total WAP funding will be allocated to the States as operating funds for this purpose, i.e., for labor, materials, equipment and administrative systems;

- State Energy Program Grants will enable state energy offices to tailor energy efficiency programs to state and local needs and to leverage non-Federal resources to supplement Federal assistance. SEP supports state partners in areas such as utility restructuring, implementing newly developed energy efficiency technologies, and urban/regional planning for sustainability. Utilizing a corporate crosscutting approach, EERE will assess the research and development program priorities and provide tailored technical assistance to States to support state and local actions that further national energy priorities; and

- EERE will educate foreign energy decision makers about the benefits of U.S. energy efficiency and renewable energy technologies. Partnerships with Tribal Governments will be built to help provide technical and financial assistance for energy efficiency and renewable energy projects, and increase capacity for long range planning that meets Tribal energy needs for residential, commercial and industrial uses.

These strategies will result in significant cost savings and a significant reduction in the consumption of gasoline, electricity, diesel fuels and natural gas while increasing the substitution of clean fuels and power – cost effectively reducing America's demand for energy, lowering carbon emissions, and decreasing energy expenditures.

The following external factors could affect WIP's ability to achieve its strategic goal: partner cost share; partner participation rates; fuel price volatility; local codes/standards; geopolitical changes and cost-effectiveness of technologies and products that can substitute for current ones, but with significantly improved greenhouse gas (GHG) emission characteristics.

In carrying out the program's mission, WIP collaborates with several groups on its key activities including:

- The Weatherization Assistance Program (WAP) works with a network of approximately 970 local weatherization agencies. WAP coordinates with the Health and Human Services Low Income Home Energy Assistance Program (LIHEAP), whose state grantees make approximately 10 percent of their funds available to local WAP agencies for weatherization improvements;

- SEP works closely with all 50 States, DC and territories; and
- Tribal Energy Subprogram maintains a close collaboration with the Bureau of Indian Affairs, Department of Interior, Department of Justice, and the Environmental Protection Agency through the Federal Interagency Working Group on Environmental Justice (IWG). The IWG was created under Executive Order 12898 in 1994 and is comprised of 11 Federal agencies and several White House offices working to integrate environmental justice into individual programs.

Validation and Verification

To validate and verify program performance, the Weatherization and Intergovernmental Activities Program will conduct internal and external reviews and audits. These programmatic activities are subject to continuing review as described below. The table below summarizes validation and verification activities.

Data Sources: The Energy Information Administration's (EIA) Annual Energy Review (AER), Renewable Energy Annual and Annual Energy Outlook, International Energy Agency, World Energy Outlook, Commercial Building Energy Consumption Survey (CBECS), Residential Energy Consumption Survey (RECS), U.S. Department of Commerce (DOC) Current Industrial Reports (CIR), the Golden Field Office REPI Reimbursement tracking system, NREL and various trade publications; and information collected directly from WIP performers or partners.

Baseline:

- Energy savings for WIP are based on market penetration of technologies after the year 2005. Savings are relative to what energy consumption would have been in the absence of this additional market penetration. State Energy Program assumes annual energy savings of 1.03 million source Btu and annual cost savings of $7.22 for every dollar of Federal funding. Weatherization Assistance Program Grants maintains a 1984 benefit-cost ratio of 1.06.
- Over 1.1 billion kWh of qualified renewable energy produced in 2004.
- IREP 2002 baseline for primary renewable energy consumption in developing countries and transition economies is approximately 12 Quads (30249 million tons of oil equivalent (Mtoe)). Tribal Energy 2003 baseline is 750 kW of renewable generation capacity on Tribal lands.

Frequency: Annual (complete revalidation of assumptions and results can only take place every 3 to 4 years, due to the reporting cycle of two critical publications, CBECS and RECS. However, updates of most of the baseline forecast and WIP outputs will be undertaken annually).

Evaluation: In carrying out the program's mission, WIP uses several forms of evaluation to assess progress and to promote program improvement.

- Operational field measurement as appropriate;

- Peer review by independent outside experts of both the program and subprogram portfolios;
- Annual internal Technical Program Review;
- Specialized program evaluation studies to examine process, impacts, or market baseline and effects, as appropriate, e.g., national evaluation of the Weatherization Assistance Subprogram;
- Quarterly and annual assessment of program and management results based performance through Joule (the DOE quarterly performance progress review of budget targets), R&DIC (annual internal review of performance planning and management of R&D programs against specific criteria), PMA (the President's Management Agenda -- annual departmental and PSO based goals whose milestones are planned, reported and reviewed quarterly), and PART (common government wide program/OMB reviews of management and results); and
- Annual review of methods, and recomputation of potential benefits for the Government Performance and Results Act (GPRA).

Data Storage: EIA data sources are available on line. Trade publications are available on a subscription basis. WIP output information is contained in various reports and memoranda. Reviews and analyses conducted by Oak Ridge National Laboratory are available on line at http://www.ornl.gov/info/reports/ORNL_reports.shtml.

Verification: Calculations are based on assumptions of future market status, equipment or technology performance, and market penetration rates. These assumptions can be verified against actual performance through technical reports, market surveys and product shipments. Weatherization Assistance Program Grants validates number of homes by State reporting through the WinSAGA system. SEP bases results on an assessment of program outcomes conducted by Oak Ridge National Laboratory whose methodology was independently reviewed in FY 2005 by the Board of Directors of the International Energy Program Evaluation Conference. Tribal Energy maintains project information and receives data from individual Tribal Governments.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. Weatherization Assistance Program Grants and State Energy Program Grants have incorporated feedback from OMB into the FY 2007 Budget Request, have addressed most of the PART recommendations, and are committed to addressing the remaining recommendations and improving performance. The Weatherization Assistance Program's efficiency performance metric is the benefit-cost ratio, which is greater than one (ratio depends on current and future energy prices). Consistent with PART recommendations, the program will initiate the

first year of a three year national evaluation designed to insure that its objectives are being met and that estimates of energy savings, bill reductions, program costs, and program benefits are valid.

The 2003 Weatherization PART recognized that the program has a very clear purpose (100%), strong planning (88%) and management (78%). The PART also found that the program coordinates effectively with other related government programs in its efforts to meet interrelated Departmental goals and still achieve its goals of a favorable benefit-cost ratio and other performance goals. While the PART recognized the program has met its planned targets for the number of homes weatherized, PART assessment of the program's 2003 Inspector General audit resulted in lower program accountability scoring, though it acknowledged program management actions are underway to address the findings. The program has undertaken an independent evaluation in response to PART recommendations.

The 2004 State Energy Program PART (its initial review) found that the program has a clear purpose (100%), strong management (89%), and has taken steps to improve its operational efficiency. While noting Oak Ridge National Laboratory's assessment that the program generates significant energy and cost savings, the PART review noted that data was not available from all States and that the study was not prepared by an independent source. ORNL's second study in the series, based on data from 50 States, 4 Territories and DC, was reviewed by the Board of Directors of the International Energy Program Evaluation Conference, an independent body comprised of many recognized peer experts in the energy efficiency program evaluation field. The program is planning future analyses to be conducted by external independent entities.

The State Energy Program PART rated the program "results not demonstrated" as the program's shift from measuring grants processed to measuring energy results was not sufficiently in place to demonstrate results. The PART Recommendations also encouraged the development of long-term and annual measures. SEP is working with States to develop a programmatic strategic plan to address PART recommendations for the development of meaningful long-term and annual performance measures, and to better quantify program results.

Expected Program Outcomes

The Weatherization and Intergovernmental Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the production and diversity of domestic fuel supplies; and provide greater energy security and reliability by improving our energy infrastructure. In addition to these "EERE business-as-usual" benefits, realizing the programs goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Also note that modeling long term benefits assumes that funding levels will be consistent with the President's commitment and assumptions in the FY 2007 Budget, and that funding will be applied to the core program. If the pattern of substantial congressionally directed projects persists over several years, the GPRA benefits estimates will need to be reduced. WIP benefits are lowered considerably from FY 2006, due to activities transferred, discontinued, or scheduled to be phased-out in the Gateway Subprogram, State Energy Assistance, and a reduction in the request for Weatherization Assistance

Program Grants. The benefit calculations for activities transferred will be included in appropriate program benefit estimates, e.g., Rebuild America is included in Building Technologies Program.

The Renewable Energy Production Incentive could stimulate the generation of roughly 700 million kilowatt hours of electricity in 2015. The Native American Renewable Initiative could stimulate approximately 3 GW of new renewable capacity by 2015.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, natural gas savings, and displaced need for electricity capacity additions that result from the realization of the WIP Program goals are shown in the table below through 2025.

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits. Results could vary significantly if external factors, such as future energy prices, differ from the "base case" assumed for this analysis. EERE's base case is based on and similar to the EIA "reference" case presented in its publication Annual Energy Outlook 2005[a]. In addition, possible changes in public policy and disruptions in the energy system which may affect estimated benefits are not modeled. External factors such as unexpected changes in competing technology costs, identified in the Means and Strategies section above, could also affect the program's ability to achieve its goals.

The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of the potential change in national benefits over time if the technology, infrastructure and markets evolve as expected. Estimated benefits which follow assume that individual technology plans and market assumptions are realized. Final documentation is estimated to be completed and posted by March 31, 2006. Uncertainties are larger for longer term estimates. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at http://www.eere.energy.gov/ba/pba/gpra.html.

[a] The Energy Information Administration's recently released Annual Energy Outlook 2006 (Early Release) indicates significantly higher oil and fuels prices for much of the forecast horizon than does the previous forecast (AEO 2005) on which this benefits analysis is based. All else equal, higher fuels prices would be expected to increase the market penetration of renewable energy and energy efficiency measures undertaken irrespective of DOE programs, as these technologies become more price competitive. As such, some of the non-renewable energy savings, cost savings and emissions reductions attributable to DOE programs might be reduced.

