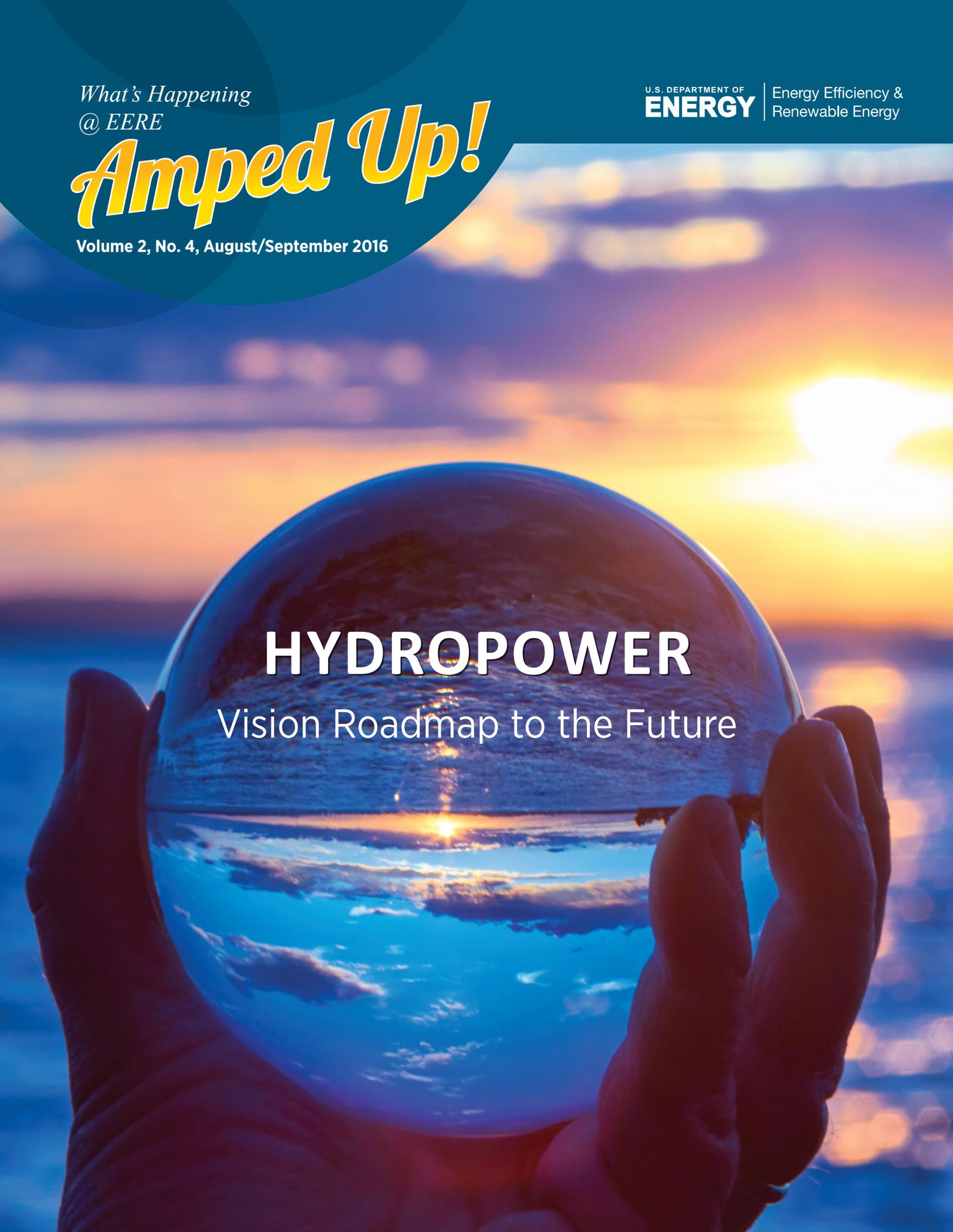


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Amped Up!

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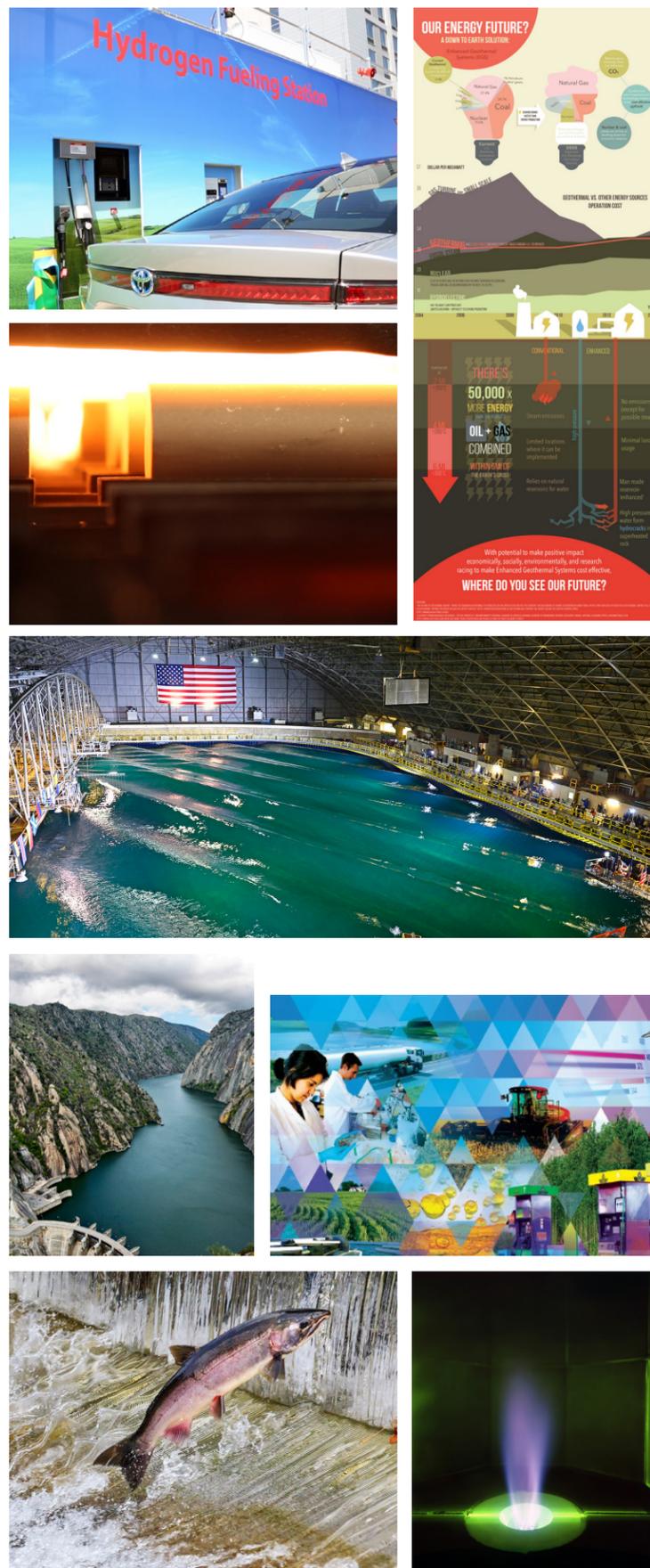


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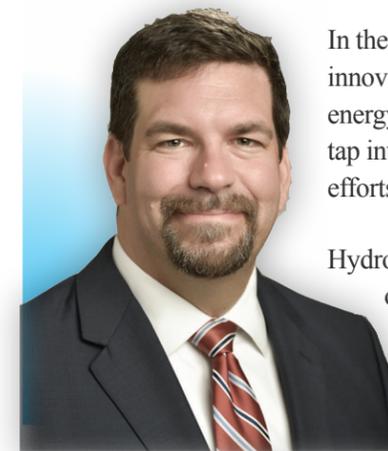
Vision Roadmap to the Future

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A Message from David



In the last issue of *Amped Up!*, I outlined my top priorities, including accelerating the pace of innovation. Even as we continue to see remarkable growth and adoption in renewable energy and energy efficiency, the data points to the reality that we need to put our pedal to the metal to fully tap into the multi-trillion dollar opportunity that clean energy represents. The need to accelerate our efforts is certainly true for sustainable hydropower, which is a key focus of this issue of *Amped Up!*

Hydropower is widely considered to be America's first renewable electricity source. At the height of the Great Depression, our country's investment in building the iconic Hoover Dam became an enduring testament to American ingenuity and determination. Over the past 65 years, hydropower has provided 10% of our domestic electricity generation and 85% of our cumulative renewable power generation—yet, we may have only skimmed the surface of what is possible so far.

