

What's Happening  
@ EERE

# Amped Up!

Volume 2, No. 5, December 2016

U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

## BUILDING A STRONGER ENERGY ECONOMY FOR AMERICA



## IN THIS ISSUE

A Message from David..... 3

Recovery Act Investments Propel Clean Energy Revolution ..... 4

L Prize® Competition Drives LED Lighting Innovation and Energy Savings ..... 6

Federal Commitments Save Energy and Create Jobs .....7

*Revolution...Now* 2016 Released..... 8

Driving the Future of Advanced Manufacturing..... 9

Offshore Wind Initiative Prepares Industry for Launch .....10

A New Era for Wind Power in the United States..... 11

SunShot Inspires Cost Reduction and Change...12

Vision for Hydropower Central to Our Energy Mix.....13

Now Boarding: Renewable Jet Fuel .....14

EERE Celebrates National Hydrogen and Fuel Cell Day ..... 15

SuperTruck Initiative Overhauls Freight Efficiency .....16

EVs Drive Americans Toward a More Secure Nation ..... 17

The Grid Modernization Initiative Predicts, Protects, and Controls the Grid.....18

U.S.-Brazil Collaboration Leads to Energy Use Reduction.....19

DOE Lab-Corps Spurs Success .....20

Game Changer: Technology Innovation Investment Playbook.....21

Charting the Path for a Cost-Competitive Bioeconomy.....22

2020—A Benchmark Year for Goals.....23

Industry Partners Lead Charge in Developing Next Generation Refrigeration Technology ....24

Appliance Standards Affect Our Everyday Lives..... 25

Q & A: SETO Director Dr. Charlie Gay .....26

Q & A: WPTO Acting Director Jim Ahlgrimm ..... 27



## A Message from David



In my last issue as Acting Assistant Secretary, I want to thank you.

I am humbled by the opportunity to lead this tremendous organization on its mission. Your hard work is not only appreciated, it makes a difference every day in strengthening our economy and tackling some of the world’s most critical challenges. I am honored to support the people who make EERE great.

This issue highlights our triumphs over the last eight years and focuses on what we have been able to accomplish, allowing EERE to invest in programs that created jobs and helped save Americans money.

From the birth of the SunShot Initiative to SuperTrucks rolling down the road, this issue celebrates how instrumental EERE has been in propelling our nation forward in the clean energy revolution.

This issue also features the 40th anniversary of the Weatherization Assistance Program and looks at the results of *Revolution... Now*, a report that depicts how far we have come. We also discuss the achievements of electric vehicles, which over the last eight years have reached the half million mark. Today, every major auto manufacturer has introduced a plug-in electric vehicle into its offerings, and consumers can choose from nearly 30 different models.


Packed full of EERE successes that have made an impact in the way we live and work today, this issue demonstrates the importance of our mission and how we will continue moving toward our goals.

Finally, you’ll have the opportunity to meet two new directors who will help carry EERE to the next level: Charlie Gay, Director of the Solar Technologies Office; and Jim Ahlgrimm, Acting Director of Water Power Technologies Office.

I hope you enjoy this issue of *Amped Up!*

*David*

*Amped Up!* is a quarterly magazine on the latest developments within EERE and is brought to you by EERE’s Communications Office; do not cite or release without prior approval. If you have any suggestions or comments about what you would like to see in this magazine, please contact eeAmpedUp@ee.doe.gov.



General Motors' Brownstown battery is an example of a plant that was built to assemble battery packs for the Volt extended range electric vehicle, but has production capability for additional electric and hybrid electric vehicles. Photo courtesy of General Motors.

## Recovery Act Investments Propel Clean Energy Revolution

In February 2009, President Obama signed the American Recovery and Reinvestment Act of 2009 (ARRA or the Recovery Act) into law, investing in programs to create jobs and fuel America's clean energy future. That moment launched the clean energy revolution, thrusting the Office of Energy Efficiency and Renewable Energy (EERE) to the frontlines.

EERE's Recovery Act funding helped local entities at a small scale, and the programs and investments it launched are continuing to help clean energy technologies develop at a larger scale.

Claudette Jones is an example of an individual who directly benefitted from ARRA funding. She lived in her Denver, Colorado, home for more than 40 years. She had no heat, her furnace was leaking carbon monoxide, and she had no hot water.

Jones turned to the Energy Department's Weatherization Assistance Program (WAP) for help.

Thanks to ARRA funding, the number of homes weatherized by WAP programs during the ARRA period, including non-ARRA funded homes, was roughly 1,482,000. As a result, low-income families have collectively saved billions on energy bills. Through WAP, Jones received a new furnace, water heater, and insulation.

"I'm really happy with it; it feels safer," said Jones. "People should ask for help. I had no idea they could do this."

WAP is just one of the many Energy Department programs that benefitted from the more than \$16 billion ARRA investment to help spark the U.S. clean energy economy from 2009–2012.

For example, thanks to ARRA, EERE's State Energy Program created tens of thousands of jobs and educated more than 575,000 people in energy audits and installations through workshops and training sessions. In addition, more than 100,000 buildings (731 million square feet) received energy efficiency upgrades, along with state wastewater treatment improvements and alternative financing.

New programs also emerged from ARRA funding, including the Energy Efficiency and Conservation Block Grant (EECBG)—the largest direct nationwide investment in energy efficiency and renewable energy technologies at the community level in U.S. history.

EECBG helped cities, communities, states, territories, and Indian tribes

develop, promote, and implement energy efficiency and conservation projects, ultimately creating jobs.

Energy Department field sites worked with headquarters and laboratory partners to handle the workload, establishing an effective team to work with more than 2,300 individual recipients to approve or disapprove their energy proposals. These efforts resulted in thousands of jobs, more than 90,000 building retrofits, and 470,000 street lights and traffic signals retrofitted for energy efficiency.

As a result of all of Recovery Act efforts, EERE created and retained more than 140,000 jobs for its growing clean energy workforce. EERE used ARRA funds to help further its mission toward a global clean energy economy by supporting projects across its portfolio in varying stages of market readiness.

For example, with nearly \$25 million in ARRA funding, the Massachusetts Large Blade Test Facility established the Wind Technology Testing Center, which is capable of simultaneously testing three large wind turbine blades of up to 90 meters in length.

The center's testing capabilities accelerate technical innovation in turbine blade design and speed up deployment of longer turbine blades, which can produce more energy per turbine and help reduce the overall cost of wind energy, both on land and offshore.

Further, as a result of ARRA, researchers at the Newberry Volcano enhanced geothermal system (EGS) project created and confirmed the development of a new reservoir surrounding the injection well at the site by using a novel chemical diversion technology.

A landmark achievement for the EGS community, the project benefitted from cutting-edge analysis techniques from three separate teams of seismologists to map complex micro-earthquake

locations and identify limitations surrounding highly advanced seismic monitoring systems.