FY 2007 GPRA Benefits Estimates for the Weatherization and Intergovernmental Activities Program[a]

Mid-Term Benefits[b,c]	2010	2015	2020	2025
Primary nonrenewable energy savings (Quads)	0.06	0.13	0.15	0.20
Energy expenditure savings (Billion 2003$)	ns	1.2	2.9	2.3
Carbon emission reductions (MMTCE)	1.2	2.6	2.5	3.8
Natural gas savings (Quads)	0.02	0.07	0.07	0.11
Total electric capacity stimulated by WIP (GW)	0.7	4.5	3.2	5.0

WIP provides a number of benefits not directly addressed in the table above. Through the Weatherization Assistance Program Grants, WIP improves energy affordability and safety for low income households who lack the financial resources to make these investments on their own. This program also provides the institutional basis for other sources of Federal, state, local, and utility dollars used to weatherize additional homes, and provides on-the-ground training and experience with advanced building efficiency technologies and technologies for building contractors throughout the country.

WIP also provides state and local governments with improved capability to address local air quality needs at a lower cost and with better results than would be achievable otherwise.

Finally, through the SEP Program, WIP provides a basis for state and local energy emergency planning and response capabilities. Initially developed to respond to oil and natural gas shortages in the 1970s, state energy planning has provided local capabilities for addressing recent electricity shortages and homeland security coordination in recent years.

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits that may be possible if all of the program's technical targets are met and funding continues at levels consistent with assumptions in the FY 2007 Budget.
[b] Mid-term program benefits were estimated utilizing the GPRA07-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2005 Reference Case.
[c] Benefits labeled as "ns" are ones that are not significant and therefore not reported numerically. These are non-zero values that are sufficiently small that they are within the convergence tolerance of the NEMS model used to measure the benefits.

Weatherization Assistance Grants

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Weatherization Assistance Grants			
Weatherization Assistance	224,738	237,996	159,648
Training and Technical Assistance	3,422	4,554	4,550
Total, Weatherization Assistance Grants	228,160	242,550	164,198

Description

The Department of Energy administers Weatherization Assistance Program Grants by providing technical assistance and formula grants to state and local weatherization agencies throughout the United States. This support improves the energy savings per home and helps States spend non-Federal funding effectively through uniform technical assistance. A network of approximately 970 local agencies provide trained crews to perform weatherization services for eligible low-income households in single-family homes, multifamily dwellings, and mobile homes. Of the homes weatherized annually, 49 percent are occupied by an elderly person with special needs or a person with disabilities. Other priorities are given to families with children, and households that spend a disproportionate amount of their income on energy bills (utility bills make up 13.5 percent of household expenses for low income families, compared to 3.5 percent or less for all other Americans). All homes receive a comprehensive energy audit, which is a computerized assessment of a home's energy use and an analysis of which energy conservation measures are best for the home; a combination of those energy-saving measures are then installed.

Benefits

Weatherization Assistance Program Grants contribute to the WIP goal by reducing the energy cost burden to low-income households that pay a disproportionate amount of household income on energy bills. Since 1976, Weatherization Assistance Grants has helped over five million American families reduce their energy bills and increase the comfort and safety of their homes resulting in average annual cost savings of $274 per household.[a] Weatherization also provides many non-energy benefits to recipient households and their communities. For example, it helps stabilize the housing stock in low-income neighborhoods and supports approximately 8,000 technical jobs in local home energy businesses. In addition to the DOE funds, the Department of Health and Human Services (HHS) also provides funding for Weatherization through its Low-Income Home Energy Assistance Program.

[a] Meta evaluation of National Weatherization Assistance Program Based on State Studies, 1993-2002 ORNL/CON-488, February, 2003.

Weatherization Assistance Funding

(in whole dollars)

State	Source of Non-Federal Funds	2005 Federal DOE Funds	2005 Non-Federal Funds [a]
Alabama	N/A	2,417,993	0
Alaska	Alaska Housing Finance Corp (State)	1,687,568	3,000,000
Arizona	Utility funds	1,364,754	350,000
Arkansas	Utility funds	2,079,513	2,350,000
California	(Utility funds operated at local level)	6,322,844	0
Colorado	Utility funds	5,504,036	2,689,149
Connecticut	(Utility funds operated at local level)	2,517,795	3,526,504
Delaware	Utility funds	577,217	542,000
Dist. Columbia	Utility Funds	651,868	1,200,000
Florida	State Funds for WAP Repair Program	1,965,864	2,000,000
Georgia	Utility funds	2,940,956	800,000
Hawaii	N/A	204,993	0
Idaho	Utility funds and private sources	1,982,038	460,000
Illinois	State public benefit funds	13,910,793	7,200,000
Indiana	(Utility funds operated at local level)	6,580,199	0
Iowa	Utility funds	5,011,292	2,247,970
Kansas	N/A	2,541,543	0
Kentucky	N/A	4,539,785	0
Louisiana	N/A	1,738,815	0
Maine	State Public Utility Commission funds	3,081,589	300,000
Maryland	(Utility funds operated at local level)	2,664,081	850,000
Massachusetts	(Utility funds operated at local level)	6,577,376	16,600,000
Michigan	N/A	15,257,442	0
Minnesota	Utility funds and special State funds	9,898,845	2,300,000
Mississippi	N/A	1,655,581	0
Missouri	Utility funds	6,029,907	1,765,000
Montana	Utility funds	2,530,390	1,819,941
Nebraska	N/A	2,504,834	0
Nevada	Utility funds	838,908	2,676,763

[a] FY 2006 data not yet available. In FY 2005, States received an estimated $220.5 from LIHEAP.

(in whole dollars)

State	Source of Non-Federal Funds	2005 Federal DOE Funds	2005 Non-Federal Funds [a]
New Hampshire	Utility funds	1,515,114	510,000
New Jersey	Utility funds, landlord contributions, other private funds	5,125,246	98,000
New Mexico	Utility funds	1,917,964	20,000
New York	Utility funds, landlord contributions, other private funds	20,259,998	8,200,000
North Carolina	N/A	4,176,834	0
North Dakota	N/A	2,507,804	0
Ohio	Utility funds, landlord contributions, other private funds	13,801,761	20,000,000
Oklahoma	Landlord contributions, other private funds	2,602,794	15,000
Oregon	Utility funds	2,833,724	3,322,040
Pennsylvania	(Utility funds operated at local level)	14,772,357	0
Rhode Island	Utility funds	1,161,108	600,000
South Carolina	N/A	1,783,179	0
South Dakota	N/A	1,925,053	0
Tennessee	N/A	4,199,886	0
Texas	Utility funds	5,599,993	10,512,259
Utah	Utility funds, TANF	2,086,136	1,019,535
Vermont	VT Weatherization Trust Fund	1,283,358	3,786,098
Virginia	Emergency Home Repair funds	4,034,302	158,090
Washington	Utility funds and State capital funds	4,560,166	7,333,891
West Virginia	Utility funds	3,225,843	225,000
Wisconsin	Utility funds	8,606,650	32,229,734
Wyoming	N/A	1,179,511	0
	Headquarters Training and Technical Assistance	3,422,400	0
Total, Weatherization Assistance Funding		228,160,000	140,706,974

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Weatherization Assistance	**224,738**	**237,996**	**159,648**

This activity will provide state formula grants to enable the weatherization of an estimated 64,084 low-income homes, saving $1.53 in energy costs for every dollar invested over the life of the measures (based on current EIA energy price data). Ninety percent of the total WAP funding will be allocated to the States as operating funds for this purpose, i.e., for labor, materials, equipment and administrative systems.

Ten percent of the total program funding will be allocated for training and technical assistance to maintain a high standard of technology application, effectiveness and results. Most training and technical assistance will be performed at state and local levels. In FY 2006, as directed by Congress, $594,000 was provided to the Office of International Energy Market Development.

Training and Technical Assistance.....	**3,422**	**4,554**	**4,550**

DOE will conduct analysis, measure and document program performance, and promote (e.g., through pilot programs, publications, training programs, workshops and peer exchange) the application of advanced techniques and collaborative strategies to continually improve program effectiveness.

Traditionally, DOE uses 1.5 percent of the total Weatherization funding to fund training and technical assistance activities that can be more cost-effectively performed at national/regional levels, to support effective program operations by the network of state and local Weatherization agencies. However, in response to PART recommendations, DOE will modify the DOE/State split on T&TA funding in order to conduct a new national evaluation of the program. In 2005, DOE began funding (approximately $600,000 from DOE T&TA) the first year of this multi-year national evaluation, estimated not to exceed $6 million, to insure that its objectives are being met and that estimates of energy savings, bill reductions, program costs, and program benefits are valid. The Weatherization Assistance Program has not conducted a national evaluation for more than a decade. The new evaluation is needed to assess the overall energy savings and cost-effectiveness of the program, assess the impact of numerous changes made to program policy and procedures, and determine the best methods to improve future program performance.

Total, Weatherization Assistance Grants	**228,160**	**242,550**	**164,198**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Weatherization Assistance	
The reduced Weatherization funding request supports core funding needed to sustain critical services. This will enable greater investments in advanced R&D within the EERE portfolio that can address critical national priorities: reducing dependence on foreign oil; accelerating the development of clean electricity supply options; and developing highly efficient new technologies and products for our homes and buildings. A number of these advances are expected to increase the effectiveness of Weatherization efforts in the outyears	-78,348
Training and Technical Assistance	
No significant changes	-4
Total Funding Change, Weatherization Assistance Grants	**-78,352**

State Energy Program Grants

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
State Energy Program Grants	44,176	35,640	49,457
Total, State Energy Program Grants	44,176	35,640	49,457

Description

The State Energy Program Grants (SEP) mission is to provide financial assistance through formula grants to States, enabling state governments to target their own high priority energy needs and expand clean energy choices for their citizens and businesses. This program was created by Congress in 1996 by consolidating two earlier efforts — the State Energy Conservation Program, and the Institutional Conservation Program, both established in the 1970's.

SEP is the only Federally-funded, state-based program administered by DOE that provides resources directly to the States. With these funds and the resources leveraged by them, the State and Territory Energy Offices develop and manage a variety of programs designed to increase energy efficiency, reduce energy use and costs, develop alternative energy and renewable energy sources, promote environmentally conscious economic development and reduce reliance on oil produced outside the U.S. State Energy Offices are also instrumental in administering public benefits funds and energy emergency preparedness.