Our Water Power Program team has done an incredible job developing a first-of-its-kind comprehensive report that lays out the potential for U.S. hydropower through 2050—a critical time period for meeting our carbon emissions goals to prevent the worst effects of climate change. *Hydropower Vision: A New Chapter for America's First Renewable Electricity Source* found that our domestic hydropower has the potential to grow from 101 gigawatts to nearly 150 gigawatts of combined electricity generation and storage capacity by 2050. The report also outlines how hydropower and pumped-storage could support more than 195,000 jobs and result in a cumulative \$150 billion in economic development by 2050.

In this issue, you'll learn more about the research, development, and deployment initiatives we are backing to sustainably harness the broad potential of our oceans and rivers. These include work underway at Pacific Northwest National Laboratory to tag fish with self-charging units that enable researchers to better determine the impact of dams on the environment, a new funding opportunity that will enable the construction of a national wave energy test facility, and other strides in hydropower and marine and hydrokinetic energy.

Also, be sure to check out the Q&A interview in this issue with Dr. Franklin (Lynn) Orr, who has visited all 17 labs in his role as Under Secretary for Science and Energy. A scientist and long-time Stanford University faculty member, he shares his "Holy Cow" moment when he grasped the full depth of expertise, resources, and science and engineering muscle of our labs.

You'll also find a recap of our first-ever Sustainable Transportation Conference and highlights from the recent Bioenergy 2016 conference.

One single issue cannot capture all of the groundbreaking work underway across our organization and the ways we are picking up the pace of innovation, but I hope that you enjoy this snapshot of some of the exciting progress underway. Thanks for everything you do each day on behalf of our nation, DOE, and EERE.

David

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Hydropower Vision Roadmap for Future

The first-of-its-kind *Hydropower Vision* report from EERE's Water Power Technologies Office made a big splash this summer with its forecast for an expanded role for hydropower and pumped-storage in America through 2050. This fresh look at the promise of hydropower—unveiled at Hydrovision 2016 held in Minneapolis this past July—adds another exciting dimension to hydropower's storied history of more than a century as the backbone of America's electric system.

In this sweeping new report, Energy Department analysts predict that U.S. hydropower could grow from 101 gigawatts to nearly 150 gigawatts of combined electricity generation and storage capacity by 2050—with more than 50% of this growth realized by 2030. Achieving this growth can happen if existing plants are upgraded, new power is added at existing dams and canals, stream-reaches are sustainably and responsibly developed, and new pumped-storage capacity is created, the report says.

“With a goal of developing a cohesive long-term future for the

benefit of the entire U.S. hydropower community, this landmark report analyzes a range of growth scenarios and establishes an objective roadmap of actions the hydropower industry, research community, and others can take to achieve higher levels of hydropower deployment within a sustainable national energy mix,” said Jose Zayas, director of EERE's Wind Energy Technologies Office. (During the development of the *Hydropower Vision* Report, Zaya was the Director of the former Wind and Water Power Technologies Office.)

Hydropower Vision highlights key advances in pumped-storage that could create an additional 36 gigawatts of capacity and pegs potential savings in avoided damages from greenhouse gas emissions at more than \$209 billion. Further, the report notes that between 2017 and 2050, hydropower could save \$58 billion from avoided healthcare costs and economic damages due to air pollution and 30 trillion gallons of water, which is equivalent to roughly 45 million Olympic-size swimming pools.

The report offers a roadmap to the future, with a range of actions needed to realize the economic and social benefits of increased hydropower. Achieving these benefits will require continued technology development and collaboration among industry experts, federal agencies, and academia.

More than 150 organizations and 300 individuals spanning all facets of the hydropower industry—including manufacturers, equipment industry associations, utilities, environmental organizations, federal and state government agencies, research institutions, and laboratories—offered their inputs to create *Hydropower Vision*.

As a result, this report provides a keen assessment of hydropower's current contribution to the nation's electric and water needs through hydropower generation and pumped-storage, while exploring further, long-term growth scenarios. More than 50 hydropower deployment scenarios were modeled to assess the influence of different variables on hydropower growth.

Findings in the *Hydropower Vision* report will help inform future decisions by policymakers at the federal, state, tribal, and local levels, whose territory included 2,198 active hydropower plants at the beginning of 2016. The results will also help key stakeholders better understand the opportunities and challenges facing the industry today.

“Continued evolution, including transformative technical innovations able to meet the co-objectives of environmental sustainability and low-carbon energy, will be critical to enabling hydropower growth,” said Zayas. This Energy Department report, he added, “will help the nation usher in a new era for hydropower—one that ensures that America's first renewable electricity source maintains its place in our nation's 21st-century energy system.”

As with every clean energy initiative, reducing cost is a must. That's why, along with the report, the Energy Department announced \$9.8 million in available funding for up to 12 projects to develop innovative technologies that will reduce capital costs and deployment timelines for pumped-storage hydropower and non-powered dams. (See page 7 for details about a recent notice of intent released by EERE covering these two resource classes.)

Present Energy Department plans call for the pumped-storage projects to study the feasibility of innovative concepts for closed-loop, pumped-storage hydropower systems. Other ongoing EERE Water Power Program work tied to the report includes ongoing efforts to coordinate regulatory responsibilities in hydro permitting with the Army Corps of Engineers and Federal Energy Regulatory Commission. *Hydropower Vision* stresses the need for collaboration to achieve milestones set forth in the report that will lay the groundwork for the future of this vital renewable energy resource.

**“Continued evolution...
will be critical to enabling
hydropower growth”
- Jose Zayas, Wind Energy
Technologies Office
Director**

Micro-Tracker Device Monitors Fish Migration through Hydroelectric Dams

In order to understand how fish swim through rivers, the Pacific Northwest National Laboratory (PNNL) developed an injectable tracking device, known as an acoustic fish tag, with a self-charging battery.

Funded by the Energy Department, this project is part of a long-term mission to contribute valuable research on fish migration through waterways when encountering hydroelectric dams. The key purpose of the study is to see whether or not fish become injured or hindered by the presence of hydroelectric devices.

fish tag capable of being injected with a syringe. The tiny tag is considerably smaller than those used on animals and dramatically speeds up the tagging process (75 seconds per implant). However, due to the size of the battery, longevity is limited to a month.

In 2015, PNNL tested self-charging tags, a revolutionary development that used the movement of fish to power and recharge batteries.

“The self-charging capability of these tags really sets them apart

The technological evolution to these more advanced tags has yielded many ecological research benefits.

“We get a much more complete view of the effects of dams and other waterway structures on fish behavior. Rather than just a month or two of data, we could receive well over a year’s worth of information,” said Deng. “Some fish, such as sturgeon, lamprey, and eels, have longer migration patterns. Self-charging tags allow us to see the impact of river obstructions and ferry terminals much clearer and across



“We began developing small acoustic transmitters for fish tracking in 2001,” said PNNL’s Daniel Deng, chief scientist, Energy & Environment Directorate. “From the start, the tags needed to be small enough to use on juvenile salmon without impeding the motion or behavior of the fish. As technology advanced, we’ve been able to steadily shrink the size of the tags while adding new tracking capabilities. The first tags, released in 2005, needed to be surgically implanted.”

By 2014, PNNL had developed a micro, 3-volt lithium battery as small as a grain of rice. This engineering shrunk the acoustic fish tag down, producing the world’s first

from current tracking tags. We used a flexible piezoelectric beam to harvest the mechanical energy from the swimming motion of the fish. Previous tags relied solely on a battery to power the tag. When the battery ran out, the tag stopped transmitting a signal,” said Deng.

PNNL’s scientists actually developed two versions of the self-charging tag. One uses a capacitor that is charged as the fish moves. The fish has to be moving for the tag to have enough power to send a signal. The second version uses a battery that stores energy from the fish’s movement. Once the energy is depleted, the fish’s movement will recharge the battery to full capacity.

a broader range of fish species.”

In addition, this technology provides dam operators and utilities more accurate data that they can use to improve the environmental performance of hydroelectric dams. The data can also be used to influence the design of emerging hydropower technology systems.

In the meantime, Deng and his team are continually working on improvements. They are developing an even smaller tag for juvenile eels and lamprey, and they made a longer-lasting tag for juvenile sturgeon last year. Testing is still underway on the self-charging tags, and according to Deng, “short-term results are promising.”

EERE to Fund Up to 12 Projects Probing Two Hydropower Resource Classes

An important step toward achieving U.S. hydropower goals set forth in the recent *Hydropower Vision* report is tied to EERE plans to invest nearly \$10 million to develop innovative technologies that will reduce capital costs and deployment timelines for pumped-storage hydropower and non-powered dams.

Scores of public and private U.S.-based corporations are expected to compete for the available funding for up to 12 projects, spanning non-powered dam and pumped-storage technologies. EERE officials have signaled their intent to invest \$4.8 million on eight projects focusing on existing non-powered dam development; \$5 million is designated for four pumped-storage projects.