In the past eight years, the number of plug-in electric vehicle models increased from one to more than 20; battery costs have decreased 70%; and the number of electric vehicle charging stations have increased from less than 500 in 2008 to more than 16,000 today—a 40-fold increase.

EERE also allocated \$1.5 billion in ARRA funds to establish the supply chain capacity and market entry required for the next generation of plug-in electric vehicles. Through these efforts, researchers in materials, cell, and battery pack manufacturing facilities established 3.5 gigawatt hours of battery capacity for plug-in electric vehicles and stationary applications.

"The Recovery Act, which represented a one-time investment equal to 10 times EERE's annual budget, launched clean energy forward and put EERE technologies on the map," states EERE's Deputy Assistant Secretary for Operations Steve Chalk. "The results of this investment set the stage for the tremendous progress over the last eight years that have made EERE technologies cost competitive."

As the recently released *Revolution... Now* report tracks the progress of wind turbines, utility-scale and distributed photovoltaics, electric vehicles, and light-emitting diodes, it does so since ARRA's investment, and the advancements are significant. The report shows how Recovery Act funding laid the foundation for these technologies that are paying off tenfold today and will continue to pay off in the years to come.

Thanks to ARRA funding and smart EERE investments, the clean energy revolution is upon us, and EERE is at the forefront—creating a blueprint for our nation and the world to advance to a clean energy future.

## Federal Commitments Save Energy and Create Jobs

Federal agencies have a tremendous opportunity and obligation to reduce energy, water, and petroleum use, as well as greenhouse gas emissions, through their operations. The President's Performance Contracting Challenge (PPCC), initiated in 2011, emphasizes innovative performance contracts to allow agencies to do just that.

The PPCC asked federal agencies to commit \$2 billion in energy savings performance contracts through 2013. Then, in May 2014, President Obama announced an expansion and extension of the PPCC to \$4 billion by the end of 2016.

"It looks like we could achieve that goal," said Schuyler Schell, supervisor for procurement services with the Energy Department's Federal Energy Management Program. "Already \$3.6 billion has been awarded and we have a pipeline that could allow the government to meet and actually exceed the \$4 billion goal."

Under energy performance contracts, utilities or energy service companies identify energy savings improvements, design a cost-effective project to meet agency needs, arrange for financing, and ensure that sufficient energy and energy-related cost savings are available to pay the projects, costs up to a 25-year term. Following the term, all cost savings accrue to the agency.

Upgrades may include lighting, heating, ventilation, and air conditioning, energy management infrastructure, water conservation improvements, and construction of renewable power generation such as solar photovoltaics.

"If we save 20% to 40% of energy and related operations costs, energy service companies (such as Honeywell, Johnson Controls, and NORESKO) are able to make significant upgrades to a site's aged infrastructure without any new appropriations, which is key because this gives them a path forward," said Schell.

As a result of the challenge, there's been a large creation of energy jobs and a significant reduction of greenhouse gas emissions. Reaching the \$4 billion goal will result in the creation of over 32,000 jobs and save 1.4 million tons of carbon dioxide annually, the equivalent of taking 268,000 cars off the road.

The PPCC includes participation from 22 federal agencies and entities, including the Departments of Energy, Defense, Veterans Affairs, Justice, and Health and Human Services; the General Services Administration; and the National Aeronautics and Space Administration. These energy performance contracts have been deployed at facilities nationwide.

"These contracts are unique tools that Congress has provided to agencies to allow them to go out and get energy and water efficiency—as well as renewable projects—done without having to wait for Congress to appropriate additional funds," Schell said. "So this is pretty remarkable, and it's a great thing agencies are taking advantage of it."

### WAP DELIVERS MORE COMFORT FOR LESS MONEY

Celebrating its 40th anniversary this year, the Weatherization Assistance Program (WAP) works with state and local partners to identify and upgrade homes in need of improvement, and millions of American lives have benefitted in the process.

Since 1976, the program has weatherized more than 7 million homes and has evolved from adding weatherstripping, caulking, and window-covering plastic sheeting, to insulating and replacing heating systems.

"Delivering services to the most vulnerable families is a national network of highly trained professionals and 22 training centers that ensure the workforce provides state-of-the-art weatherization," says WAP Manager David Rinebolt. "WAP sets the standard for the home performance industry."

As the nation's oldest and largest whole-house energy efficiency program, WAP serves families living at or below 200% of the federal poverty level, with priority given to families with children, seniors, and disabled individuals.

The results speak for themselves—analysis shows that for every \$1 invested, the return is \$4.50. Weatherized homes reduce utility bills and promote economic development. The program has a proud history of making a difference and looks forward to making that difference for many decades to come.

## L Prize® Competition Drives LED Lighting Innovation and Energy Savings

Thanks in part to an Energy Department competition, [L Prize®](#), light-emitting diodes (LEDs) have dropped in cost and increased in performance. The competition, which launched in 2008, contributed to holding the LED replacement lamp market to higher levels of performance, helped catalyze the market, and pushed industry toward a clear target.

According to the latest Energy Department [Revolution...Now](#) report, total installation of LED A-type bulbs (the most common type) exceeded 200 million last year, growing 160% over 2014 and now accounting for 6% of all currently installed A-type lamps.

But it wasn't always that way. When LED bulbs started to emerge in 2007, they were costly. A 94% reduction in cost has largely enabled their growth, and today, the best-performing 60-watt-equivalent LED bulbs on the market consume 85% less energy than the incandescent bulbs they're intended to replace.

The L Prize competition was instrumental in making these positive

changes to spur market growth. When the competition launched, most LED replacement bulbs were poor quality and wouldn't satisfy consumers looking to replace the ubiquitous 60-watt incandescent bulb. The Philips Lighting North America entry proved Energy Department targets were reachable, and motivated others to follow its lead.

As the 2011 L Prize winner, Philips set the bar for consumer satisfaction and success. The company's technology advances—including more efficacious LED chips, electronic miniaturization, better heat transfer, improved optics, and remote phosphors—have had a lasting impact on its LED offerings.

The advances developed for the L Prize entry found their way into millions of subsequent Philips products that continue to save massive amounts of energy each year. Philips estimates that this family of products reached sales representing more than \$51.3 million in energy savings in the first two years alone.

Ed Crawford, CEO of Philips Lighting, credits the L Prize with

pushing his company to focus its research efforts on LED bulbs—accelerating those efforts 3–5 years ahead of where they would have been without the competition.

To win the competition, the Philips entry had to survive more than 8,000 hours of accelerated long-term testing under elevated ambient temperatures. Following the win, some of the samples continued to test through more than 50,000 hours of continuous operation.

For Jim Brodrick, Energy Department Lighting Program manager, the L Prize made a world of difference.

"The L Prize challenges the best and brightest minds in the U.S. lighting industry to make the technological leaps forward that can greatly reduce the money we spend to light our homes and businesses each year," says Brodrick. "Not only does the L Prize challenge innovative companies like Philips to make LED technology even more energy efficient, it also spurs the lighting industry to make LEDs affordable."