Benefits

SEP contributes to EERE's deployment goals by supporting the core capabilities of States to implement activities that promote energy efficiency and adopt renewable energy technologies. The SEP, among many other activities, funds the development and maintenance of energy emergency planning at the state and local levels, a critical security benefit. SEP has recently taken steps to better quantify the energy benefits of the program activities, including savings and emissions reductions.[a] An internal program evaluation concluded that the program achieves an annual energy cost savings of 1.17 million source Btu and $7.23 in annual energy cost savings for each $1 of Federal funding. An external evaluation is being planned. The program is currently focused on supporting the implementation of the SEP Strategic Plan for the 21st Century, which is addressing key goals of market transformation and collaboration with environmental and economic development interests.

[a] Estimating Energy and Cost Savings and Emissions Reductions for the State Energy Program Based on Enumeration Indicators Data ORNL/CON-487 January 2003.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
State Energy Program Grants	**44,176**	**35,640**	**49,457**

Provide grants to 50 States, DC, and territories for energy efficiency/renewable programs. Support implementation of SEP Strategic Plan for the 21st century, addressing key goals of market transformation and collaboration with environmental and economic development interests. Assist States in strategic planning and logic modeling. Provide technical assistance and training to develop state level capabilities to form collaborative partnerships and conduct evaluation of the impact of state energy efficiency and renewable energy programs nationwide. Provide technical assistance to address emerging regional energy and environmental issues such as transportation and air quality. Support information technology systems for program evaluation and reporting in compliance with E-Gov initiative. Additional program funds in 2007 may be used to support provisions in the 2005 Energy Policy Act as appropriate.

Utilizing a corporate crosscutting approach, EERE will assess the research and development program priorities and provide tailored technical assistance to States to support state and local actions that further national energy priorities. This refocusing of our deployment activities reinforces the systems approach to technology development and provides new leadership for state grant activities.

Total, State Energy Program Grants	**44,176**	**35,640**	**49,457**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Increase state and local financial and technical assistance to improve emergency preparedness and reducing the impact of energy market volatility. Support provision of the 2005 Energy Policy Act as appropriate	+13,817
Total Funding Change, State Energy Program Grants.....	**+13,817**

State Energy Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
State Energy Activities			
Planning and Evaluation Support for State and Local Grant Programs	2,320	495	0
Total, State Energy Activities	2,320	495	0

Description

The State Energy Activities Subprogram complements the State Energy Grants Program activities. Cooperative agreements with States provide assistance for energy-related applied research, development, and field testing, which are excluded from the State Energy Program enabling legislation. Planning and evaluation projects will allow for additional technical assistance to States in support of State Energy Assistance and for necessary information management, planning, analysis, and evaluation projects on the formula grant programs.

Benefits

State Energy Activities contribute to WIP deployment goals by supporting State Energy Grants Program activities. This assistance allows States to implement planning and analysis for grants related energy efficient and renewable energy technology research, development, and field-testing, thus improving program effectiveness.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Planning and Evaluation Support for State and Local Grant Programs	**2,320**	**495**	**0**
Activities, including Oak Ridge metrics evaluation study updates, program oversight, State Energy Advisory Board support, and response to Congressionally mandated requirements under EPAct 2005 (training and technical assistance); are included in the State Energy Program Request.			
Total, State Energy Activities	**2,320**	**495**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Planning and Evaluation Support for State and Local Grant Programs	
The activities previously funded under this line item will be funded under the State Energy Program line item in FY 2007	-495
Total Funding Change, State Energy Activities	**-495**

Gateway Deployment

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Gateway Deployment			
Rebuild America	8,641	3,769	0
Energy Efficiency Information and Outreach	1,064	346	0
Building Codes Training and Assistance	5,597	4,455	0
Clean Cities	10,626	7,920	0
ENERGY STAR®	3,672	5,940	0
Inventions and Innovations	3,945	2,970	0
Technical/Program Management Support	385	0	0
SBIR/STTR	--	0	0
Total, Gateway Deployment	33,930	25,400	0

Description

Gateway activities in FY 2007 have either been transferred to the applicable Technology Development Program or discontinued. Activities transferred include Rebuild America (to Building Technologies Program), Clean Cities (to FreedomCAR and Vehicle Technologies Program) and ENERGY STAR® (to Building Technologies Program). This realignment will result in improved coordination and linkage between activities that are focused on developing new technologies and those that are reducing the barriers to their market adoption. Revised goals will be determined by program manager and be consistent with newly announced deployment strategy of technology advancement as opposed to market barrier removal.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Rebuild America	**8,641**	**3,769**	**0**

Rebuild America is a technology information network and operations results-tracking service that develops, acquires or provides financial assistance to distribute the use of best practice decision tools

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

for senior management in various difficult markets. In FY 2007, Rebuild America and all activities have been transferred to the Building Technologies Program.

Energy Efficiency Information and Outreach	**1,064**	**346**	**0**

Information and Outreach activities focused on key market segments, homeowners, and school officials. Outreach will include use of web based tools, media outlets and business communication channels to leverage effectiveness. Future activities will be addressed within the EERE Office of Technology Advancement and Outreach.

Building Codes Training and Assistance.....	**5,597**	**4,455**	**0**

In support of Energy Conservation and Production Act Section 304, this activity provided technical and financial assistance to States, to update and implement their energy codes. States have developed sufficient expertise in this area, therefore the activity is being discontinued in FY 2007. To the extent that any future work is done in this area, activities would be carried out within the Building Technologies' Residential Buildings Integration subprogram.

Clean Cities	**10,626**	**7,920**	**0**

In support of Energy Policy Section 505, Clean Cities promotes alternative fuel efforts and expands activities to promote the use of additional petroleum displacement technologies. The technologies include anti-idling devices in heavy duty trucks and buses, expanded use of non-petroleum blends, hybrid technologies and a better public understanding of the benefits of fuel economy. In FY 2007, Clean Cities is being transferred to the Vehicle Technologies' Technology Introduction subprogram.

ENERGY STAR®	**3,672**	**5,940**	**0**

In FY 2007, ENERGY STAR® is being transferred to the Building Technologies' Technology Validation and Market Introduction subprogram. ENERGY STAR® expands consumer interest in energy efficient appliances, and updates appliance criteria, in consensus with industry. A major activity emphasis is the Home Performance ENERGY STAR®, a subactivity with the goal of creating market-based residential retrofit industries in select metropolitan areas.

Inventions and Innovations.....	**3,945**	**2,970**	**0**

This activity funds grants to independent inventors and small technology-based businesses. It provides assistance to small businesses and independent inventors to develop skills in technology commercialization. In accordance with Research and Development Investment Criteria regarding closeness to commercialization and potential public benefits, this activity is being discontinued in FY 2007. Technology development activities will continue in individual technology programs and in grants and activities funded through the State Energy Program.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technical/Program Management Support.....	**385**	**0**	**0**

This activity previously supported analysis and evaluations for the design of Gateway technical assistance, education and outreach efforts. It prepared program, strategic plans, and operating plans; feasibility studies and trade-off analysis; evaluation of the impact of new legislation on programs; analysis of energy issues pertinent to the R&D program; development of communication tools; identification of performance measures and methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management. This activity is being discontinued for the Gateway subprogram in FY 2007. Remaining analysis activities will be funded from within the Weatherization, SEP and Intergovernmental programs consistent with Energy and Water standard practice.

SBIR/STTR	**--**	**0**	**0**

In FY 2005, $411,000 and $8,000 were transferred to the SBIR and STTR programs respectively

Total, Gateway Deployment	**33,930**	**25,400**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Rebuild America	
Reduction reflects the transfer of this activity to the Building Technologies Program.....	-3,769
Energy Efficiency Information and Outreach	
The decrease in funding is due to the consolidation of former WIP efforts into the EERE Communication and Outreach Office	-346
Building Codes Training and Assistance	
OWIP does not request funding for this activity in FY 2007. States have developed sufficient expertise in this area, therefore this activity is being discontinued.....	-4,455

	FY 2007 vs. FY 2006 ($000)
Clean Cities	
Reduction reflects the transfer of activities to FreedomCAR and Vehicle Technologies Program	-7,920
ENERGY STAR®	
Activity transferred to the Building Technologies Program	-5,940
Inventions and Innovations	
Federal funding no longer requested. Technology development activities will continue in individual technology development programs and in grants and activities funded through the State Energy Program	-2,970
Technical/Program Management Support	
In FY 2007, technical program management support activities are funded as needed within the preceding programmatic budget lines, consistent with Energy and Water standard practice	0
Total Funding Change, Gateway Deployment	**-25,400**

International Renewable Energy Program

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
International Renewable Energy Program			
International Renewable Energy Program	4,464	406	2,473
Congressionally Directed, National Center for Energy Management and Building Technologies	1	0	0
Congressionally Directed, International Utility Electricity Partnership	1,984	3,465	0
Total, International Renewable Energy Program	6,449	3,871	2,473

Description

The International Renewable Energy Program (IREP) promotes market transformation in international energy markets to increase the installation of domestically-developed (i.e., U.S.-manufactured) technologies. Specific activities include understanding local energy needs, raising awareness of renewable energy opportunities, delivering training and technical assistance to foreign energy decision-makers, and apprising them of opportunities related to their domestic energy markets. Additionally, the Department co-sponsors targeted renewable energy projects that advance United States energy technology and economic objectives. The results of these activities help to reduce both technical and non-technical barriers (e.g., financing, resources, tariffs, and local prohibitions) and increase the installation of renewable energy technologies.

Benefits

The IREP supports the program mission through technical assistance with National Laboratories and outside experts, helping meet specific commitments contained in bilateral and multilateral agreements. It provides technical support to the Clean Energy Technology Exports (CETE) Initiative for joint public/private cooperation to increase the export of U.S. products and services. It also provides support to the Asian Pacific Economic Cooperation (APEC) forum in order to help U.S. energy firms competing in markets abroad by working to implement a system of clear, open and transparent rules and procedures governing foreign investment. Level playing fields for U.S. companies overseas, and reduces barriers to investment in EERE technologies. U.S. climate-change policy is currently based upon voluntary action and incentives. A key enabler for voluntary action is the availability and cost-effectiveness of technologies and products that can substitute for current ones, but with significantly reduced GHG

emission characteristics. IREP activities directly support this goal and the President's stated commitment to support "growth that provides the resources for investment in clean technologies."[a]

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
International Renewable Energy Program	**4,464**	**406**	**2,473**

International Renewable Energy activities are conducted in partnership with foreign governments and companies that design and install renewable energy technologies – both foreign and domestic. All efforts are focused on advancing U.S. energy technology, energy security, and economic interests.