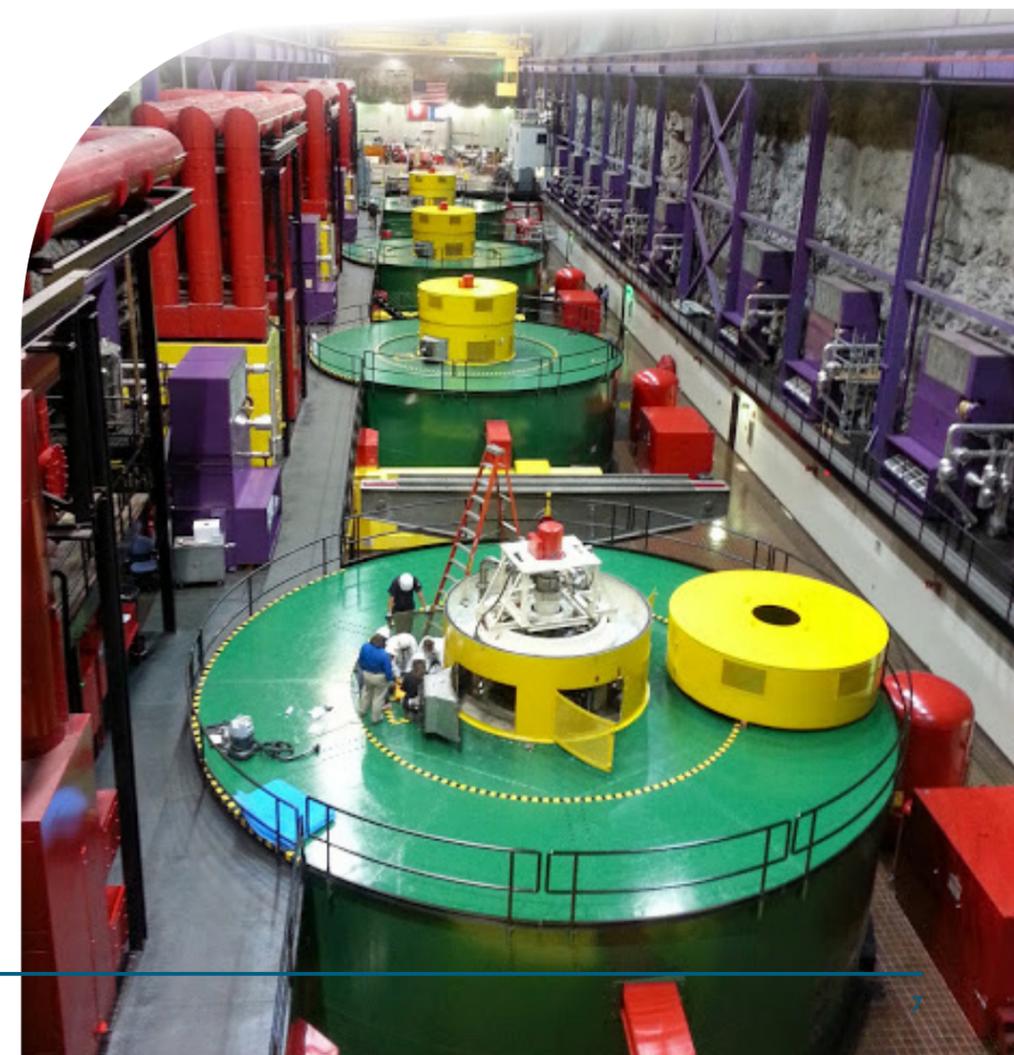
The goal of this funding announcement is to stimulate research and development in these two areas of the hydropower sector. Plans call for the selected project proposals to produce a design model, analyze and prove its prospective capacity, and then investigate its market viability.

Today, only 3% of the nation’s dams generate electricity. Non-powered dam work involves the conversion of existing dams into electricity-generating dams by integrating turbine and electrical generator units into the existing infrastructure. The EERE funding opportunity calls for smaller modular standardized units that can operate interchangeably at various sites and can be installed in existing spaces within the frame of the dam rather than the traditional site-specific units that require supplementary construction. The project criteria includes a 20% reduction in capital costs associated with structure installation, while maintaining at least 80% power conversion efficiency.

Pumped-storage hydropower pumps water into higher-elevation reservoirs at times when there is a surplus of electricity and then releases that water into lower-elevation reservoirs to generate electricity when needed. Pumped-storage has the potential to increase the flexibility and stability of the U.S. electricity grid, as well as to support the integration of variable renewable resources like wind and solar.

EERE’s work in the pumped-storage realm aims to develop an innovative system that includes adjustable speed pumps for varying electricity loads, closed-loop water sources for the protection of the river ecosystem, and smaller pump units for distribution on a more localized scale—all while maintaining an energy roundtrip efficiency of 70%.

Through this funding, EERE officials hope to develop and accelerate deployment of innovative hydropower technologies that lower costs, improve performance, and provide environmental stewardship. The *Hydropower Vision* report estimates that domestic hydropower could grow from 101 gigawatts to nearly 150 gigawatts of combined electricity generation and storage capacity by 2050.





Collaboration Toolkit Keeping the Permits Flowing

As in every major venture, when it comes to getting a project approved, regulations dictate and impact timelines. This is no different in the hydropower industry. Thanks to the Energy Department’s [Hydropower Regulatory and Permitting Information Desktop \(RAPID\) Toolkit](#), tracking down which guidelines apply at a specific project site has never been easier.

Today, hydropower developers face a multiyear venture that requires them to follow regulations and obtain state and federal permits during each phase of the project. That’s why Energy Department officials have been working for the past several years with the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission to improve the onerous permitting process that requires layers of approval at a number of jurisdiction levels.

With federal, state, and local licensing

and permitting regulations mapped out by a state and year-by-year timeline, the speed by which one acquires this pertinent information becomes less of a hurdle. This new toolkit designed to help hydropower developers navigate the regulatory process is one of several steps Energy Department officials have been taking to help advance future hydropower projects.

Energy Department officials have been working with the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission over the past several years to improve the permitting process.

The RAPID Toolkit makes permitting information accessible from one

online location. It features links to permit applications, processes, manuals, and related information. In addition, it provides best practices to help hydropower stakeholders navigate the regulatory process.

The Toolkit’s Regulatory Flowchart Library and Reference Library contain links and documents outlining the major requirements and regulations not only for hydropower, but for additional renewables, including solar and geothermal. And through active participation by industry and federal and state regulatory agencies, the Toolkit’s content is consistently accurate and up to date. Learn how you can contribute [by visiting the project wiki](#).

These and other efforts will help to ensure that hydropower lives up to its tremendous untapped potential, as outlined in the *Hydropower Vision* report.

EERE Announces Funding for Test Facility to Accelerate Wave Energy Technology

With the potential to power nearly one-third of all U.S. homes one day, wave energy is at the core of the EERE Water Power Program’s near-term investment strategy.

Recent studies by the Energy Department show that America can technically recover up to 1,229 terawatt hours of wave energy per year. That’s enough to power more than 110 million U.S. homes. To harness that power, wave energy devices must progress.

That’s why the Water Power Program announced a funding opportunity in July for the award of up to \$40 million to construct a grid-connected, wave energy test facility inside U.S. federal or state waters.

The proposed national site will support the full-scale testing of marine and hydrokinetic (MHK) wave energy devices and will help develop codes and standards prior to large-scale

deployment. Plans call for the test site to have at least three test berths to test the devices simultaneously and independently.

“This site will reduce device development time by providing a pre-permitted, open-water facility with access to the electrical grid for full-scale devices,” said Alison LaBonte, program manager for EERE’s MHK portfolio.