## Revolution...Now 2016 Released

The Energy Department released its annual *Revolution...Now* report in September, charting the progress of five clean energy technologies: wind turbines, utility-scale and distributed solar photovoltaics, electric vehicles (EVs), and light-emitting diodes (LEDs).

The report proves that continued investments in these technologies are paying off—demonstrating dramatic increases in America’s clean energy deployment, with price reductions as high as 94% since 2008. A few of the major findings include the following:

- Wind and solar accounted for more than two-thirds of all new U.S.-installed electricity capacity.
- Installation of LED A-type bulbs exceeded 200 million through 2015—growing 160% over 2014. The cost of LED bulbs has dropped by 94% since 2008.
- Total sales of EVs reached more than 490,000 as of August 2016, with more than 500,000 on U.S. roads.

In addition, the report also explores the status of emerging technologies, including fuel cells, grid-connected

batteries, energy management systems, and big area additive manufacturing, commonly known as 3-D printing.

“*Revolution...Now* summarizes in a clear and accessible way the remarkable progress in the cost and deployment of the five core clean energy technologies that are having a dramatic impact today, while giving readers a sneak preview of clean energy technologies that are most likely to revolutionize the energy system of tomorrow,” said Stephen Capanna, director of the Energy Department’s Strategic Priorities and Impact Analysis Program.

### MANUFACTURING USA—THE NETWORK THAT SPANS THE INDUSTRY

The United States is in a global race with foreign countries to provide clean, safe, and affordable energy to people around the world. This multi-trillion dollar economic opportunity means hundreds of thousands of new jobs for Americans in energy, transportation, and other sectors as manufacturing continues to make a comeback in the 21st century.

The Energy Department is aggressively working to help revitalize U.S. manufacturing and encourage companies to invest in America. One key factor in strengthening this resurgence is through the support of President Obama’s National Network for Manufacturing Innovation—now known as Manufacturing USA—a network of institutes that span the manufacturing industry, government, and academia. These public-private partnerships connect people, ideas, and technology to solve advanced manufacturing challenges.

EERE continues to lead the push for 15 initial institutes that will eventually grow to 45 over the next 10 years. The Advanced Manufacturing Office recently established its fourth innovation facility in November and has plans to establish a fifth institute this month. In addition, EERE has also helped establish two new high-impact manufacturing demonstration facilities with the national labs that focus on additive manufacturing and high-performance computing.

EERE-led institutes include PowerAmerica; the Institute for Advanced Composites Manufacturing Innovation; Smart Manufacturing Innovation Institute; Modular Chemical Process Intensification Institute; and the soon-to-launch REMADE America Institute.

Since its start in 2011, Manufacturing USA has grown to nine connected institutes, with nearly 1,300 member companies, universities, and nonprofits.



A prototype Mustang hood part formed by the RAFFT machine hangs in the machine’s clamping system. (Photo courtesy of Ford Motor Company)

## Driving the Future of Advanced Manufacturing

The Advanced Manufacturing Partnership, launched in 2011 by President Obama, included an investment of about \$100 million from the Energy Department’s Advanced Manufacturing Office (AMO) for the Innovative Manufacturing Initiative—part of AMO’s vigorous portfolio of cutting-edge manufacturing research and development (R&D) projects.

This initiative brought together industry, universities, and the federal government to fund targeted investments in transformational industrial technologies that are expected to create manufacturing jobs and enhance our global competitiveness. The 30 awarded projects emphasized processes and materials that were innovative in their design or impact and were capable of being commercialized within a few years.

“These projects drive innovation in game-changing technologies. They aren’t just ideas being tested in a lab; these are technologies that industry is eager to start using,” said Isaac Chan,

R&D projects program manager for AMO.

For example, Tulane University was awarded \$1.5 million to develop an Automatic Continuous Online Monitoring of Polymerization (ACOMP) reactions platform, the first computationally assisted active control of polymerization conversion. Traditional polymer manufacturing utilizes batch processes that use labor-intensive, offline analyses to validate products and perform quality control. The ACOMP system provides a closed loop feedback controller where the concentration will pass to an automatic controller, which then sets the reactor feed pump rate without any human intervention.

As a result of a partnership with Louisiana State University and Advanced Polymer Monitoring Technologies, Tulane researchers were able to demonstrate a successful pilot-scale system, and they are continuing to improve and scale the technology to meet commercial

polymer manufacturing requirements.

In another project, the Ford Motor Company designed a new rapid freeform sheet metal forming system (RAFFT) for small-volume, on-demand industrial parts. The RAFFT system, built by Ingersoll Production Systems, clamps a metal sheet in place and uses two stylus-type tools, one on either side, that are eliminating the need for stamping dies and their associated heavy machinery and presses.

The RAFFT system helps manufacturers drastically cut down lead time, decrease energy consumption by 50%–90%, and reduce the cost of low-volume production by up to 90%.

Innovation is critical to U.S. competitiveness in manufacturing and the global energy race. The industry support and private sector follow-on funding for these projects show that AMO’s work is driving the future of advanced manufacturing.

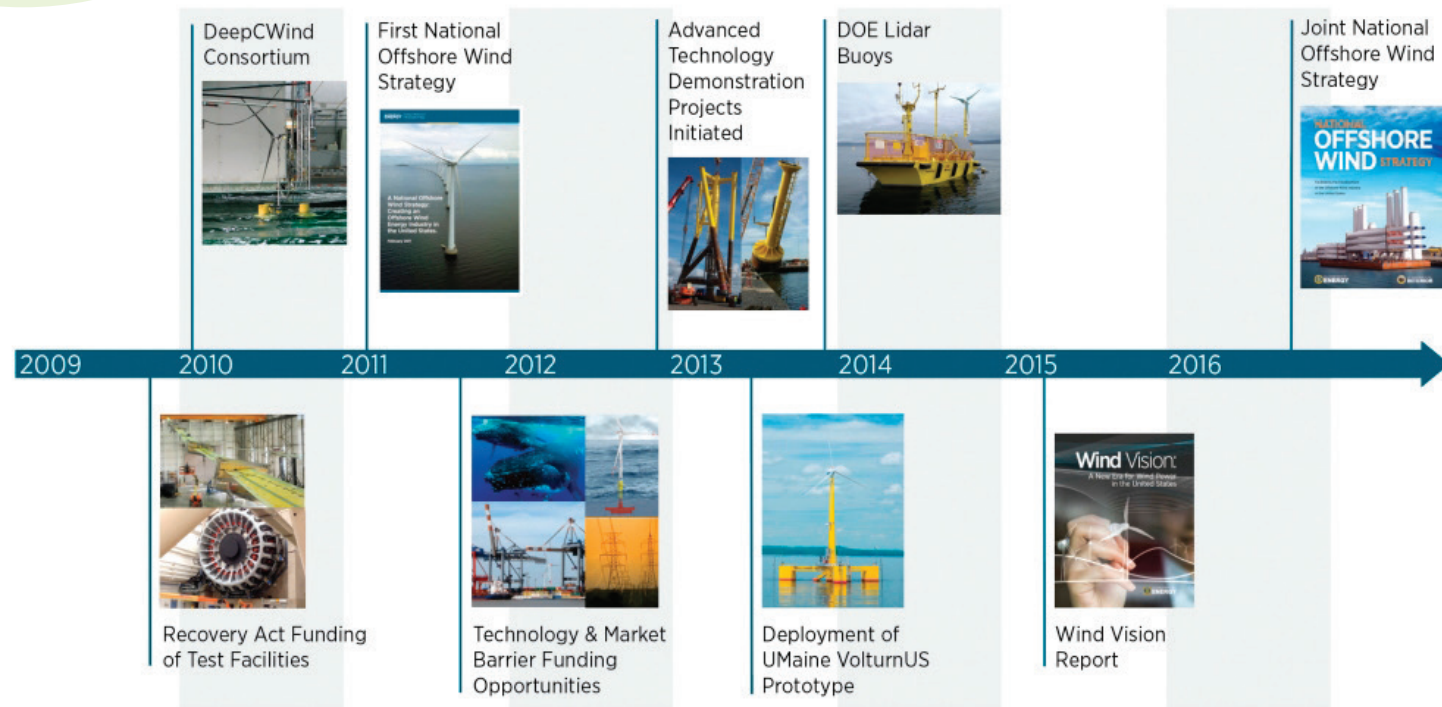
## Offshore Wind Initiative Prepares Industry for Launch