Congressionally Directed, National Center for Energy Management and Building Technologies	**1**	**0**	**0**

Activities funded under this Congressionally directed project were to address HVAC research needs and improve the efficiency, productivity, and security of the U.S. building stock by developing and disseminating synergistic and complementary solutions to energy management, indoor environment quality, and security concerns in new and existing buildings. No further funds are requested as resources have been reallocated to activities that better support the mission goals and objectives of the program.

Congressionally Directed, International Utility Electricity Partnership	**1,984**	**3,465**	**0**

Provides for the electric industry to partner with the developing world in voluntary greenhouse gas (GHG) reduction efforts. No further funds are requested as resources have been reallocated to activities that better support the mission goals and objectives of the program.

Total, International Renewable Energy Program	**6,449**	**3,871**	**2,473**

[a] Remarks by the President on Climate Change and Clean Air, National Oceanic and Atmospheric Administration, Silver Spring, Maryland February 14, 2002.

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
International Renewable Energy Program	
The IREP funding request supports core funding for promoting international deployment and use of energy efficient and renewable energy technologies.....	+2,067
Congressionally Directed, International Utility Electricity Partnership	
No funds are requested because activities are not closely aligned with the program's goal.....	-3,465
Total Funding Change, International Renewable Energy Program.....	**-1,398**

Tribal Energy Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Tribal Energy Activities			
Tribal Energy Activities	3,473	2,970	3,957
Congressionally Directed, Pyramid Lake Paiute Tribe Renewable Energy Park	992	0	0
Congressionally Directed, Council of Renewable Energy Resource Tribes, (CERT)	992	990	0
Total, Tribal Energy Activities	5,457	3,960	3,957

Description

Tribal Energy Activities builds partnerships with Tribal Governments to help assess Native American energy needs for residential, commercial and industrial uses. Additionally, it provides technical and financial assistance in energy efficiency and renewable energy development. The activities provide the means for Tribal leaders to make knowledgeable choices regarding their Tribes' energy future, through resource assessments, workshops, training, and energy plan development assistance. Energy projects are competitively awarded on a cost-shared basis for Native American Tribes to implement comprehensive energy plans that incorporate energy efficiency and renewable energy technologies and resources. As a result, projects are underway for the development of renewable energy resources on Tribal lands.

Benefits

Tribal Energy Activities contribute to WIP's mission by building partnerships with Tribal Governments to help assess Native American energy needs for residential, commercial and industrial uses employing EERE technologies. Tribal Energy Activities develops implements and manages technical and financial assistance projects to promote energy, environmental and economic development policy objectives for Native Americans.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Tribal Energy Activities	**3,473**	**2,970**	**3,957**

The Tribal Energy activity supports the development of capacity within the 565 Federally recognized

Native American Tribes to assess and meet their energy needs both for residential and economic development. Tribal Energy activities support cooperative agreements and build partnerships with Tribal Governments, as other DOE programs do with States, to foster information exchange and support technical and financial assistance projects. Tribal Energy activities provide financial and technical assistance to Tribes for:

- Strategic Planning
- Energy Options Analysis
- Organizational Development
- Capacity Building
- Feasibility Studies

Economic development is an ongoing challenge facing Tribal leaders and access to energy is a particular problem in this regard. Because of their remote locations and distance from, or access to, transmission and distribution systems, many Tribes have an inadequate energy service, which inhibits economic development efforts and programs to promote rural education, public health, and safety. In many ways, the energy problems faced by the Tribes resemble the energy problems faced by developing nations and remote populations around the world.

In FY 2007, the Tribal Energy activities will continue to address the energy concerns of Tribal Governments with the understanding that each may be at different locations on the "development spectrum" from needing assistance with resource analysis to seeking leveraged funding for a viable project. Thus, the Tribal Energy activities will include the issuance of competitive solicitations to meet program objectives. These activities will prepare the foundational work for private sector investment leading to an expected 100 MW of generation installed by 2010.

These solicitations will build on those undertaken in FY 2004 and FY 2005 to facilitate a "project pipeline" in Indian Country which will move projects from resource assessment to application Prior year efforts will be closed out where appropriate. Efforts will be undertaken with Tribal Colleges and Universities to increase the awareness of the potential for renewable technologies among Tribal students and to prepare them for emerging jobs in renewable energy enterprises.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed, Pyramid Lake Paiute Tribe Renewable Energy Park	**992**	**0**	**0**
Provided for an assessment of solar, wind and geothermal resources.			
Congressionally Directed, Tribal Energy/Council of Renewable Energy Resource Tribes (CERT)	**992**	**990**	**0**
Provided technical expertise and training for Native Americans in renewable energy resources development.			
Total, Tribal Energy Activities	**5,457**	**3,960**	**3,957**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Tribal Energy Activities	
Increase funding to provide additional support and technical expertise and training for Native Americans in renewable energy resource development	+987
Congressionally Directed, Pyramid Lake Paiute Tribe Renewable Energy Park	
No change	0
Congressionally Directed, Council of Renewable Energy Resource Tribes, (CERT)	
No funds are requested because activities are not closely aligned with the program's goal	-990
Total Funding Change, Tribal Energy Activities	**-3**

Renewable Energy Production Incentive (REPI)

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Renewable Energy Production Incentive.....	4,960	4,950	4,946
Total, Renewable Energy Production Incentive	4,960	4,950	4,946

Description

REPI provides financial incentive payments to publicly owned utilities, not-for-profit electric cooperatives, and tribal governments and native corporations that own and operate qualifying facilities generating renewable electricity.

Benefits

REPI supports the WIP goal to promote increases in the generation and utilization of electricity from renewable energy sources and to further the advances of renewable energy technologies.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Renewable Energy Production Incentive.....	**4,960**	**4,950**	**4,946**

REPI will review applications and distribute financial incentive payments for electricity produced and sold by qualifying renewable energy generation facilities owned by publicly owned utilities, not-for profit electric cooperatives, and tribal governments and native corporations, as allowed under Section 202 of the Energy Policy Act of 2005.

Total, Renewable Energy Production Incentive.....	**4,960**	**4,950**	**4,946**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No significant change	-4
Total Funding Change, Renewable Energy Production Incentive	**-4**

Program Direction

Funding Profile by Category

	(dollars in thousands/whole FTEs)		
	FY 2005	FY 2006	FY 2007
Headquarters			
Salaries and Benefits	41,937	43,187	40,948
Travel	2,221	2,093	2,159
Support Services	9,973	7,450	8,429
Other Related Expenses	6,675	6,579	6,894
Total, Headquarters	60,806	59,309	58,430
Full Time Equivalents	308	333	344
Golden Field/Project Management Center			
Salaries and Benefits	10,249	10,783	17,900
Travel	340	396	928
Support Services	1,540	1,333	2,925
Other Related Expenses	1,863	2,182	4,585
Total, Golden Field Office/Project Management Center	13,992	14,694	26,338
Full Time Equivalents	83	91	160
National Energy Technology Laboratory/Project Management Center			
Salaries and Benefits	4,624	5,579	5,707
Travel	116	138	141
Support Services	2,105	261	267
Other Related Expenses	115	138	141
Total, National Energy Technology Laboratory	6,960	6,116	6,256
(Reimbursable Full Time Equivalents, non-add)[a]	(39)	(34)	(34)
Regional Offices			
Southeast			
Salaries and Benefits	2,365	2,390	0

[a] Non-EERE Employees

	(dollars in thousands/whole FTEs)		
	FY 2005	FY 2006	FY 2007
Travel	200	148	0
Support Services	273	272	0
Other Related Expenses	240	490	0
Total, Southeast	3,078	3,300	0
Full Time Equivalents	19	21	0
Northeast			
Salaries and Benefits	1,791	1,848	0
Travel	180	139	0
Support Services	325	331	0
Other Related Expenses	379	651	0
Total, Northeast	2,675	2,969	0
Full Time Equivalents	16	18	0
Midwest			
Salaries and Benefits	1,872	1,819	0
Travel	200	99	0
Support Services	330	356	0
Other Related Expenses	148	540	0
Total, Midwest	2,550	2,814	0
Full Time Equivalents	18	20	0
Central			
Salaries and Benefits	2,540	2,258	0
Travel	235	175	0
Support Services	321	413	0
Other Related Expenses	75	409	0
Total, Central	3,171	3,255	0
Full Time Equivalents	19	21	0
Mid-Atlantic			
Salaries and Benefits	1,748	2,075	0
Travel	112	99	0

	(dollars in thousands/whole FTEs)		
	FY 2005	FY 2006	FY 2007
Support Services	321	393	0
Other Related Expenses	218	472	0
Total, Mid-Atlantic	2,399	3,039	0
Full Time Equivalents	16	18	0
Western			
Salaries and Benefits	1,887	2,098	0
Travel	188	178	0
Support Services	276	334	0
Other Related Expenses	233	423	0
Total, Western	2,584	3,033	0
Full Time Equivalents	19	21	0
Total Program Direction			
Salaries and Benefits	69,013	72,037	64,555
Travel	3,792	3,465	3,228
Support Services	15,464	11,143	11,621
Other Related Expenses	9,946	11,884	11,620
Total, Program Direction	98,215	98,529	91,024
Total, Full Time Equivalents	498	543	504
(Total Reimbursable Full Time Equivalents, non-add)[a]	(39)	(34)	(34)

Public Law Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Supply and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 95-619, "National Energy Supply Policy Act" (NECPA) (1978)
P.L. 96-294, "Energy Security Act" (1980)
P.L.102-486, "Energy Policy Act of 1992"
P.L. 109-190, “Energy Policy Act” (2005)

[a] Non-EERE Employees

Mission

The mission of the Office of Energy Efficiency and Renewable Energy is to strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that promote energy efficiency and productivity, bring clean, reliable, and affordable energy technologies to the marketplace, and make a difference in the everyday lives of Americans by enhancing their energy choices and quality of life. Viewing each of our technology development programs from a systems perspective, it is the EERE responsibility to direct a complex network of National Laboratories, industrial partners, state and local governments, universities and private companies to facilitate the passage of bench research into the market place.