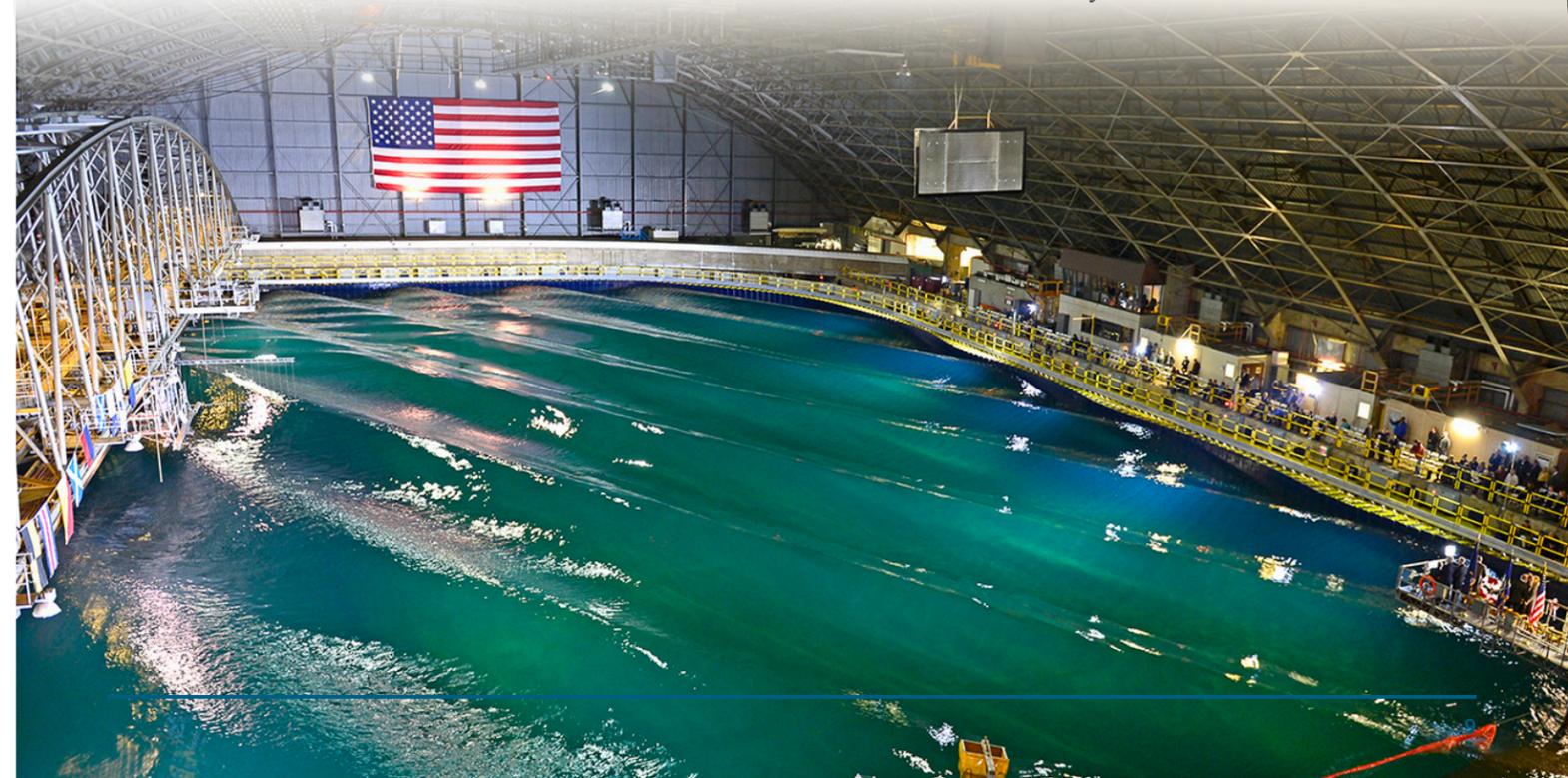
The site location must produce a yearly average wave power density of more than 30 kilowatts per meter, with water depths greater than 60 meters. The facility should also accommodate all wave energy converter types and should be capable of deploying environmental instrumentation for monitoring and measuring wave energy testing effects.

Testing facilities play a crucial role in accelerating the emerging MHK industry. This site will assist in

analyzing wave energy device designs and can accelerate development and deployment efforts by reducing technical risks, testing costs for developers, and the time it takes for the devices to reach commercial readiness.

“Not only will this site lower the cost burden on device developers,” said LaBonte, “but device testing will reduce risk and allow wave energy converters to more rapidly progress toward commercialization.”

The Water Power Program currently sponsors a 20-month Wave Energy Prize competition that aims to double the performance of wave energy devices to help the resource become more cost competitive with traditional sources of energy. The Energy Department will announce winners in November at the Naval Surface Warfare Center’s Maneuvering and Seakeeping Basin, located in Maryland.



Q&A: DOE Under Secretary Dr. Franklin Orr Bullish on Clean Energy Progress

As Under Secretary of Science and Energy at the U.S. Department of Energy (DOE), Dr. Franklin Orr oversees its vast science and applied energy portfolio. In a recent interview with the *Amped Up!* team, Dr. Orr shared his outlook on the *Hydropower Vision* report, efforts to strengthen the impact of the national labs, and progress on climate change.

Q. What is your reaction to DOE's *Hydropower Vision* report that lays out significant growth potential for America's first renewable electricity source?

A. It was not terribly surprising that there is significant potential for additional hydropower around the country, particularly if we use the unpowered dams. What was a surprise in the report was the potential impact of pumped hydro storage, which has this huge value that the roundtrip efficiencies are really good. If it's true that we can deliver additional storage there, at costs that look very competitive against other ways we try to store energy, then that's potentially quite important, and it's something that gives us another tool in the toolkit.

Q. There's been a push to strengthen ties between the labs and U.S. businesses to spur clean energy innovation. What has been your role?

A. It's certainly true there has been a DOE-wide effort to think about how to capitalize on this incredible strength that we have in our national labs. And, there are a variety of ways to do that. We can think about making the technologies that are developed in the labs more available for licensing and industry, as well as ways to mature those technologies to get them out the door. We established our Office of Technology Transitions to help us do a better job of looking for commercialization opportunities. And, we recently announced \$16 million in funding for 54 projects for the Technology Commercialization Fund that do exactly that—they take some idea in the lab and mature it to get it closer to being ready for actual commercialization.

Those of us who work in labs think, "We have this cool idea; it ought to just jump into the marketplace." But, there's a lot of work to be done in understanding markets and developing products. There's the Clean Energy Investment Center, which provides one-stop shopping for companies interested in engaging with the labs to find ways into our complicated organization. We have also done some other experimentation with pilots like Cyclotron Road at Lawrence Berkeley National Laboratory.

Q. How do you assess the current level of urgency across the globe on climate change?

A. There are actually some hopeful signs. Along with last year's Paris negotiations and Mission Innovation. I thought that the Clean Energy Ministerial meeting held in San Francisco in June was quite a remarkable gathering. There was a real sense in that room with all those energy ministers that they could see pathways to do what needs to be done. This is not to discount the effort remaining, but I had a sense that the countries representing three-quarters of the world's emissions were ready to roll up their sleeves and get to work. And, of course, DOE is positioned to play a leading role for the United States. Roughly three-quarters of our nation's Mission Innovation investment involves DOE activities, including much of EERE's work, putting us at the forefront of the effort to develop and deploy the technologies needed to meet our clean energy goals.



Communities' Clean Energy Futures Brighten with Boost from EERE

Communities from Maine to Hawaii are making great strides as they pivot toward a clean energy system with assistance from the Energy Department's Energy Transition Initiative (ETI).

Led by EERE's Technology-to-Market program and in coordination with experts at the National Renewable Energy Laboratory, the initiative has helped shape the clean energy goals of these areas and sparked the interest of other communities seeking sustainable energy futures.

Launched in 2014, ETI encourages the development of constructive relationships between government entities and local stakeholders to establish a long-term energy vision and identify clean energy solutions. Through this initiative, Energy Department officials and its partners provide communities with the guidance and technical tools they need to develop local resources as a viable alternative to imported fuels.

So far, ETI has aided communities stretching from the coast of Maine to Puerto Rico and the U.S. Virgin Islands (USVI), all the way over to Hawaii in the Pacific Ocean. In fact, ETI has its roots in two prior DOE efforts, the [Hawaii Clean Energy Initiative](#) and the [Energy Development in Island Nations project](#) for the USVI, which are ahead of schedule in meeting their energy goals. ETI hopes to help other communities replicate that success.

These prior Energy Department investments inspired [ETI's Islands Playbook](#), which describes the

replicable model for energy transitions that ETI resources are designed to support. The beauty of the Playbook is that it features lessons learned from islands, states, and cities that have successfully taken steps toward their vision of a sustainable energy future, allowing other communities to make decisions about their goals and projects in a comparable context.

The other resources provided through ETI—including an array of energy data, tools, and training—provide a pathway for small, isolated, and/or developing countries to plan and achieve ambitious clean energy goals that maintain a high quality of life. For example, at a recent energy development conference in New Zealand, representatives from nations in the Pacific gathered to discuss targets and lay the groundwork for a clean energy transition.

"Remote islands that are heavily dependent on fossil fuels can find themselves at the mercy of volatile energy prices due to their reliance on imported fuels," said Stephen Walls, a policy advisor whose background in international relations, economics, and law led him to EERE's Office of Strategic Programs.