Offshore wind is coming of age.

Today, coastal and Great Lakes states account for nearly 80% of U.S. electricity demand. Winds off the shores of these coastal load centers have a technical resource potential twice as large as the nation's current electricity use.

But how did we get here, and where are we headed? Through the Energy Department's demonstration projects and the *National Offshore Wind Strategy*, recently released with the Department of the Interior, we have a roadmap to offshore wind's role in a clean, affordable, and secure national energy mix.

The Energy Department's Wind Energy Technologies Office (WETO) has allocated over \$200 million to offshore wind research, development, and demonstration projects across the country under the auspices of the first national offshore wind strategy released in 2011.



“Since 2011, our office has been supporting a robust portfolio of offshore wind technology development, market acceleration, and advanced technology demonstration projects to address key challenges and opportunities facing U.S. offshore wind,” said WETO Director Jose Zayas. “A flagship of DOE’s offshore wind portfolio is the \$168 million advanced technology demonstration program, which features innovative offshore wind technologies that have yet to be deployed on a commercial scale. These demonstration projects have innovative features and are among the first of their kind making their way through state and federal permitting, approval, and grid interconnection processes in the United States.”

The Fishermen’s Energy Atlantic City Windfarm is one of those projects. It will feature six 4-megawatt (MW) turbines on domestically produced twisted jacket foundations off the coast of Atlantic City, New Jersey. But that’s not the only project making a difference in the offshore wind arena. Lake Erie Energy Development Corporation’s Icebreaker project will feature six 3.45-MW turbines on Mono Bucket foundations off the coast of Cleveland, Ohio, in Lake Erie. These are only two examples of several projects that are making a difference in the wind arena.

The recently released *National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States* details the current state of offshore wind in the country, presents the actions and innovations needed to reduce deployment costs and timelines, and provides a roadmap to support the growth and success of the industry. Its findings are significant; it shows us where we’re going, and for Zayas, the path to get there.

## A New Era for Wind Power in the United States

The Energy Department released the highly anticipated *Wind Vision* last year—a report that quantifies the economic, environmental, and social benefits of a robust wind energy future through 2050. Defining a roadmap of targeted actions that the country can take to build upon wind energy’s continued success, *Wind Vision* revisits the findings of the 2008 *20% Wind by 2030* report.

The report takes America’s current installed wind power capacity across all facets of wind energy (land-based, offshore, and distributed) as its baseline—a capacity that has tripled since 2008. It assesses the potential economic, environmental, and social benefits of a study scenario where U.S. wind power supplies 10% of the nation’s electrical demand in 2020, 20% in 2030, and 35% in 2050. *Wind Vision* builds upon the continued success of the wind industry to date and quantifies a robust wind energy future.

Several key findings include the following:

***Wind energy has the potential to provide clean, renewable energy***

***in every state.*** *Wind Vision* shows that wind can be a clean and viable source of renewable electricity in all 50 states by 2050.

***Wind supports a strong domestic supply chain.*** Wind has the potential to support over 600,000 jobs in manufacturing, installation, maintenance, and supporting services by 2050.

***Wind is affordable.*** The price of wind energy is projected to be directly competitive with conventional energy technologies within the next decade.

***With more wind energy available, the electric utility sector is anticipated to be less sensitive to the volatility in natural gas pricing.*** By reducing our national vulnerability to price spikes and electrical supply disruptions, researchers anticipate that wind will save consumers \$280 billion in natural gas costs by 2050.

***Wind reduces air pollution emissions.*** Wind energy already helps the country avoid the emissions of over 250,000 metric tons of air pollutants each year, which include sulfur dioxide, nitrogen oxides, and

particulate matter. Wind is expected to offset the emissions of more than 12.3 gigatonnes of greenhouse gases by 2050.

***Wind energy preserves water resources.*** By 2050, wind energy can save 260 billion gallons of water—the equivalent to roughly 400,000 Olympic-size swimming pools—that would have been used by the electric power sector.

***Wind deployment can increase community revenues.*** Local communities will be able to collect additional tax revenue from land lease payments and property taxes, reaching \$3.2 billion annually by 2050.

More than a year after the *Wind Vision* release, the U.S. wind energy industry employs more than 88,000 people, the first offshore wind farm stands off the coast of Rhode Island, and our nation’s wind power capacity stands at over 75 gigawatts, which is enough to power 20 million American homes.

As a viable source of renewable power that will help our country achieve energy independence, wind has the potential to push the boundaries of energy further than ever before.