Three years ago, EERE implemented a radically new business model to reinvent the way it conducted its business. The thrust of this business strategy was to put the focus on core technology programs, emphasize and measure for results, create a project management ethic and capability, and accomplish all of this with the most efficient business systems. This budget reduces our FTE request by approximately 39 FTEs. This is accomplished by establishing a fully functional EERE Project Management Center (PMC) at the Golden Field Office, and by developing the one, best way of doing business for all of EERE.

Program Direction provides for the Federal staffing resources and associated costs for supporting the management and oversight of that complex network of National Laboratories, industrial partners, state and local governments, universities and private companies. It funds staff, travel, policy review and coordination, infrastructure and construction management, contracts for security and administrative support at the Golden Field Office (GO), support services for budget formulation and execution, development of corporate management IT systems, IT hardware and other equipment and supplies, and general office and human capital resources management.

Program Direction funding helps to advance the Department's energy efficiency and renewable goals and objectives as well as implementation of the President's Management Agenda. Since EERE's reorganization in 2002, supporting business management functions are now centralized to eliminate overlap of responsibilities and reinforce program customer focus. The new EERE business operations model is removing stovepiped and fragmented administrative practices and expenses; eliminating organizational layers; enhancing competitive sourcing, fiscal accountability and information technology services through one central organization for business systems and processes; empowering program managers with accountability by focusing their attention on results rather than bureaucratic processes; integrating performance planning and budgeting; and providing the Assistant Secretary for Energy Efficiency and Renewable Energy with more direct accessibility for improved program and business oversight. EERE's efforts in these respects have been recognized as exemplary by the Department and are being emulated by other components of DOE.

As stated in the Departmental Strategic Plan, DOE's Strategic and General Goals will be accomplished not only through the efforts of the major program offices in the Department but with additional effort from offices which support the programs in carrying out the mission. EERE performs critical functions which directly support the mission of the Department. These functions include activities that are performed in three office groups:

- Headquarters, where policy and programmatic development and technical and budget planning are centered, and where the first stages of program execution occur;
- GO, which provides field management of the National Renewable Energy Laboratory and is one element of EERE's PMC to handle the later stages of program execution; and
- National Energy Technology Laboratory (NETL), which serves as a unit of EERE's PMC on a reimbursable-services basis for program execution through a Memorandum of Agreement (MOA) between the Assistant Secretary for Energy Efficiency and Renewable Energy and the Assistant Secretary for Fossil Energy.

EERE is consolidating six Regional Offices (RO) in FY 2006 and is transferring and consolidating their business functions to the PMC.

Headquarters

EERE is organized around nine technology based programs: Hydrogen Technology, Biomass and Biorefinery Systems R&D, Solar Energy, Wind Energy, Building Technologies, Federal Energy Management, Vehicles Technologies, Weatherization and Intergovernmental Activities and Industrial Technologies. The FY 2007 budget eliminates the Geothermal Technology Program and realigns portions of the Weatherization and Intergovernmental Activities (WIP) office. These program managers are led by the Deputy Assistant Secretary for Technology Development.

In the case of the Geothermal Program, market acceptance had reached the point where cost/benefit analysis indicated that further work on the part of the Government is not prudent. The existing Geothermal workforce will be reassigned to other EERE expanding programs.

Consistent with Congressional direction, the EERE Distributed Energy Resources Program (4 FTE and $2 million) was transferred to the DOE Office of Electricity Delivery and Energy Reliability in FY 2006.

A portion of OWIP has been realigned by functions. Where they directly impact a specific technology, former Gateway Deployment activities have been realigned to that program, e.g., Rebuild America to Building Technologies and Clean Cities to the FreedomCAR and Vehicles Technology. This refocus of our deployment activities reinforces the systems approach to technology development and provides new leadership for state grant activities.

Headquarters program personnel are responsible for the following functions:

1) Defining the program goals and policies;
2) Developing Strategic, Multi-year and Annual Operating Plans to achieve the goals;
3) Developing and defending the budget necessary to execute the plan; and
4) Overseeing the technical progress of the program and feeding back lessons learned to re-baseline program activities.

The EERE Technology Programs are supported by the Deputy Assistant Secretary for Business Administration consisting of the Offices of Program Execution Support, Planning, Budget and Analysis,

and Information and Business Management Systems. Together, with the EERE PMC, these organizations provide a centralized provision of business management services to implement the programs. These organizations lead the EERE President's Management Agenda initiatives for Human Capital Management, E-Government, Budget and Performance Integration, Improved Financial Management, R&D Investment Criteria and Competitive Outsourcing.

In response to outside recommendations (e.g. the National Academy of Public Administration - NAPA) and its own continuing self assessments, EERE has established a Management Action Plan for FY 2004-2006 to guide reforms that have been addressing identified shortcomings, including:

- Continuing to implement our streamlined and integrated program and business operations model, which consolidated our work into eleven (and ultimately nine) technology development and deployment programs and centralized our business administration functions into a single EERE organization. Our work focused on culture change and consolidating the improvements already made;
- Continuing a formal Program Management Initiative begun in FY 2003, focused on training for all program managers. As a result, EERE intends to have a fully certified and trained program management corps;
- Integrating the Strategic Management System (SMS) with the best features of the existing EERE project management systems and with the evolving DOE I-Manage initiative to create the EERE Corporate Planning System (CPS), which will provide a unified corporate approach toward annual budget planning, program execution, and performance measurement across EERE. Program and financing information was migrated to the CPS in FY 2004, and all activities began using the system in FY 2005;
- Developing new standard operating procedures intended to reduce end-of-year uncosted balances;
- Implementing advance procurement planning and improved "work packaging" to reduce procurement and financial assistance "churning" due to administrative change orders and numerous very small funding actions;
- Implementing a workforce restructuring in FY 2004-2007 to achieve the most effective distribution of FTEs across EERE's programs, based on a Workforce Analysis performed in FY 2004, in order to provide effective oversight and manage towards performance goals;
- Developing stronger management oversight on the use of support service contracts, and combining that with the workforce analysis to develop a strategy for optimally and flexibly deploying support service resources for maximum benefit; and
- Working with the DOE Chief Financial Officer (CFO), the Office of Management and Budget (OMB), and the Congress to better convey and account for expenditures of program direction and policy analysis costs.

The Headquarters program direction budget supports staff, facilities, and contracted services in four functional areas that are essential for productive operation of the EERE enterprise:

- Program Management. Supplies the critical expertise needed within the R&D and deployment programs at Headquarters to organize, plan, direct and monitor RD&D activities associated with Energy Supply and Conservation's nine programs;

- Program Execution Support (PES). Provides a full spectrum of program execution business activities for EERE managers from a single integrated organization. These services include all actions associated with program execution; acquisition, reporting and analysis steps that make appropriation intentions reality; support to the Office of Planning, Budget, and Analysis (PBA) for budget execution activities; capital resources development, travel, training, operations and logistics, security activities (except cyber security); and providing administrative management policy direction and support to Program Managers, GO and RO (through FY 2006);

- Planning, Budget, and Analysis (PBA). PBA leads EERE's activities in budget formulation, defense, and execution; strategic and portfolio planning and assessment; performance management; and program evaluation. It coordinates development of EERE's budget requests, including integration of performance measures and updates of the EERE Strategic Plan. PBA tracks, reports, and analyzes the allocation of appropriated funding, and performs the initial steps in budget execution, including coordinating the development and implementation of Approved Funding Plans. PBA manages development of EERE's annual Government Performance and Results Act (GPRA) metrics and EERE's performance measurement framework. PBA also coordinates the Planning, Analysis, and Evaluation activities required for EERE's Strategic Management System and for consistent implementation of the President's Management Agenda (PMA) and R&D Investment Criteria, and manages EERE's reporting of PMA performance and progress through OMB's Program Assessment Rating Tool (PART). PBA directs and manages the activities funded under the Planning, Analysis, and Evaluation subprogram line item. PBA also provides analysis for the statutorily-required biennial National Energy Policy report and similar government-wide policy efforts; and

- Information and Business Management Systems (IBMS). Develops and manages corporate level information and business management systems to ensure consistent, efficient and effective business policies and practices for EERE's Headquarters and field organizations. These information systems serve all of the business activities associated with planning and budget formulation, program and project management, budget execution, analysis, and evaluation. This function also provides support to other DOE headquarters business systems (such as the I-MANAGE, ePME, and E-Gov initiatives) and provides support to (but does not directly fund) IT activities at EERE's GO and RO; provides all headquarters information technology and associated cyber security; addresses management reviews; coordinates environmental safety and health and continuity-of-operations issues; coordinates audit activities and National Laboratory evaluations; and identifies field facility needs, reviews construction plans, and oversees the construction decision and approval process at headquarters.

EERE PMC

The FY 2007 budget provides for the fully developed EERE PMC. The PMC is a virtual organization consisting of project management staff at the GO and the Office of Fossil Energy's NETL. This year's biggest management efficiency consolidates the activities of the six former ROs into the PMC to establish a more seamless provision of full-service project management services.

The PMC was created to address the following EERE project management deficiencies:

1) Fragmented project implementation with little opportunity for program integration;
2) High service and transaction costs;
3) Inefficient and inappropriate use of DOE's National Laboratories for subcontract project management difficulty in making corporate-level EERE decisions using data coming from multiple sources and systems; and
4) Difficulties for EERE and its customers caused by multiple procurement and project management approaches.

With this budget, the PMC is fully funded and staffed to implement the EERE budget. This will have the following results:

1) EERE now has a full service project management implementation capability with all the essential disciplines for field oversight, technical, procurement, finance, and legal;
2) Common project management business practices are being employed across all of EERE;
3) EERE now has contracting officer and contracting officer representative capabilities covering all of its work; and
4) The combined resources of GO, NETL and the former ROs provide a seamless way of conducting business to the public.

The PMC personnel are responsible for providing an integrated, multi-disciplinary function and structured approach that ensures that all program implementation activities are defined, initiated, and carried out successfully in pursuit of EERE program goals and objectives.