At last year's Paris climate conference, where 23 world leaders pledged to double investments in clean energy research and development over the next five years, the 44 members of the Alliance of Small Island States (AOSIS) were strong advocates

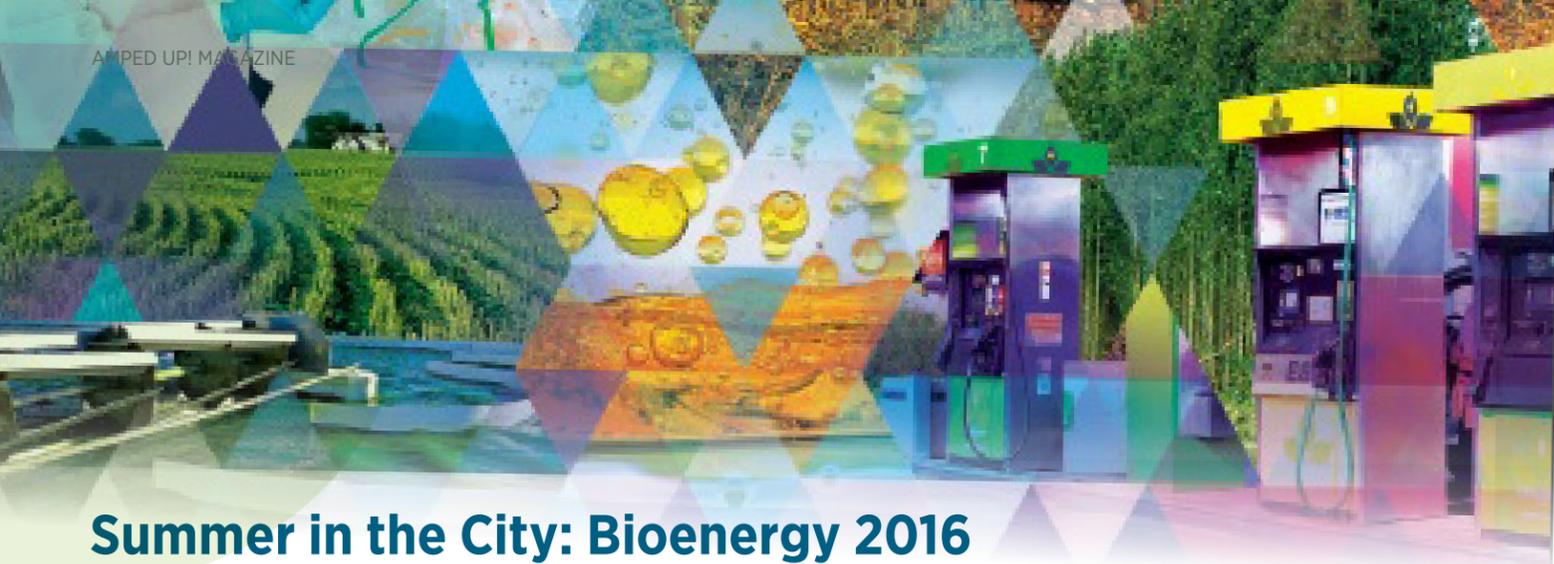
on behalf of reaching an agreement.

Following the 21st session of the Conference of the Parties, the first three countries to ratify the Paris agreement were Pacific Island countries. An analysis from one AOSIS member shows that 58 countries, representing 54% of emissions, are on track to ratify by the close of 2016—just shy of the threshold needed to bring the agreement into force. Walls continued, "Island countries and territories are really taking the lead here, setting the most ambitious clean energy targets in the U.S. and the rest of the world. And, given their relative size, they'll be first to hit very-high-penetration levels of EERE technologies."

Against this backdrop, ETI will continue to help lay the groundwork for these and other communities to incorporate the clean energy economy into their vision of sustainability.

ONWARD AND UPWARD

In 2015, Vice President Biden highlighted the U.S. Virgin Islands (USVI) for its success. And, if everything keeps to schedule, the USVI will no longer burn any diesel or heavy fuel oil for electricity by the end of this year, as they switched to the cleaner-burning alternative fossil fuel propane and are at over 20% peak solar. With a biomass power purchase agreement signed and wind resources characterized, the USVI is looking to have a diverse energy mix with several renewable energy and energy efficiency technologies contributing to its sustainability goals.



Summer in the City: Bioenergy 2016

The Energy Department's Bioenergy Technologies Office (BETO) hosted its ninth annual conference—*Bioenergy 2016: Mobilizing the Bioeconomy through Innovation*—which drew bioenergy experts and stakeholders from around the nation to the Walter E. Washington Convention Center on July 12–14 in Washington, D.C.

Senior Energy Department officials, including DOE's Deputy Under Secretary Adam Cohen, EERE's Acting Assistant Secretary David Friedman, EERE's Deputy Assistant Secretary for Transportation Reuben Sarkar, and BETO Director Jonathan Male, shared their perspectives on the future of bioenergy.

Representatives included members of the bioenergy industry, federal government, academia, U.S. Congress, national laboratories, and the financial community. The conference, held in partnership with the Clean Energy Research and Education Foundation, focused on opportunities to grow future feedstock supplies, as well as on issues vital to the growth and success of the bioeconomy. The “bioeconomy” is the developing industry of biofuels, bioproducts, and biopower made from biomass, which is organic material made up of agricultural

waste, grasses, forestry trimmings, and/or algae that can be used as raw material to produce energy.

Key topics of interest at the event included renewable aviation fuels, workforce development, and bioproducts and renewable chemicals. There were scores of sessions over several days on a host of timely topics, ranging from discussions about BETO's new strategic plan, to its work to develop a synthetic biology foundry to address biomanufacturing challenges.

Other conference highlights included:

- A speech by Rep. Marcy Kaptur (D-Ohio), who encouraged conference participants to develop technologies to convert waste to energy.
- The rollout of the [2016 Billion-Ton Report](#), volume 1, which affirms the U.S. potential to produce at least 1 billion dry tons of nonfood biomass resources annually by 2040.
- Presentations by officials from top companies, international partners, and other organizations, including Vann Bush (Gas Technology Institute), Julie Felgar (Boeing), Brent Erickson (Biotechnology Industry

Organization), Jim Lane (Biofuels Digest), Jeffrey Jacobs (Ensyn Corporation), Bernardo Silva (Brazilian Industrial Biotechnology Association), and Jan Koninckx (DuPont Industrial Biosciences).

- Algae funding selections; EERE officials announced the selection of three organizations (Global Algae Innovations; Algenol Biotech LLC; and MicroBio Engineering, Inc.) to receive funding to reduce the production cost of algae-based biofuels and bioproducts through improvements in algae yield.
- A preview roundtable panel on BETO's upcoming strategic plan.
- Recognition of the winners of the BioenergizeME Infographic Challenge.

BETO works with a broad spectrum of industrial, academic, agricultural, and nonprofit partners across the United States to develop and demonstrate commercially viable, high-performance biofuels, bioproducts, and biopower made from renewable, U.S. biomass resources that reduce America's dependence on imported oil, while lowering greenhouse gas emissions.

Summer in the City: Sustainable Transportation Summit

The temperatures were sky high in the nation's capital this summer, and so was the drive at the Energy Department's inaugural Sustainable Transportation Summit, held in July at the Washington Convention Center in Washington, D.C.

Energy Secretary Ernest Moniz addressed a crowd that convened stakeholders who are championing an array of low-carbon alternatives to petroleum fuel, from biofuels, to electric vehicles, to hydrogen fuels and infrastructure.

The summit highlighted progress and achievements in sustainable transportation research and development, as well as efforts to bring new technologies to market. It also put the spotlight on sustainable transportation work tied to the President's EV Everywhere Grand Challenge to increase the number of plug-in electric vehicles on U.S. roads and bolster U.S. manufacturing leadership in electric vehicles.

Moniz was joined by industry experts, including EERE Acting Assistant Secretary David Friedman, Ford Motor Company's Vice President of Research and Advanced Engineering Ken Washington, and former Governor of Michigan Jennifer Granholm. Also addressing the crowd was former director of EERE's Vehicles Technologies Office, SMI Vice President Patrick Davis. White House Council on Environmental Quality Federal Chief Sustainability Officer Christine Harada joined Davis at a panel session on electric vehicle development. The panel fielded questions from the audience along with the first director of the Energy Department's EV Everywhere effort, EERE's Bob Graham.

The panel discussed the need to emphasize the superior driving experience of electric vehicles, how to stimulate further adoption of these vehicles, the expansion of the charging infrastructure, and the coming transition to a new administration.

2016 BILLION-TON REPORT

The United States has the potential to sustainably produce at least 1 billion dry tons of nonfood biomass resources annually by 2040, according to the newly published *2016 Billion-Ton Report*, volume 1, which was released at Bioenergy 2016. These biomass resources could include agricultural, forestry, and algal biomass, as well as waste. They could be used to produce biofuel, biopower, and bioproducts that could be used in place of petroleum-derived fuels and products to substantially decrease greenhouse gas emissions in the transportation and utility sectors and reduce U.S. dependence on imported oil.