## Hydropower's Vision: Central to our Energy Mix

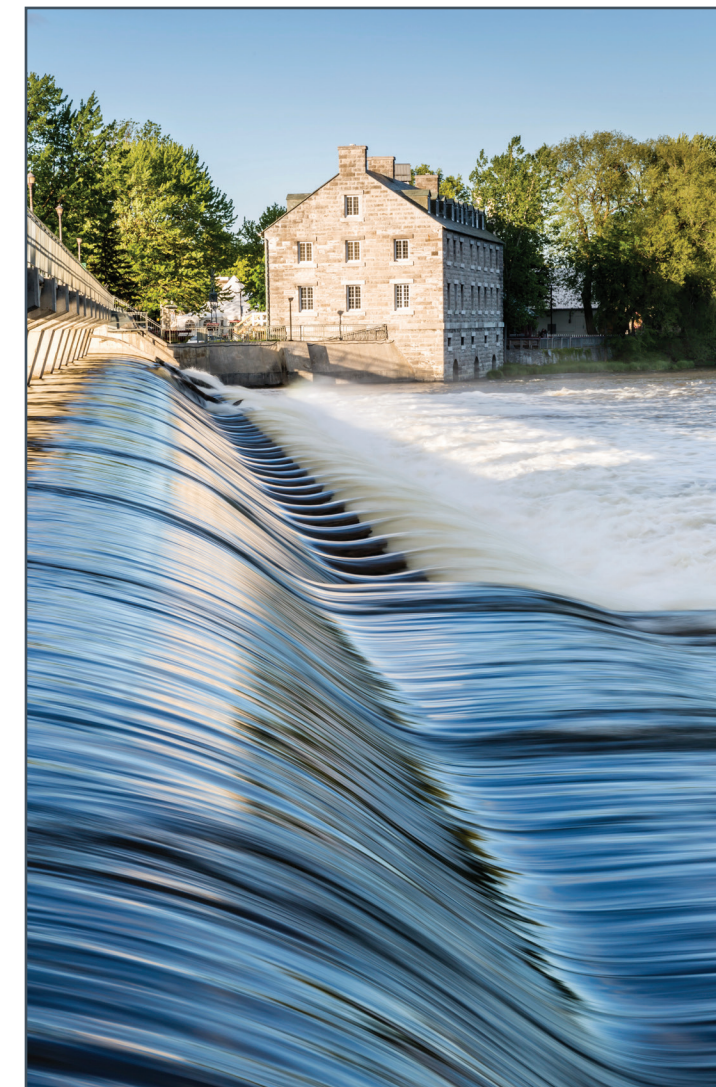
For more than a century, hydropower has produced affordable, reliable, and domestic electricity. It provides [about 7% of the nation's electricity](#) and supports more than 143,000 jobs in engineering, manufacturing, construction, and utility operations and maintenance—all while improving the environment and strengthening our economy.

As we look to the future, hydropower's role remains essential to our nation's energy mix. [Pumped-storage hydropower](#), for example, represents 97% of all energy storage in the United States, offering the flexibility and reliability the electricity grid needs to deliver affordable energy to homes and businesses.

During the past two years, the Water Power Technologies Office (WPTO) collaborated with more than 300 experts from more than 150 hydropower industry companies, environmental organizations, state and federal governmental agencies, academic institutions, electric power system operators, research institutions, and other stakeholders to explore how the hydropower industry could evolve in the coming decades.

These experts conducted a first-of-its-kind comprehensive analysis to evaluate future pathways for hydropower in the United States through 2050. The resulting [Hydropower Vision](#) report defines the societal, environmental, and economic benefits of hydropower in a scenario where U.S. hydropower could grow from 101 gigawatts (GW) of combined generating and storage capacity in 2015 to nearly 150 GW by 2050, with more than 50% of this growth by 2030.

“The *Vision* lays out the many actions and efforts to further the advancement of domestic hydropower as a key energy source of the future,” said WPTO's Hydropower Program Manager Tim Welch.



Although the report does not make any policy recommendations, it does provide a roadmap that the hydropower industry, research community, and others can use to achieve higher levels of hydropower deployment within a sustainable national energy mix.

Carrying out the roadmap actions will usher in a new era of growth in sustainable domestic hydropower, while protecting the nation's energy, environmental, and economic interests.

The five “action areas” that would help achieve the *Hydropower Vision* include: developing innovative technologies that will help reduce costs and improve power production efficiencies and environmental performance; using integrated approaches that balance environmental, social, and economic factors; incentivizing new and existing hydropower for the numerous energy production and grid support services it provides; increasing access to shared data, making information on relevant scientific advances available, enhancing process efficiency, and reducing risks and costs; and sharing best practices for maintaining, operating, and constructing facilities, as well as for developing program curricula to train new hydropower professionals.

The Energy Department is proud to have worked with several hundred experts and organizations, including the national laboratories, to develop this vision for America's hydropower future. This is just the beginning of what hydropower can accomplish in the decades to come.



The Mueller community in Austin, Texas, has the highest concentration of owner-installed solar rooftop panels in the country.

## SunShot Inspires Cost Reduction and Change

Five years ago, the Energy Department launched the SunShot Initiative to accelerate solar cost reduction. Today, solar power is more affordable and accessible than ever. There are more than one million solar installations nationwide that provide enough electricity to power more than six million average American homes.

But where did it start? The SunShot name was inspired by President Kennedy's 1962 “moon shot” speech that set the country on a path to lead the space race, land a man on the moon, and ensure a safe return. This bold vision propelled the country forward and proved successful. The Energy Department has a similarly bold vision for solar energy.

Since its launch, SunShot has been dedicated to establishing the economic competitiveness of solar, both domestically and internationally. This program, which is overseen by the Solar Energy Technologies Office (SETO), has funded hundreds of projects that have created a portfolio of opportunities and demonstrated

progress in making every step of the “going solar” process more affordable.

“SunShot has established credibility in the power of solar to be a major contributor in the clean energy portfolio,” said SETO Director Charlie Gay. “Our investments cover the panorama of diverse opportunities for reducing cost while improving efficiency and reliability. By teaming with industry stakeholders spanning from large solar companies to small start-ups, along with universities and national labs, we are on track to reach our goals ahead of schedule.”

As the country expects to continue increasing the number of solar jobs and scaling the rate of solar adoption, the pipeline of opportunities and ever-expanding talent pool will continue to drive down costs—making clean energy an ever increasing part of American life.

SunShot has made progress across its entire portfolio. The photovoltaic (PV) subprogram has catalyzed increased solar panel efficiency and targeted practical approaches to increase module

and system reliability. The technology-to-market subprogram has streamlined collaborative opportunities for industry to reach scale.

In addition, the soft costs subprogram has helped reduce the red tape involved with permitting and installing a solar energy project. The concentrating solar power subprogram has continued to emphasize solutions that make solar energy available when the sun isn't shining. And the systems integration subprogram has made it easier for utilities to integrate solar with the modern U.S. electric grid.

As a result, the average price per kilowatt-hour of a utility-scale PV project has dropped from over \$0.20 to less than \$0.07 today. With its 2020 goal in clear sight, Sunshot is already planning for the next decade. The new goal for 2030 is to cut the cost of utility-scale solar by an additional 50% to reach \$0.03 per kilowatt-hour, which would make the electricity from solar among the least expensive options for new power plant generation.

## Now Boarding: Renewable Jet Fuel

More than 87,000 flights take off each day in the United States, and of those flights, approximately 1.56 million barrels of jet fuel is consumed, according to the *Energy Information Administration Short-Term Energy Outlook*. This indicates a priority for the airline industry to develop cleaner alternative sources of jet fuel—a huge priority for the Energy Department’s Bioenergy Technologies Office (BETO).

In 2014, BETO joined Farm to Fly 2.0, a partnership with the U.S. Department of Agriculture, the Federal Aviation Administration, and commercial airlines to develop a viable renewable jet fuel market. This year alone marked an industry milestone as United Airlines became the first major U.S. airline to use commercial-scale volumes of biofuel for regularly scheduled flights.