GO/PMC

The GO budgets for 160 FTE's in FY 2007 – an increase of 69 over FY 2006 due to the consolidation of the ROs and the merger of their business functions at the PMC. GO serves as one of the two PMC units under EERE's Project Management Initiative, the other being the NETL. As a PMC, GO/NETL provides dedicated Contracting Officers (COs) and Contracting Officer Representatives (CORs) to perform field project management of R&D partnerships. The staff of COs and CORs is supported by approximately 20 Technical Monitors hired under a support-services contract. GO also supports EERE Energy Supply and Conservation efforts through administration of the National Renewable Energy Laboratory M&O contract, and serves as a field coordinator and Federal Project Managers of facility planning and construction. GO provides management support for approximately 950 agreements in nearly every State and in several other nations to support the following programs:

- Hydrogen Technology;
- Solar Energy;
- Federal Energy Management Program;
- Biomass and Biorefinery Systems R&D;
- Weatherization and Intergovernmental Activities;
- Industrial Technologies; and
- Wind Energy

Key activities include:

- Administering the management and operating (M&O) contract for the National Renewable Energy Laboratory (NREL);
- Managing the Federal Energy Management Program (FEMP) Super Energy Savings Performance Contracts ("Super-ESPCs") and serving as the focal point for FEMP finance and procurement activities;
- Partnering with industry and academia in joint R&D projects to further develop and facilitate delivery of applied R&D, to include work with Hydrogen Technology;
- Implementing Memoranda of Understanding between DOE and other Federal agencies, such as the Environmental Protection Agency, General Services Administration, Federal Emergency Management Agency (FEMA), and the Department of the Interior (DOI), to implement joint projects where the whole portfolio of EERE technologies is relevant;
- Providing EERE's national program managers at Headquarters with customer feedback on how to make their programs more effective and efficient; and
- Supporting and helping deliver special initiatives of the President, Secretary, and Assistant Secretary.

NETL/PMC

The NETL serves as one of two PMC units for EERE; the other is the GO. NETL is primarily an Office of Fossil Energy facility, and it provides project management and financial services to other elements of DOE on a reimbursable basis. In FY 2004, EERE and FE signed a Memorandum of Agreement that formalized this reimbursable arrangement.

NETL provides procurement, financial assistance, and project management services to the following programs:

- Vehicle Technologies;
- Weatherization and Intergovernmental Activities;
- Building Technologies;
- Federal Energy Management Program (Project Financing activity only).

As one unit of EERE's PMC, NETL provides dedicated COs and CORs to perform field project management of R&D partnerships. The staff of COs and CORs are supported by in-house procurement and legal specialists, along with other services as needed.

While EERE and NETL gain experience with the PMC business model, the exact costs of support will continue to be refined, but the table below shows the funds programmed in FY 2005 and the estimated cost allocations in FY 2006 and FY 2007.

	(dollars in thousands)		
Programs Served by NETL	FY 2005	FY 2006	FY 2007
Biomass and Biorefinery Systems R&D	320	0	0
Building Technologies	1,674	2,065	2,236
Distributed Energy Resources	1,098	0	0
Federal Energy Management Program	214	216	234
Industrial Technologies	548	336	0
Vehicle Technologies	1,496	1,688	1,826
Weatherization and Intergovernmental Activities	1,610	1,811	1,960
Total, NETL funding from Program Direction	6,960	6,116	6,256
(Total, Reimbursable Full Time Equivalents, non-add)[a]	(39)	(34)	(34)

Consolidated, previous RO functions which will now be performed at both PMC locations (GO and NETL) include:

- Administering EERE's principal technology deployment grant programs, including the Weatherization Assistance Program and the State Energy Program;
- Delivering EERE's principal technical assistance programs, including Clean Cities, Rebuild America, and the Federal Energy Management Program;
- Serving as EERE's liaison to state energy offices, other state agencies, regional organizations of the National Governors Association, and other stakeholders involved in energy and environmental quality issues;
- Organizing over 150 meetings, workshops and conferences per year across all EERE technologies, and providing logistical support and briefing materials for high-profile/VIP events and visits for senior EERE and DOE management;
- Creating local, state, and regional partnerships and leveraging local, state, and regional resources to maximize the impact of EERE's technologies and programs; and
- Helping EERE's end use sectors deliver their programs to state and local stakeholders.

[a] Non-EERE Employees

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Salaries and Benefits	**69,013**	**72,037**	**64,555**

The DOE Headquarters component, consisting of 344 FTEs, is responsible for the development of policies, strategic plans and related guidance to energy efficiency and renewable energy and hydrogen program offices; the evaluation of program performance; the formulation, defense and execution of renewable and energy efficiency budgets; as well as technology advancement and outreach with the public and stakeholders regarding policies, funding, program performance, and related issues.

EERE Program Direction supports a GO personnel level of 160 FTEs. This maintains a centralized EERE PMC at GO, with a particular emphasis on increasing the program execution support for the President's Hydrogen Fuel Initiative.

EERE Program Direction also supports a NETL EERE personnel level of approximately 34 reimbursable FTEs.

Current and future staff performance is measured by responsiveness to National Energy Policy goals and objectives; implementation of the President's R&D Investment Criteria for priority decision making; continued improvement in the utilization of Federal personnel, travel, and support service activities; increases in competitive and cost-sharing procurement awards; extending the use of more efficient electronic government information systems; improving financial performance, particularly in reducing uncosted balances; and further integration of program metrics into resource allocation processes.

Travel	**3,792**	**3,465**	**3,228**

The closure and consolidation of the Regional Office functions at the GO/PMC thereby decreases the requirement for travel.

The FY 2007 request provides travel funds for 504 FTEs, including the enhanced staff of project managers at the EERE PMC.

Support Services	**15,464**	**11,143**	**11,621**

Includes funding for support service contractors, including IT (LAN and PC) support and e-mail service; cross-cutting planning, analysis, and evaluation; and general Assistant Secretary initiatives that support all renewable and energy efficiency programs.

By Congressional direction, general management support services are funded within this line-item. Support for technical analyses, road-mapping, market studies, etc., is funded within the individual R&D Programs. The request provides support services needed for business management systems development and support for I-MANAGE, ePME, safety and health support; facility safeguards and security; and computer hardware and software installation, configuration, and maintenance activities.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

The request for FY 2007 continues to provide full funding for landlord services at the GO and for IT services and local-area network operations. It would also permit some additional program and project management activities to be directly funded and managed through the GO, rather than having the work subcontracted through the National Laboratories, by providing assistance in activities that are not "inherently Federal," such as preparation of draft administrative paperwork, technical editing of contract and technical review documents and summary reports to GO and HQ management, funding of outside technical reviewers, and routine status tracking of contracts, outreach and communications, procurement, and financial and human capital resources management. It will provide administrative support for technical symposia, and necessary data-entry and analytical graphics services. The request also provides staff training and funding for Defense Contract Audit Agency audits.

These funds also include the estimated portion of the reimbursable work at NETL that will be applied to support services for administrative and editorial assistance to the NETL project managers.

Other Related Expenses.....	**9,946**	**11,884**	**11,620**

This activity encompasses the Headquarters Working Capital Fund (WCF), IT equipment purchases and maintenance (such as a 3-year replacement cycle for desk-top PCs) at both Headquarters and the GO, contractual services associated with landlord support of the GO, DCAA audits, and software purchases and licenses. Within the Working Capital Fund, rent is the largest component, but the WCF also includes telephones, copying, headquarters network operations, payroll and other employee services, printing, etc. The decrease in FY 2007 reflects the consolidation of the Regional Offices and the merger of their business activities at the PMC.

The FY 2007 request will support:

- $6,779,000 for Headquarters Working Capital Fund (WCF) activities such as administrative services, rent, automated office support, contract close out, telephone services, postage, printing, graphics, and similar services; and
- $1,167,000 for rent at the GO PMC unit.

$1,663,000 for Other Related Expenses, including computer equipment and support, utilities, postage, printing, graphics, administrative expenses, and security at GO and the RO, plus Worker's Compensation, software licenses, publications, and conferences, plus directly reimbursable Other Related Expenses at NETL.

Total, Program Direction	**98,215**	**98,529**	**91,024**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
Salaries and Benefits	
Decrease in salaries and benefits are due to personnel savings associated with the anticipated net attrition of approximately 39 FTEs in FY 2006 due to EERE Regional Office consolidation	-7,482
Travel	
Decrease in travel is due to savings associated with the closure of the ROs in FY 2006, and the consolidation of those activities at the PMC	-237
Support Services	
Support services increase due to increasing service costs	+478
Other Related Expenses	
Decrease in Other Related expenses is due to savings associated with the consolidation of the RO in FY 2006, and the merger of those activities at the PMC	-264
Total Funding Change, Program Direction	**-7,505**

Support Services by Category

(dollars in thousands)

	FY 2005	FY 2006	FY 2007	$ Change	% Change
Technical Support					
Development of Specifications	2,004	0	0	0	0.0%
Economic and Environmental Analyses	50	50	50	0	0.0%
Surveys or Reviews of Technical Operations	40	40	40	0	0.0%
Total, Technical Support	2,094	90	90	0	0.0%
Management Support					
Analyses of Workload and Work Flow	150	0	0	0	0.0%
Directives/Management Studies	200	125	125	0	0.0%
Automated Data Processing	2,751	2,767	2,905	+138	+5.0%
Preparation of Program Plans	200	175	175	0	0.0%

	(dollars in thousands)				
	FY 2005	FY 2006	FY 2007	$ Change	% Change
Training and Education	621	550	500	-50	-9.1%
Analyses of DOE Management Processes	170	95	95	0	0.0%
Reports and Analyses Management and General Administrative Services	9,278	7,341	7,731	+390	+5.3%
Total, Management Support	13,370	11,053	11,531	+478	+4.3%
Total, Support Services	15,464	11,143	11,621	+478	+4.3%

Other Related Expenses by Category

	(dollars in thousands)				
	FY 2005	FY 2006	FY 2007	$ Change	% Change
Other Related Expenses					
Rent to GSA	3,057	3,152	1,441	-1,711	-54.3%
Rent to Others	106	80	80	0	0.0%
Communications, Utilities, Miscellaneous	301	602	916	+314	+52.2%
Printing and Reproduction	30	260	380	+120	+46.2%
Other Services	40	560	620	+60	+10.7%
Operation and Maintenance of Equipment	25	340	340	0	0.0%
Supplies and Materials	79	216	350	+134	+62.0%
Equipment	48	122	350	+228	+186.9%
Working Capital Fund	6,260	6,552	7,143	+591	+9.0%
Total, Other Related Expenses	9,946	11,884	11,620	-264	-2.2%

Program Support

Funding Profile by Subprogram

(dollars in thousands)

	FY 2005 Current Appropriation	FY 2006 Original Appropriation	FY 2006 Adjustments[a]	FY 2006 Current Appropriation	FY 2007 Request
Program Support					
Planning, Analysis and Evaluation.....	4,935	8,406	-85	8,321	7,418
Technology Advancement and Outreach.....	1,530	1,550	-15	1,535	3,512
Congressionally Directed Activities....	10,372	3,500	-35	3,465	0
Total, Program Support	16,837	13,456	-135	13,321	10,930

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 109-190, “Energy Policy Act” (2005)

Mission

The mission of the program support function is to enable management at all levels to achieve departmental goals. This is done by providing timely, high quality, independent, credible, and usable information to inform decisions for portfolio investment and market adoption of EERE based processes, individual technologies, and energy systems. The EERE offices use that information to guide and provide direct support to satisfy both corporate and program needs resulting in best-in-class strategic management system products which enable EERE to meet the requirements of the President’s Management Agenda and to effectively achieve its goals.