The report's analysis was led by Oak Ridge National Laboratory, with contributions from 65 experts from federal agencies, including the U.S. Forest Service, Department of Agriculture, Environmental Protection Agency, Department of Transportation, and Federal Aviation Administration, as well as U.S. national laboratories, universities, and private companies. Researchers and decision-makers can use the report and its interactive data features on the [Bioenergy Knowledge Discovery Framework](#) to better inform national bioenergy policies and research, development, and deployment strategies. Volume 2 of the report, focused on environmental sustainability, is set for release later this year. The report is an update to the [2005 Billion-Ton Study](#) and the [2011 U.S. Billion-Ton Update](#).



EERE Projects Stoke Hydrogen Storage, Fuel Cell Successes

Hydrogen and fuel cell technologies are continuing to advance at an electrifying rate, and recent Energy Department funding of more than \$13 million for eight projects under two newly established consortia should quicken this pace.

These consortia—Fuel Cell Consortium for Performance and Durability (FC-PAD) and Hydrogen Materials-Advanced Research Consortium (HyMARC)—utilize industry, university, and laboratory expertise to propel American innovation in fuel cell performance and durability and advanced hydrogen storage technologies.

Led by Los Alamos National Laboratory, FC-PAD projects will work to enhance the performance and durability of transportation fuel cells, which will decrease the cost and improve the life of fuel cell electric vehicles. The selected projects include 3M Company (St. Paul, Minnesota); UTRC (East Hartford, Connecticut); Vanderbilt University (Nashville, Tennessee); and General Motors (Pontiac, Michigan).

Similarly, HyMARC features a core team of Sandia, Lawrence Livermore, and Lawrence Berkeley National Laboratories, which will leverage the unique capabilities and expertise of these labs to carry out the foundational research necessary to advance hydrogen materials storage technologies. The selected projects include Argonne National Laboratory (Argonne, Illinois); Pennsylvania State University (University Park, Pennsylvania); University of Hawaii (Manoa, Honolulu, Hawaii); and University of Missouri (St. Louis, Missouri).

The uniqueness of this EERE effort “lies in the approach of adding partners to the already-established lab consortium core team,” said Dimitrios Papageorgopoulos, Fuel Cells program manager, Fuel Cell Technologies Office. “This will foster sustained capabilities and collaborations for an influx of innovative ideas and research.”

For example, 3M’s project aims to meet the Energy Department’s 2020 technical targets to simultaneously improve fuel cell performance and durability, while lowering cost. It has already developed a low-platinum group metal catalyst that meets Energy Department targets, and this new project will tackle the next hurdle—developing an electrolyte that will allow this new catalyst to be successfully integrated into a next-generation fuel cell.

Andrew Haug, senior research specialist with 3M’s ENERGY components program, believes this funding allows the company to assemble the cross-functional team required to tackle the complex electrochemistry and mass transport of fuel cell electrode operation.

With HyMARC, the end goal is similar to that of FC-PAD; HyMARC projects are working to advance onboard automotive hydrogen fuel cells by decreasing cost and increasing storage capacity to enable driving ranges comparable to gasoline-fueled cars.

For Ned Stetson, Hydrogen Storage program manager, Fuel Cell Technologies Office, these projects are channeling future innovation.

“These projects will accelerate American innovation in advanced hydrogen storage and fuel cell technologies to strengthen U.S. energy security, environmental quality, and economic vitality.”



Hydrogen Fueling Station Facility Opens in Nation’s Capital

An emerging technology that could play an integral role in the future of sustainable transportation is now on display in the nation’s capital.

In partnership with the National Park Service (NPS), EERE’s [Fuel Cell Technologies Office \(FCTO\)](#) launched a technology demonstration hydrogen refueling station in Washington, D.C., on July 11. The [new station](#), located at the NPS Brentwood Maintenance Facility, showcases cutting-edge hydrogen generation technology that will validate recent advances in electrolyzer technology, which uses electrical energy to split water into oxygen and hydrogen.

“This puts hydrogen availability right here in D.C.,” said Reuben Sarkar, EERE deputy assistant secretary for transportation. “Before this, there wasn’t a station that we could utilize to show different departments, agencies, and

congressional staff the potential of hydrogen fuel cell technology.”

As part of a loan through the technology validation project, the Energy Department and NPS are adding commercial fuel cell electric vehicles (FCEVs) to their fleets—a first for any federal agency. These vehicles will be showcased at public outreach events and demonstrations, and they will collect hydrogen station data that feeds back to FCTO’s research program.

“This is a perfect example of demonstrating cutting-edge technology, from the laboratory, in real-world conditions for hydrogen infrastructure,” said FCTO Director Sunita Satyapal. “At the same time, we have these vehicles in the D.C. area to showcase them to the public.

Provided by Connecticut-based Proton OnSite and corporate partner SunHydro, the small-footprint hydrogen refueling

station incorporates FCTO-funded electrolysis and high-pressure operation advancements. It’s equipped to produce 30 kilograms of hydrogen per day—enough to fully fuel six cars and last each vehicle an estimated 300 miles.

FCEVs use a [fuel cell stack](#) to convert hydrogen gas and oxygen into electricity to power the vehicle. Two models, the Toyota Mirai and Hyundai Tucson, are commercially available in California, with more than 300 leased or sold. Funding is in place to install 100 stations in the state. Plans are also underway for stations in the Northeast region, with other markets expected to develop as consumer demand increases.

Since 2008, FCTO-supported research and development efforts have helped cut the cost of [hydrogen fuel cells](#) by 35%. Now, nearly every major automaker is actively pursuing the development of FCEVs.

Forging Company Plans Expansion Following Fruitful Research Partnership

Struggling to remain competitive in 2004 with business declining and its machinery growing old, Queen City Forging President Rob Mayer knew he had to make a move and fast.

A metal components supplier for 120 years, the Cincinnati, Ohio-based company drew most of its revenue from manufacturing small metal components for horseshoes and sewing machines.

“It was clear we had to take some different directions,” said Mayer.

The company began producing a small batch of aluminum turbocharger impellers for diesel engines, which increase the efficiency and power output of internal combustion engines. And that’s when Mayer “started being concerned with metallurgical properties.” Specifically, he wanted to know “how we could achieve the superior properties” that forging could bring to the table.

Mayer learned about a new infrared heating technology through the Forging Industry Association that the Energy Department’s Oak Ridge National Laboratory (ORNL) developed through EERE funding.

This technology refines the internal grain size of aluminum parts by processing them in a special infrared oven that allows for rapid heating and cooling. These finer internal grains improved the aluminum’s overall strength, hardness, and fatigue life.

ORNL teamed up with Queen City Forging, the Forging Industry Association, and industry partner Infrared Heating Technologies to develop a rapid infrared heating furnace to produce aluminum turbochargers. The partners built an industrial-sized continuous hybrid furnace designed to pre-heat large quantities of aluminum. Their objective was to determine if the infrared furnace could integrate into a manufacturing line. Integration at the industrial level could influence a significant increase in production and energy savings.

ORNL researchers tested the infrared furnace against traditional heating methods at Queen City Forging’s Cincinnati plant. On the first try, the infrared oven produced 50 aluminum impellers that exceeded customer requirements. More importantly, as researchers increased the aluminum

production volume, the new infrared oven shortened pre-heating time for aluminum billets from 4 hours to 15 minutes.

Working with the entire supply chain, the turbocharger line took less than two years to deploy and now makes up half of Queen City Forging’s gross earnings. In addition, the new heating technology has quadrupled the company’s production, decreased energy consumption by 70%, and reduced its maintenance costs.

With hundreds of thousands of impellers produced per year, the company recently announced plans to expand its Cincinnati manufacturing plant. Queen City Forging’s use of state-of-the-art heating technologies has propelled it to a leading provider of advanced aluminum components for use in critical diesel truck and off-highway vehicle/construction equipment parts, railroad signal relays, small aerospace parts, and other original equipment manufacturer component applications.

“I’d guess I’d have to say it saved our bacon in one way,” said Mayer.

New Easy-to-Install Air Conditioning Unit Frees Up Window Space in a Snap

Chuck Booten and Jon Winkler are on the brink of a breakthrough. The pair of engineers at the [National Renewable Energy Laboratory](#) (NREL) developed the EcoSnap-AC Heat Pump System—an affordable, wall-mounted unit that takes just minutes to set up.

Targeted for the do-it-yourself customer, the duo’s prototype is an easy-to-install heating and cooling unit that frees up your window and places the evaporator on one side of a wall and the condenser on the other—similar to a mini-split heat pump. The difference is in the connection and cost. Unlike mini-splits that require professional installation, EcoSnap-AC sets up in minutes by simply drilling one small hole and “snapping” a few connections together without any tools.