For aviation and heavy-duty transportation, biofuel technologies offer one of the only energy alternatives to traditional petroleum-based sources.

The development and deployment of cost-competitive renewable jet fuels also offer the largest opportunity for the aviation industry to reduce greenhouse gas emissions, while ensuring long-term fuel security and price stability for the sector. These “drop-in” renewable jet fuels meet the same specifications as petroleum jet fuel—meaning they can be used in today’s aircrafts and engines without engine modification and provide the same level of performance and safety.

The commercial aviation industry has made offtake agreements to biofuel companies, including Red Rock Biofuels, LLC and Fulcrum BioEnergy, Inc. These are two projects receiving funds under the Advanced Drop-in Biofuels Production Project of the Defense Production Act, a joint initiative between the Departments of Energy and Agriculture.

In 2015, FedEx Express and Southwest Airlines entered into a jet fuel supply agreement with Red Rock Biofuels to purchase its jet fuel once the biorefinery is constructed and producing. Also in 2015, United Airlines announced a \$30 million equity investment in Fulcrum BioEnergy, Inc., the largest investment by a domestic airline in the alternative fuels market.

Beyond these investments, which indicate industry promise, some companies are already reaching significant technology milestones. Renewable fuel company LanzaTech recently announced its achievement of producing 1,500 gallons of renewable jet fuel from industrial waste gases.

This revolutionary process, developed in partnership with Pacific Northwest National Laboratory and funded in part by BETO, works in two stages. First, carbon monoxide, a byproduct of incomplete combustion and key emission from the steel industry, is captured and fed to microbes that consume the gas and produce ethanol. This ethanol, called “Lanzanol,” is then converted into a renewable jet fuel. The final jet fuel product, which is compatible with existing aviation infrastructure, will be used in planes flown by Virgin Atlantic.

Through these efforts, BETO, federal partners, and the aviation industry are building a vibrant and robust alternative jet fuel sector that will be part of a thriving bioeconomy.

## EERE Celebrates National Hydrogen and Fuel Cell Day

Fuel cell electric vehicles (FCEVs), which are powered by fuel cells rather than internal combustion engines, have the potential to significantly reduce our nation’s oil use and lower harmful emissions that contribute to climate change. And, they can be more than twice as efficient as today’s gasoline vehicles.

On October 8, EERE, along with stakeholders and industry, celebrated National Hydrogen and Fuel Cell Day—a day aptly chosen to represent the atomic weight of hydrogen (1.008). EERE commemorated the day with a number of events, including ride and drives, hydrogen station tours, informational presentations, and more.

National Hydrogen and Fuel Cell Day culminated a momentum that has been building all year. Hyundai and Toyota both introduced their FCEVs in 2015, and Honda has unveiled their concept car as well. Several other companies also plan to release FCEVs, including GM, Daimler, Honda, and BMW, in the near future.

In California, hydrogen is a fueling option at more than 20 commercial retail gas stations, and there are plans for several fueling stations to be opened soon in the Northeast. In addition, a new advanced hydrogen refueling demonstration station opened for the first-ever government FCEV fleet in Washington, D.C.

Fuel cells provide reliable power for more than just vehicles—buildings, cell phone towers, and other applications all increase our energy security with fuel cells.

Following the first oil embargo in the mid-1970s, a group of national lab researchers met with leaders from the private sector and federal government at Los Alamos National Laboratory in Albuquerque, New Mexico, to brainstorm ideas that would ultimately revolutionize the transportation sector as we know it.

Now, 40 years later, we have commercial fuel cell vehicles on the road and continued federal and private sector support driving the industry forward.

### HYDROGEN DEMONSTRATION STATION OPENS IN DC

A new hydrogen refueling station opened in Washington, D.C., this summer, which will advance the benefits of hydrogen power as a fuel, as well as highlight the benefits of FCEVs in the region.

This station will produce roughly 30 kilograms of hydrogen per day, enough fuel for roughly six cars per day to each travel approximately 300 miles.

“We celebrated the commissioning of DOE’s advanced hydrogen technology demonstration station, along with the delivery of the world’s first commercially available fuel cell electric vehicles to the U.S. Department of Energy and the National Park Service fleets,” said Fuel Cell Technologies Office Director Sunita Satyapal. “This collaboration between DOE and the Department of Interior will showcase cutting-edge hydrogen generation technology and provide an opportunity to demonstrate FCEVs at federal agencies and in the surrounding region.”







Navistar

Daimler Trucks  
North America

Cummins-Peterbilt

Volvo

## SuperTruck Initiative Overhauls Freight Efficiency

You see them on the highway driving beside you, but did you know that these heavy-duty tractor-trailers—the same ones that haul about 80% of the goods that fill our stores—consume about 28 billion gallons of fuel per year, or around 22% of total transportation energy usage?

Creating and scaling up technology that helps tractor-trailers burn less fuel and run more efficiently can help us make major strides in reducing pollution, strengthening our domestic energy independence, and cutting our carbon emissions.

The Energy Department kicked off the [SuperTruck I](#) initiative in 2009 with industry partners to improve the fuel efficiency of Class 8 vehicles.

The initiative supported four teams of manufacturers and suppliers (Cummins/Peterbilt; Daimler North America; Volvo North America; Navistar) who aimed to boost a baseline truck's freight efficiency by 50% and engine thermal efficiency by 20%.

The teams' success set the foundation for more than 50 technologies that could bring efficiency improvements to vehicles over the next decade. More than 20 SuperTruck technologies,

including advances in aerodynamics and engine/drivetrain integration, have already reached the commercial market.

In addition, an estimated 26 technologies have the potential to succeed in the next 2–4 years, while roughly 13 SuperTruck technologies offer the promise of additional fuel savings within the next 5–10 years.

The teams achieved this success with breakthroughs in advanced combustion engines, lightweight materials, and aerodynamic improvements. If all Class 8 trucks leveraged these technologies, Americans would stand to lower oil usage by an estimated 300 million barrels annually, and truck operators could save as much as \$20,000 per year on fuel.

As the SuperTruck I projects concluded, the Energy Department competitively selected new cost-shared projects for SuperTruck II. This program aims to research, develop, and demonstrate Class 8 trucks that have greater than 100% improvement in vehicle freight efficiency relative to 2009 baseline vehicles. The Energy Department has selected the following four SuperTruck II teams:

- Cummins, Inc. (Columbus,

IN) will design and develop a new, more efficient engine and advanced drivetrain and vehicle technologies.

- Daimler Trucks North America LLC (Portland, OR) will develop and demonstrate a tractor-trailer combination using a suite of technologies that includes active aerodynamics, cylinder deactivation, hybridization, and the electrification of accessories.
- Navistar, Inc. (Lisle, IL) will design and develop a vehicle and powertrain with electrified engine components that can enable higher engine efficiency and a more aerodynamically reengineered cab.
- Volvo Technology of America LLC (Greensboro, NC) will develop and demonstrate a tractor-trailer combination with a lightweight cab that achieves its freight efficiency goal using alternative engine designs and a variety of system technologies.