Benefits

The Planning, Analysis, and Evaluation subprogram establishes and maintains the methods, information base, and standards for planning and policy analysis, budget formulation, and performance management and evaluation. The subprogram provides direct expertise and funds contracts that provide technical, economic, and policy analyses and support for strategic and multi-year planning, performance and budget integration, Government Performance and Results Act (GPRA) benefit estimation for all DOE Renewable and Energy Efficiency (EERE) programs, and foundational understanding of current and future energy and technology markets. Each of these activities is central to achieving the goals of the President’s Management Agenda, each implements the requirements of the GPRA, and each is also key to effective management of the DOE, Energy, Science, and Environmental (ESE), and EERE programs and to informing decisions on the optimal allocation of resources among the programs. Each provides key information that enables the technology programs to select portfolios and pathways that will result in the benefits of our national energy goals.

[a] Includes a rescission of $135,000 in accordance with P.L. 109-148, the Emergency Supplemental Appropriations to address Hurricanes in the Gulf of Mexico, and Pandemic Influenza, 2005.

The Technology Advancement and Outreach subprogram (TAO) manages and creates regular, consistent outreach mechanisms and products that keep EERE stakeholders advised of corporate management issues affecting EERE operations. The TAO coordinates and manages efforts to make all of the other programs' work – their results and their potential – known to the public. This contributes both to the EERE programs' deployment goals and to Administration E-government initiatives to make government more transparent and accessible to the public.

The Office maintains resources that provide information on request to the general public and other stakeholders through web based and toll free telephone services. Forming partnerships with industry, state and local governments, and non-government organizations (NGOs), the Office produces and disseminates documents in both English and Spanish to educate homeowners on energy saving techniques and technologies.

Planning, Analysis and Evaluation

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Planning, Analysis and Evaluation	4,935	8,321	7,418
Total, Planning, Analysis and Evaluation	4,935	8,321	7,418

Description

Planning, Analysis, and Evaluation (PAE) will collect, analyze, and integrate economic, market, and technology characterization data and develop cross-cutting technological and economic models and forecasts, providing the analytic basis for strategic planning, benefits estimation, and corporate portfolio analysis at DOE, ESE, EERE and technology program levels. In addition, PAE funds development of enhanced planning, analytical, and evaluation methodologies and tools. In support of the Government Performance and Results Act (GPRA) and EERE's own strategic planning, PAE assesses the market and economic impact EERE's energy-efficiency and renewable energy technology portfolio might have, and the potential energy, economic, environmental, and social benefits that would result.

Both renewable and efficiency technologies have broad impacts across energy markets. Because of these market interactions, it is necessary to analyze the impacts of EERE investments in the context of EERE's overall portfolio and both energy supply and demand markets. For example, improvements in building efficiency will reduce the demand for electricity, and, as a result, affect the market for wind energy. Likewise, improvements in wind technologies will reduce the demand for natural gas in electricity markets, making additional natural gas available for use in industrial cogeneration or hydrogen production. The integrated approach used by EERE to analyze program market impacts provides the context necessary to ensure that these interactions are taken into account; improves consistency in assessing technology choices; provides a more realistic picture of impacts and promotes better understanding of the synergies and competition across EERE's portfolio.

These analyses are essential for program planning, prioritization, management and inform EERE’s allocation decisions. A solid analytical foundation is basic to understanding the potential for increasing the penetration of energy efficient and renewable energy technologies, and for achieving the correct balance and direction of programmatic activities. In addition, analysis and evaluation activities are required to ensure continued program alignment with the goals of the National Energy Policy (NEP) and the President's Management Agenda (particularly Budget and Performance Integration and the PART/RDIC components), and to properly explain the budgets and potential benefits of EERE's programs.

EERE maintains strong capabilities in data analysis and model development to ensure that decisions regarding program direction and resource allocation are based upon common assumptions guided by the best possible information at the program, EERE corporate, and DOE Applied Energy R&D levels. Analytical capabilities and supporting databases are continually refined and strengthened to improve the information available for program guidance decisions and to better evaluate the energy, economic, and

environmental impacts of programmatic alternatives. An Office of Planning, Analysis and Evaluation (PAE) multiyear plan is under development to improve EERE's evaluation, planning, and analytical capabilities. PAE is supporting and building upon the benefits framework developed by the National Research Council (NRC) as one of the organizing principles for developing and implementing EERE's analytical agenda.

Improving the ability of programs to estimate potential benefits is an integral component of the Administration's R&D Investment Criteria initiative. The programs continue to work toward improved transparency in describing assumptions, methods, sensitivities, and uncertainties, and toward improved consistency in assumptions, modeling procedures and scenario analyses.

Benefits

The key benefits are broader and better-quality information to support management decisions at the program and corporate levels. Specifically, the Planning, Analysis, and Evaluation subprogram establishes and maintains the EERE-wide standards for planning and policy analysis, budget formulation, budget execution, and performance management and evaluation. The subprogram funds contracts that provide technical, economic, and policy analyses and support for strategic and multi-year planning, performance and budget integration, GPRA benefit estimation for all EERE programs, and foundational understanding of current and projected energy markets. Each of these activities is central to the goals of the President's Management Agenda, each implements the requirements of the Government Performance and Results Act, and each is also key to effective management of the EERE programs and to deciding on the optimal allocation of resources among the programs.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Planning, Analysis and Evaluation	**4,935**	**8,321**	**7,418**

EERE-wide Planning, Analysis and Evaluation activities provide a unified approach toward planning, budget formulation, and evaluation at both the individual program and all DOE corporate levels. These PAE activities include the development and use of both programmatic and external economic, market, and technology characterization data to develop cross-cutting technological and economic models and forecasts, providing the analytic basis for strategic planning, benefits estimation, and portfolio analysis at the program and corporate level. This provides EERE with the capability of meeting the analysis and reporting requirements of the Government Performance and Results Act; the President's Management Agenda (PMA); OMB's Program Assessment and Rating Tool and R&D Investment Criteria; and EERE's own strategic planning in a consistent way across programs and within the DOE.

Activities include development of enhanced planning, analytical, and evaluation methodologies and tools; benefits analyses based upon the program and the integrated EERE portfolio; and the potential energy, economic, environmental, and social benefits that would result. These benefits estimates provide a consistent representation of the benefits likely to result from the budget request. EERE is also

working with other applied DOE R&D programs to improve consistency in the methods and assumptions used to estimate benefits. The aim is to improve comparability to inform budget decisions across the Department's energy technology portfolio.

In addition, the development and use of a portfolio approach helps align program and corporate investments with energy policies, needs, and uncertainties. The crosscutting PAE activity also develops program performance and evaluation tools and methods that support the program in the corporate context and are routinely used to manage both program and corporate priorities. As in FY 2006, the investments in FY 2007 for corporate analysis and portfolio decision-making are broken out under this heading to clearly and transparently identify the PAE costs.

Funding is used for: technical and strategic and program management guidance, quality control, integration, reports, and activities including strategic and operating plans; support for multi-year planning; evaluations of the impact of Federal, state and local investment, legislation, and regulations on R&D programs and projects for deployment; assessing the nature and magnitude of barriers to renewable energy and energy efficiency; analysis of changes in market trends; identification and application of evaluation and performance methodologies (including the GPRA and OMB's Program Assessment Rating Tool (PART) and the Research and Development Investment Criteria (RDIC)); peer reviews of R&D programs and program portfolios collection, analysis, and integration of economic, market, and technology characterization data and development of cross-cutting technological and economic models and forecasts, providing the analytic basis for strategic planning, benefits estimation, and corporate portfolio analysis, and data collection to assess program and project performance, milestones, efficiency, and impacts on accomplishing the Department's mission).

The FY 2007 request for this crosscutting activity is slightly less than FY 2006. This budget line supports the development, interpretation, and dissemination of the basic data and economic and benefits models required to implement energy policy and manage and evaluate renewable and energy efficiency programs. It also funds analyses related to the biennial National Energy Plan required by the Department's Organization Act, and reviews technology commercialization successes and failures to quantify retrospective benefits.

Recent emphasis on GPRA and the President's Management Agenda, including the Office of Management and Budget's "Program Assessment Rating Tool" and "Research and Development Investment Criteria," and a Congressionally-supported National Research Council study, requires a greater effort to project benefits, assess past performance and benefits, anticipate future markets, and provide a more solid integration of analysis tools and products across the EERE program portfolio. As a part of the EERE FY 2005 budget submission, this budget line supported the preliminary work to extend the analysis timeframe to 2050 in order to address longer-term portions of the EERE portfolio, and has begun work on indicators related to energy security.