“The connection eliminates the skill involved, so you don’t need to pay extra for labor,” said Booten. “You can connect and disconnect with just a couple of clicks.”

Booten and Winkler first came up with the EcoSnap-AC concept almost four years ago while working on a performance mapping project on window air conditioning (AC) units for the Energy Department. Momentum started to build in 2015 when they participated in EERE’s first [Lab-Corps cohort](#). Part of EERE’s Technology-to-Market program, Lab-Corps is designed to help lab researchers commercialize their technologies.

“Lab-Corps really helped us take this concept and define its value proposition,” said Winkler. “We determined there was a market need, and it was addressing people’s specific problems.”

With a true market defined to compete with window and portable ACs, which free up window space but are less efficient options that take up valuable floor space, Winkler and Booten quickly built their first prototype. They’re currently searching for additional funding and private investment opportunities. Once commercialized, they envision a price point between \$50 and \$100 more than current window ACs, which average around \$250 according to NREL.

EcoSnap-AC—which has been nominated for an R&D 100 Award by *R&D Magazine*, a publication that recognizes the most innovative technologies—is estimated to be at least 15% more efficient than standard window units. By mounting the model on the wall, it virtually eliminates air leakage and water infiltration, and it improves home security (a concern for many consumers). The design also includes less refrigerant charge than a mini-split system, which reduces its impact on the environment.

“The key point in all of this is keeping the cost down,” said Booten. “We want to give people what they want, at a price they want to pay. What the Energy Department wants in terms of energy efficiency sort of comes along for the ride.”



EERE Salutes Top Performing Organizations in Better Buildings Campaigns

The results of this year's Better Buildings Alliance technology and market campaigns are in: there are now more than 160 participants and supporters in the Interior Lighting Campaign (ILC) and 40 Green Lease Leaders. The ILC netted \$13.5 million in energy savings in its first year, and Green Lease Leaders added 1 billion square feet of commercial building space.

Dr. Kathleen Hogan, deputy assistant secretary for energy efficiency, announced these results and recognized the top performing participants of the campaigns at the Building Owners and Managers Association 2016 Conference & Expo on June 27 in Washington, D.C.

"The marketplace is seeing a rapid adoption of highly efficient indoor lighting and green leasing practices as the price of cutting-edge technologies and the risk of creative approaches continue to decline," Dr. Hogan told the gathering of commercial real estate professionals.

Dr. Hogan recognized ILC participants, including the Army Reserve, CKE Restaurant Holdings Inc., Cleveland Clinic Foundation, Northern Arizona University, Target, and T-Mobile. Others recognized at the event for energy efficiency improvements included Brandywine Realty Trust; Cuyahoga County, Ohio; Ivanhoe Cambridge; and JBG Companies.

Launched in 2015, the ILC quickly exceeded its initial goal of replacing 100,000 indoor fluorescent lighting troffers. Its new target is to upgrade 1 million more lighting troffers in commercial buildings across the country. Building owners can save up to 60% in energy costs by upgrading to newer troffers and up to 75% of lighting energy by adding controls such as dimmers, timers, and occupancy sensors.

Regarding green leasing, savings can be as much as 22%, representing a \$3 billion opportunity in annual cost savings across the nation. Green leases break down the barriers of traditional commercial leases in an effort to attain increased environmental and economic benefits for both owners and tenants.

Through Better Buildings, the Energy Department aims to make commercial, public, industrial, and residential buildings 20% more energy efficient over the next decade.



Small Business Vouchers Pilot Announces New Round of Awardees

The [Small Business Vouchers \(SBV\) Pilot](#) announced its second round of awardees, launching 43 new small business partnerships with the national laboratories. This pilot—which provides U.S. small businesses with funding, technical assistance, and access to the national laboratories' facilities and renowned technical experts—is part of the [National Laboratory Impact Initiative](#) to enhance the industrial impact of the labs in the clean energy sector.

The awardees, announced in August, received vouchers totaling more than \$8 million in funding from EERE to help them access the capabilities of the laboratories and bring their clean energy technologies to market faster. These small businesses will

address clean energy technologies in nine technical areas: advanced manufacturing, water, wind, bioenergy, buildings, solar, fuel cells, geothermal, and vehicles. Additionally, the second round introduces three new national laboratories to the program with whom businesses will partner.

One of the new SBV selectees, Elko Heat Company, received a \$200,000 voucher to work with Lawrence Berkley National Laboratory on geothermal development near the City of Wells, Nevada, where geologists have identified a tremendous geothermal asset that can be leveraged for economic development. By partnering with the city, Elko

Heat has a unique opportunity to strengthen its company, while significantly impacting the local economy and environment.

Another small business selected in SBV's second round is SiNode Systems, a battery materials venture developing silicon-graphene anodes for the next generation of lithium-ion batteries. In addition to its voucher from SBV, SiNode previously received a 2013 Department of Energy Small Business Innovation Research award and a \$4 million grant from the U.S. Advanced Battery Consortium, which included funding from EERE's Vehicle Technologies Office.

SBV's third round of competition will open this fall, so stay tuned!

Students Create Winning Designs Touting Geothermal Energy Merits

'Draw the heat beneath your feet.'

That was the challenge two winning teams took to heart during the Geothermal Design Challenge 2016 that ended this summer. The competition dared high school and university students to research, design, and promote infographics that explore the future of geothermal energy.

More than 100 teams from across the country participated in the three-phase competition hosted by the Energy Department in partnership with the Center for Advanced Energy Studies and Idaho National Laboratory (INL). Eleanor Roosevelt High School in Maryland and Yale University in Connecticut were announced as the first place winners on August 10, and each received a \$2,500 prize.

Carnegie Mellon University in Pennsylvania was named the grand prize winner. Its team received \$2,500 plus an all-expense-paid trip to the Geothermal Resource Council's 40th Annual Meeting, which will be held October 23–26 in Sacramento, California.

Competition sponsors are proud of the students and hope that what they learned stays with them, or better, opens doors to their future.

EERE's Geothermal Technologies Office (GTO) "must continue to reach out to new audiences and increase the number and diversity of geothermal advocates and consumers," said Elisabet Metcalfe, a physical scientist with GTO's Enhanced Geothermal Systems Program. "By engaging students and their schools, exposing them to geothermal technologies, and incentivizing participation in a geothermal competition, GTO

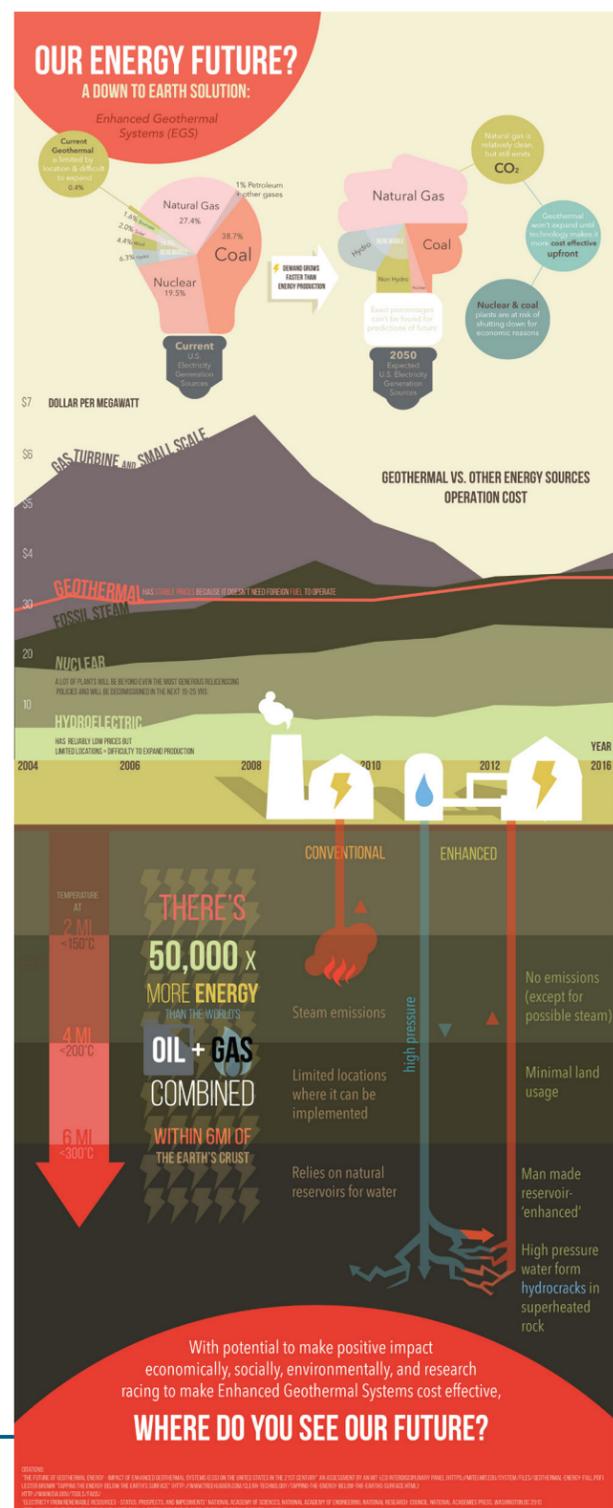
hopes to generate interest and encourage students to pursue a career in geothermal energy."