SuperTruck II will emphasize technologies that are more cost effective for end users to eventually purchase, continuing to propel the industry toward a clean energy future.

## EVs Drive Americans Toward a More Secure Nation

Compared to a similar gasoline-fueled car, an average electric vehicle (EV) reduces greenhouse gas emissions by 58%. With the nation's electricity supply continuing to move to cleaner energy sources, EVs are poised to become even cleaner and more accessible.

For the Energy Department's Vehicle Technologies Office (VTO), this validates its efforts in battery research and development (R&D) and EV deployment throughout the years.

Today, every major auto manufacturer has introduced a plug-in electric vehicle (PEV) into its offerings, and consumers can choose from nearly 30 different models.

There are currently more than 500,000 PEVs and 38,000 charging outlets in the United States, and as performance improves and charging infrastructure becomes more available, public acceptance keeps growing.

The [EV Everywhere Grand Challenge](#) has a goal of making PEVs as affordable and convenient as gasoline vehicles by 2022. After the home, the workplace is likely where a vehicle will spend the most time parked, and charging at work can potentially double a PEV driver's all-electric daily commuting range. EV Everywhere's [Workplace Charging Challenge](#) has a goal to increase the number of employers that offer charging to their employees tenfold in five years, rising from 50 in 2013 to 500 in 2018. With nearly 400 partners, the Challenge is more than three-quarters of the way to its goal.

Already a leader in battery R&D investment, between 1992 and 2012, the Energy Department devoted \$1 billion to battery R&D. These investments led to the commercialization of hybrid electric vehicles (HEVs), of which 2.4 million were sold in the United States between 1999 and 2012. Since then, another two million HEVs and 500,000 PEVs have been sold in the country, further demonstrating the viability and attractiveness of these technologies. These HEVs and PEVs currently on the road are projected to save consumers \$16.7 billion at the pump through 2020.

The Energy Department continues to make significant progress working with industry, academia, and its national laboratories toward achieving an aggressive goal of \$125 per kilowatt-hour (kWh) modeled battery costs by 2022. Looking ahead, DOE and its partners are already taking steps toward a more aggressive goal of \$100/kWh battery. Further, the announcement of the VTO Battery500 consortium aims to more than double the specific energy (to 500 watt-hour per kilogram) relative to today's battery technology, while achieving 1,000 EV cycles.

The adoption of these technologies is helping to lead U.S. drivers to a cleaner America.



## The Grid Modernization Initiative Predicts, Protects, and Controls the Grid

The U.S. electric grid relies on clean energy technologies to deliver the nation’s climate and energy goals. This requires new tools and technologies to ensure the electric power system continues to operate in a safe, reliable, and cost-effective manner.

It is with that in mind that the Grid Modernization Initiative (GMI)—an Energy Department-wide effort works with public and private partners to develop the very concepts, tools, and technologies to analyze, predict, protect, and control the grid.

But how exactly does it do that, and to what means?

Back in 2011, the Under Secretary for Science and Energy established the Grid Tech Team with the directive to better align all Energy Department activities in grid modernization. Its work helps integrate conventional and renewable sources of electricity, solve challenges of energy storage and distributed generation, and provide a critical platform for U.S. competitiveness and innovation in a global clean energy economy.

These initial meetings provided GMI’s foundation. Primary participants include the Offices of Electricity Delivery and Energy Reliability, Energy Efficiency and Renewable Energy, and Energy Policy and Systems Analysis.

“Grid modernization efforts will help the grid make full

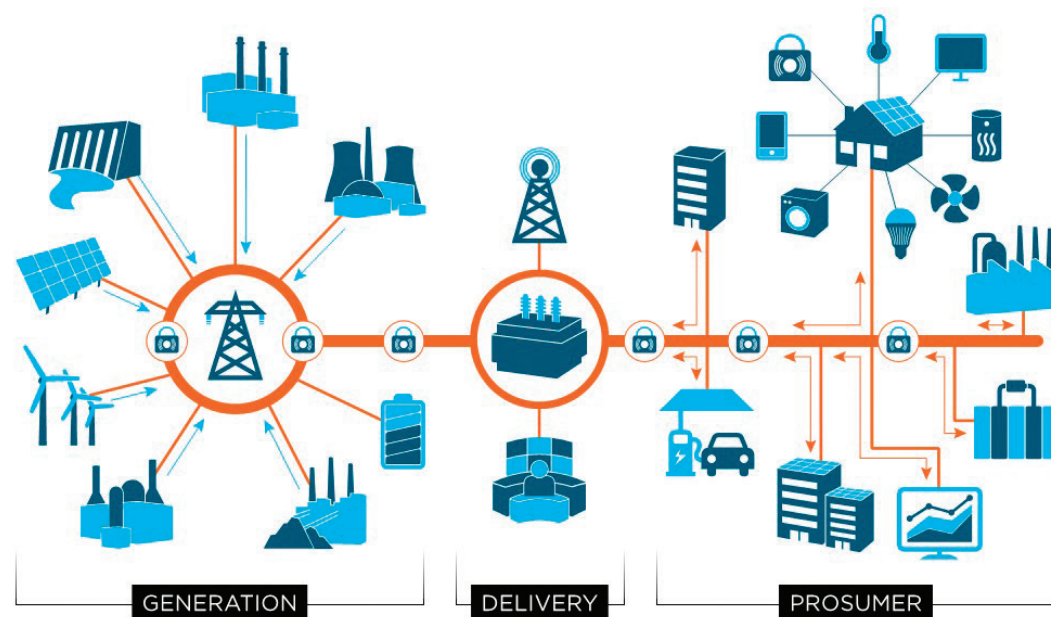
use of today’s advanced technologies and serve our needs in the 21st century. While the vast majority of upgrades are implemented by private sector energy companies that own and operate the grid, Energy Department has been investing in technologies that are revolutionizing the way we generate, store, and transmit power,” said Dr. Franklin Orr, under secretary for science and energy.

It is through funding and partnerships that GMI is able to strengthen its strategy. This past January, the Energy Department announced funding of up to \$220 million over three years for its national laboratories and partners. In particular, funding for the Grid Modernization Laboratory Consortium supports critical research and development in advanced storage systems, clean energy integration, standards and test procedures, and a number of other key grid modernization areas.

Many GMI projects have just begun, but there are already significant accomplishments.

One is the advanced inverter testing, optimization in a real-time, low-risk environment that allowed the Hawaiian Electric Company (HECO) to quantify the impacts of both ground fault and load rejection overvoltage. This study allowed HECO to raise its distributed solar power daytime load from 120% to 250%, clearing the customer backlog.