With this budget submission, EERE has extended its analysis to address at least two potential future energy scenarios (developed in conjunction with the Office of Fossil Energy) to assess how well EERE's portfolio prepares the Nation for a broader range of possible future energy needs. Funding and

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007

analytical resources have been redirected towards additional priority analytical needs, including development of: common EERE approaches to assessing and managing program performance risk; an enhanced ability to model hydrogen, biomass, and other changes in energy markets resultant from EERE's portfolio; an assessment of retrospective benefits; and a more standardized approach to program planning and evaluation.

During FY 2007, PBA expects to develop final FY 2008 benefit estimates, and preliminary FY 2009 estimates; provide analysis of program options for the FY 2009 budget; update retrospective benefit estimates; and provide analytical support for EERE and DOE level strategic planning. Capacity improvements scheduled for FY 2007 include refinement of formal measures of local air quality and energy reliability improvements; and refinement of standard methods for assessing program risk.

Total, Planning, Analysis and Evaluation	**4,935**	**8,321**	**7,418**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The decrease is due to efficiencies gained by the consolidation of analysis efforts in FY 2007	-903
Total Funding Change, Planning, Analysis and Evaluation	**-903**

Technology Advancement and Outreach

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Advancement and Outreach	1,530	1,535	3,512
Total, Technology Advancement and Outreach	1,530	1,535	3,512

Description

For FY 2007, the new Office of Technology Advancement and Outreach is absorbing and expanding the mission of the former Office of Information, Communications, and Outreach.

Public information and technology awareness and outreach activities in EERE are carried out by the Office of Technology Advancement and Outreach (TAO). TAO communicates the EERE mission, program plans, accomplishments, and technology capabilities to a variety of stakeholder audiences including Congress, the public, educational institutions, industry, and other government and non-government organizations. In addition, TAO prepares speeches and presentations by the Assistant Secretary and others when requested; manages the EERE public website and EERE's centralized public information clearinghouse; manages official correspondence; and coordinates reviews of EERE-related statements by other DOE offices and Federal agencies.

Beginning in FY 2007, additional funds are being requested for the Office of Technology Advancement and Outreach to initiate the consolidation of corporate outreach activities across EERE in an integrated fashion, ensuring that they are effectively structured and managed to meet EERE’s goals and objectives. A newly-developed long-term strategic plan will guide the development of a detailed TAO Multi-Year Plan.

TAO will continue its support of the corporate EERE webpage and the consumer guide on that web-page and will operate the EERE Information Center which answers request from consumers and users of technology submitted via toll free telephone or computer. TAO maintains a catalogue of all EERE information products, including publications, CDs, and analytic tools, and makes that information available on-line. Working with a newly developed five-year strategic outreach plan, TAO coordinates, consolidates and integrates outreach activities across the organization. TAO will continue to develop programs and information to encourage efficient use of energy and adoption of renewable energy technologies by the public and bring to market newly developed technologies which are mature and ready for deployment.

The objectives of the EERE public website and the central information clearinghouse activities are: (1) to provide accurate information on energy efficiency and renewable energy technologies to the public so EERE's customers can make informed decisions in the marketplace, resulting in an increase in the adoption of energy efficiency technologies and practices; (2) to raise the general awareness of state-of-

the-art energy efficiency technologies and practices; (3) increase industry and public awareness of advances in technology and the direction of research into efficiency and renewable energy technologies; (4) identify opportunities for collaboration with industry to provide and distribute information that will advance and disseminate technology; and (5) develop and disseminate information products that highlight new technologies that will enable consumers to either save energy or use renewable energy resources.

TAO coordinates outreach and information activities across EERE, integrating outreach efforts from all programs to provide an audience rather than a technology-focused approach. Thus consumers, be they the general public, industry or other governments, will learn about all EERE technologies that may apply to them rather than simply receiving information on only one aspect of energy efficiency or renewable energy. Such coordinated efforts are directed at targets of opportunity where rising prices or tight energy supplies may spur the acceptance for new technologies. Such efforts are also directed toward removing barriers to technology acceptance and implementation and to correcting misconceptions about EERE technologies.

TAO develops and implements long-range plans and strategies for increasing new renewable and energy efficiency technology for potential users and manufacturers of these technologies. The office maintains a corporate outreach connection with the general public; state, local and other Federal Government agencies; and industry for the purpose of increasing awareness, disseminating information and expediting deployment of EERE-developed technologies.

Successful outreach will aid in the break down of barriers to adoption of EERE technologies leading to more efficient use of energy and increased use of renewable technologies. Providing vision and long-range planning to EERE outreach efforts will enable more efficient evaluation of outreach programs and targeting of appropriate audiences.

Benefits

The Technology Advancement and Outreach subprogram coordinates and manages efforts to make all of the other programs' work – and their results – known to the public and provides a regular, consistent outreach mechanism that keeps EERE stakeholders advised of corporate issues and technology opportunities. This contributes both to the EERE programs' deployment goals and to Administration E-government initiatives to make Government more transparent and accessible to the public.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Technology Advancement and Outreach	**1,530**	**1,535**	**3,512**

Increasing at a rate of 1.5 million a year, the number of web pages viewed by users in 2005 reached 28.8 million, up from 27.3 million in the previous year. Increased demand for website information requires us to increase web-server operations and maintenance and to enhance and accelerate content creation and updates. In 2006, EERE will complete transfer of all websites to a single server and a content management system (CMS). In 2007, TAO will continue to identify and implement improvements to web content and timeliness in response to increased consumer and stakeholder usage. The website will be updated to reflect new technology advancements, new information for consumers and improved access to EERE business and technical resources.

TAO, with the increased funding, will implement a long-range strategic plan that combines currently dispersed outreach efforts into a proactive and visionary coordinated corporate approach incorporating new media and traditional means of outreach.

The toll-free information clearinghouse provides a more personalized service than the website, and is available to consumers and businesses that do not have Internet access. The clearinghouse fielded 18,000 inquiries and delivered 225,000 publications to consumers, businesses, and schools in 2005. As awareness of EERE technologies and their benefits increases, it is expected that inquiries to the clearinghouse will rise and require increased resources to meet this demand.

In FY 2006, this main clearinghouse was combined with several program-specific clearinghouses that have been operated in the past by different EERE programs. This direct funding will pay for about half of the clearinghouse costs. In FY 2007, funding for the clearinghouse will be provided by TAO funding with no charge back to the programs.

Total, Technology Advancement and Outreach.....	**1,530**	**1,535**	**3,512**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
The increase is for assumption of the program portion of the EERE Information Center and to develop a consolidated and unified corporate outreach capability. TAO will provide the coordination to eliminate duplication of effort while providing a "one-stop," centralized information office. The TAO will provide the opportunity to address multiple technologies to the public in layman's terms, thereby raising awareness and interest.....	+1,977
Total Funding Change, Technology Advancement and Outreach.....	**+1,977**

Congressionally Directed Activities

Funding Schedule by Activity

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Congressionally Directed Activities	10,372	3,465	0
Total, Congressionally Directed Activities	10,372	3,465	0

Description

Continued Congressionally directed efforts of the National Renewable Energy Laboratory (NREL) to develop renewable energy resources uniquely suited to the Southwestern United States, through its virtual site office in Nevada.

The Cooperative Program with States was a Congressionally directed activity that funded cooperative agreements with States, which in turn supported technology development, field testing, and deployment activities that promoted the commercialization of energy-efficiency technologies. The National Academy of Sciences review of selected R&D activities completed the activity directed in FY 2004 and FY 2005.

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
Southwestern Multi-Programs Virtual Site Office in Nevada	**2,977**	**3,465**	**0**

Through support of the National Renewable Energy Laboratory (NREL) virtual site office in Nevada, assisted in the development of renewable energy resources uniquely suited to the Southwestern United States. Funding is not included in the FY 2007 Budget Request in order to support higher priorities within the EERE portfolio that will contribute to the achievement of technology program goals and portfolio results.

Cooperative Program with States	**3,944**	**0**	**0**

FY 2005 funds were distributed through cooperative agreements with States to support technology development, field testing, and deployment activities that promote the commercialization of energy-efficiency technologies. No follow-on funding was requested.

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
National Academy of Sciences (NAS) Program Review	**493**	**0**	**0**
The National Academy of Sciences studied the prospective (predicted) benefits of Energy Conservation programs, and the methodologies for such predictions. No follow-on funding was requested.			
Energy and Research Consortium of the Western Carolinas	**2,958**	**0**	**0**
This activity was executed in accordance with Congressional direction. No follow-on funding was requested.			
Total, Congressionally Directed Activities	**10,372**	**3,465**	**0**

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
No funds are requested because activities are not closely aligned with the program's goal	-3,465
Total Funding Change, Congressionally Directed Activities	**-3,465**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2005	FY 2006	FY 2007
General Plant Projects	2,482	3,828	5,850
Capital Equipment	2,381	1,952	1,978
Total, Capital Operating Expenses	4,863	5,780	7,828

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2005	FY 2006	FY 2007	Unappropriated Balance
NREL Science and Tech Facility	22,637	800	6,627	10,410	0	0
Research Support Facilities			0	9,900	0	0
Total, Construction	22,637	800	6,627	20,310	0	

Major Items of Equipment

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2005	FY 2006	FY 2007	Completion Date
Process Development and Integration Lab, NREL.....	6,500	6,500[a]	0	1,000	2,750	2,750	FY 2007
Total, Major Items of Equipment.....				1,000	2,750	2,750	

a

Cost ($K)	Item	Cost ($K)	Item
$1,200	CIS PVD Workstation (3 chambers - Se, S based PVD, CdS or other)	$460	Thin-film Analyzer (Auger Electron Spectrometer)
$550	Thin-Si iodine transport or other high temperature process	$230	Stationary Universal Sample Transfer Interface Platform
$800	X-ray and Ultraviotet Photoelectron Spectrometer	$185	CBD CdS-controlled ambient glove box (CdTe/CIS)
$550	Multi-target Sputtering system (TCO/metallization)	$370	Real Time Spectroscopic Ellipsometer
$1,200	A-Si CVD Workstation (Low T processing, 3 chambers p, i, n, all combi)	$235	Optical Probe Workstation, phase II, (FTIR, ATR)
$700	Optical Probe Workstation, phase I, (PL, TRPL, Raman, rf-PCD)	**$6,480**	**Total**