The competition brought together teams across 30 states, including Idaho, Connecticut, North Carolina, and California. Using topic areas of enhanced geothermal systems, hydrothermal resources, and low-temperature and co-produced resources, GTO asked students to research data, interpret the information, and create a captivating infographic to tell the story of the future of geothermal energy. Their first deadline was March 15.

Next, students had to refine and revise their infographics by May 15. Students also received a technical mentor to work with them. Finally, students had to add in a social media component, also with the help of a mentor, by July 15. Teams leveraged multiple channels to promote their infographics, including LinkedIn, YouTube, Facebook, Tumblr, Instagram, Snapchat, and Pinterest. One team had a total of 392,345 Twitter impressions over a two-week period. Students were judged on research content, design/aesthetic communication, and innovation by a committee of engineers, energy experts, and creative professionals.

With lessons learned from the original competition in 2014, this year's challenge was bigger and better than ever, said Tammi Borders, an INL scientist.

"I was very impressed with the diversity of capabilities and the progress [the students] made," said Borders. "They recognized the social impact and policy needed to accelerate commercialization of clean energy technology."



Rare Earth Element Extraction Technology Focus of EERE Geothermal Work

Pacific Northwest National Laboratory (PNNL) researchers are among a handful of teams exploring new methods to recover strategic, critical, and high-value metals (SCVM) vital to a host of clean energy technologies, such as solar panels, wind turbines, electric vehicles, and energy-saving lighting.

PNNL began developing and testing a magnetic partitioning method during the first phase of the Geothermal Technologies Office's (GTO's) [Mineral Recovery](#) initiative in 2014, and the lab will continue to advance the technology with the help of an additional \$1.65 million recently awarded by the Energy Department for Phase II of the initiative.

The Energy Department is pursuing a range of research and development efforts to secure and diversify the supply of SCVM, including rare Earth elements; identify substitute materials; and develop better ways to recycle

these materials. One exciting area of this research is the recovery of materials from fluids or "brine" produced from the Earth's subsurface by geothermal and other energy or mining projects.

GTO is exploring unique ways to extract valuable resources that are sometimes dissolved in the large fluid volumes brought to the surface by geothermal plants. Brine pumped from underground naturally contains minerals and other metals, such as rare earth elements, that are found within the hot rock below the Earth's surface. Extracting these valuable elements could provide geothermal energy producers with another revenue source—the sale of rare earth elements. However, because the concentration of these elements is often very small, conventional extraction methods are simply too large and too expensive, and they would degrade the efficiency of geothermal energy plants.

Enter PNNL Fellow, [Pete McGrail](#); he and his team developed a new process to extract rare earth elements from geothermal brine by incorporating magnetic properties into a unique nanomaterial then using simple magnets to collect the material. The new method introduces magnetic nanoparticles consisting of a shell or framework that combines metal and an organic structure, or MOF, into the geothermal brine. The MOF outer layer carries molecules that are attractive to rare earth elements, causing the elements to stick to the nanoparticle.

Using this method, the brine is then passed through a magnetic separator to remove the nanoparticles containing rare earth elements. The now nanoparticle-free brine is recirculated to recover more rare earths from the geothermal fluids. What's more, PNNL test results showed a nearly perfect rare earth element extraction rate of 99.99%.



Office Round Ups

ENERGY EFFICIENCY

Advanced Manufacturing Office

New Composites Recycling Partnership Leverages AMO's Shared Innovation Infrastructure

Three partners in the composites industry came together on July 1 for a ceremonial signing of two memorandums of understanding. The collaborative agreements brought together the Composite Recycling Technology Center, the Institute for Advanced Composites Manufacturing Innovation, and Peninsula College in Port Angeles, Washington, to develop advanced methods of recycling composite materials.

Better Plants Team to Sponsor World Energy Engineering Conference in September

AMO's Better Plants program is sponsoring the World Energy Engineering Conference this year. The program will lead four sessions: Value of ISO 50001, Onsite Generation, Water/Energy, and Data Analysis. Each session will feature speakers from AMO partners. They will also have a booth in the expo where they will showcase a 3D printer, program materials, and other visuals. Better Plants will also host an invite-only breakfast for partners to include an update on program activities; recognitions from Mark Johnson, the AMO director; and a guest presenter, the former energy manager for Alcoa.

Federal Energy Management Program

Energy Exchange 2016

This year's Energy Exchange event, organized by FEMP, through Oak Ridge National Laboratory, kicked off August 9-11 at the Rhode Island Convention Center in Providence. FEMP Director Dr. Tim Unruh, Federal Chief Sustainability Officer Christine Harada, and U.S. Army Secretary Eric Fanning were among the featured speakers at the training event, where energy managers from across the nation meet to share cost-effective, actionable solutions for federal sustainability. The three-day event trained more than 2,200 energy managers and sustainability professionals from both the public and private sectors. The majority of participants were federal employees working to improve federal facility performance, increase the use of renewable energy, reduce greenhouse gas emissions, and provide energy leadership to the country.



RENEWABLE POWER

Solar Energy Technologies Office

SunShot Launches Solar Training Network

SunShot announced the launch of the Solar Training Network, which connects solar workforce trainers, solar employers, and individuals interested in working in the solar industry. The office also released a request for information to plan for a Community Solar Challenge. It is designed to encourage teams in dozens of communities to develop innovative models to increase solar deployment, particularly in low-income communities. In addition, SunShot announced \$11 million for 16 projects intended to develop innovative, early-stage solutions in both photovoltaics and concentrating solar power. Finally, the office did a themed content week this summer featuring solar and real estate. This campaign included five blog posts and numerous social media posts that proved quite popular with the public.

STRATEGIC PROGRAMS

Technology-to-Market

Incubatenergy Network Connects in California

Technology-to-Market staff joined leading clean energy incubators, accelerators, and entrepreneurs as they connected with industry executives and investors at the Incubatenergy Network Summer Meeting August 2-3 in Marina Del Ray, California. The meeting included a visit to the Los Angeles Cleantech Incubator for a full-day workshop addressing key business, technological, and innovation challenges for the incubator and utility communities.

EERE International

EERE International and South Africa's Department of Energy co-hosted the Smart Energy Technology Conference in Pretoria in June, gathering more than 70 stakeholders, government officials, and U.S. businesses to discuss innovative clean energy technologies. Also in South Africa, Lawrence Berkeley National Laboratory trained more than 30 government officials and researchers on using Energy Department-developed building simulation software. The lab presented its recommendations to the South African Bureau of Standards for adopting more stringent, energy-efficient building codes, which will save energy for South Africa, while creating market opportunities for U.S. providers of efficient building materials and components.

TRANSPORTATION

Vehicle, Fuel Cells, and Bioenergy Technologies Offices

Administration Accelerates EV Actions on Heels of Sustainable Transportation Summit

On the heels of the Energy Department's first-ever [Sustainable Transportation Summit](#), hosted by EERE, the Obama Administration announced new steps from the federal government, private sector, and states, as well as a new framework for collaboration among vehicle manufacturers, electric utilities, electric vehicle charging companies, and states—aimed at putting more electric vehicles on the road and speeding deployment of the charging infrastructure.

The collaboration—announced by the White House on July 21 among the Departments of Energy and Transportation, the U.S. Air Force and the Army, and the Environmental Protection Agency—is centered on a set of Guiding Principles to Promote Electric Vehicles and Charging Infrastructure signed by representatives from nearly 50 organizations. The effort is designed to help ensure that electric vehicle drivers have access to charging stations at home, at work, and on the road, and it is creating a new way of thinking about transportation to drive America forward, the White House statement said.

The planned actions include unlocking up to \$4.5 billion in loan guarantees and inviting applications to support the commercial-scale deployment of innovative electric vehicle charging facilities; launching the FAST Act process to identify zero emission and alternative fuel corridors, including for electric vehicle charging across the country; and leading an effort to develop a 2020 vision for a national network of electric vehicle fast charging stations that will help determine where along the corridors it makes the most sense to locate the fast charging infrastructure.

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