These efforts alone prove how GMI activities can have a direct impact on the deployment of EERE technologies—substantiating that GMI needs to deliver resilient, reliable, flexible, secure, sustainable, and affordable electricity. Its technologies will continue to analyze, predict, protect, and control the grid, and its reliability, for the future.



## U.S.-Brazil Collaboration Leads to Energy Use Reduction

A new device—the Portable Window Energy Meter (PoWEM)—can reduce energy losses in buildings by measuring and assessing the energy performance of windows without removing them from their building site.

The development of this device is timely, as the reduction of energy use in buildings is a key part of the Energy Department’s strategy to achieve several goals, including doubling energy productivity by 2030, meeting emissions reductions targets in the President’s Climate Action Plan, and related U.S. commitments to the Paris climate accord.

The Energy Department estimates the amount of energy lost annually through windows in the United States corresponds to approximately \$40 billion. Measuring energy performance of installed windows can inform replacement decisions and the production of more efficient windows, diminishing energy losses from buildings.

The PoWEM helps determine the level of energy efficiency of a window by measuring the thermal and optical properties of glazing systems in the field. The device uses a special set of surface meters to determine the amount of heat flowing through the window glazing. The exterior temperature, solar radiation intensity, and light intensity are measured on the outdoor side of the glazing.

Researchers measured the performance of windows using the PoWEM and compared the results with predicted values, which are calculated using several different standards, including ISO 15099 in the Lawrence Berkeley National Laboratory (LBNL) WINDOW software tool. Measurements using the PoWEM in the field were consistent with laboratory and calculated measurements.

The PoWEM was originally developed by Professor Saulo Güths from Brazil’s Federal University of Santa Catarina. With support from EERE’s International Program, Dr. Charlie Curcija, one of LBNL’s lead scientists on the windows and

daylighting research team, guided Professor Güths’ efforts to improve and test the new device during Professor Güths’ one-year fellowship at LBNL.

Dr. Curcija presented the device for the first time during the National Fenestration Rating Council Fall Membership Meeting in October.

“The audience received the presentation with interest and raised relevant questions,” Dr. Curcija says. “Most questions came from the manufacturing and regulatory sector. Utilities, state energy agencies, and nonprofit organizations see a potential market among energy auditors.”

The development of this new device is part of a larger effort funded by EERE’s International Program to accelerate the deployment of clean energy technologies under the U.S.-Brazil Strategic Energy Dialogue. EERE International accelerates the speed and scale of clean energy deployment through strategic international collaboration.



Portable Window Energy Meter (prototype)—jointly developed by Brazil Federal University of Santa Catarina and U.S. Department of Energy Lawrence Berkeley National Laboratory under the U.S.-Brazil Strategic Energy Dialogue.

## DOE Lab-Corps Spurs Success

Innovation is critical at the Energy Department's national laboratories. These scientists invent and improve technologies that address our global energy challenges; but how do these innovations become tangible industry solutions once they're created?

The DOE Lab-Corps program is one way to help make these game-changing technologies a reality.

Only one year into the program, DOE Lab-Corps has grown from a small pilot focused solely on EERE technology areas to an expanded training, welcoming support from five other Energy Department offices, including the Offices of Fossil Energy, Nuclear Energy, Environmental Management, Electricity Delivery and Energy Reliability, and Science.

This expansion reflects the positive outcomes seen from the first few classes and demonstrates the critical need to expose scientists across research areas to the importance of early industry engagement.

DOE Lab-Corps is managed by the National Renewable Energy Laboratory, which also provides teams with industry mentors that offer

valuable insight in the effort to bridge the gap between labs and industry.

Throughout the seven-week training, participants develop customer discovery questions, strategic business plans, and technology pitches. Customer discovery interviews with potential industry partners are crucial to teams understanding the market impact of their innovations.

Since the start of the program, more than 2,000 industry conversations have occurred with companies such as Hitachi, Lowe's, Johns Manville, Lego, Amazon, Tesla, GE, and Home Depot.

"The biggest impact is [the participants'] understanding what the industry is actually interested in about their technologies," said EERE's Lab Impact Director Victor Kane. "They have theories about who would be interested in using this technology, but until they actually go out and talk to people, they don't know whether it is true or not."

Peter Fiske, a successful startup veteran and DOE Lab-Corps faculty member from the summer 2016 class, sees the program's value clearly. Fiske launched his first company

with a Reactive Atom Plasma from the Lawrence Livermore National Laboratory.

He is not the only one. Graduates since the first class realize the benefits too.

"DOE Lab-Corps showed me how I can maximize the benefit of my basic research at Argonne [National Laboratory] to create technology that has real-world commercial impacts for Americans. That's a very rewarding feeling," said fall 2015 graduate Dr. Ralph Muehleisen.

Dr. Muehleisen believed that a startup company was the best way to commercialize his SonicLQ technology. However, it wasn't until taking the DOE Lab-Corps training that he had the knowledge and skills to confidently launch a startup with his program industry mentor.

When participants graduate in December, the program will have 51 alumni teams, participation from 10 national laboratories, and projects covering 13 technology areas. It will also have engaged more than 50 mentors and faculty advisers from all across the energy ecosystem.

## Game Changer: Technology Innovation Investment Playbook

When it comes to investing in American innovation and making it easier for promising entrepreneurs to develop technologies of the future, the Energy Department's Advanced Manufacturing Office (AMO) and Technology-to-Market (Tech-to-Market) program have a winning strategy.

The Lab-Embedded Entrepreneurship Program, funded by AMO and co-managed with Tech-to-Market, takes aim at the global problem of climate change and energy by making sound investments in human potential. Its objective is to bring the best and brightest innovators from across the country into the national laboratory system to receive world-class mentorship from scientists and the business community. And, it is already seeing positive results.

The initiative has been a game changer since the inception of its pilot program, Cyclotron Road at Lawrence Berkeley National Laboratory in California in 2014. The Cyclotron Road model focuses on aspiring scientific entrepreneurs with great ideas and a passion for clean energy, giving them the resources and mentorship to develop their ideas into transformative clean energy technologies that can impact the world.

Two years later, two cohorts of innovators at Cyclotron Road are navigating through the program with great success. Such achievements include funds to extend their project runway beyond the program, as well as successful private equity fundraising from actor Ashton Kutcher and prominent press features by *Forbes Magazine's* Top 30 under 30 and MIT's Top 35 under 35.

Innovators have also raised follow-on funding through competitive federal and state grants totaling over \$5 million, including awards from the Energy Department's Advanced Research Project's Agency-Energy, EERE, the National Science Foundation, the Department of Defense, and California Energy Commission, plus others.

Building off of the success of the Cyclotron Road pilot, the Lab-Embedded Entrepreneurship Program has continued to expand, launching two new nodes: Chain Reaction Innovations at Argonne National Laboratory in Illinois and Innovation Crossroads at Oak Ridge National Laboratory in Tennessee.

A commitment to making investments in research, entrepreneurship, and human capital is critical to growing clean energy technologies. By working collaboratively, AMO and Tech-to-Market are doing their part by enabling aspiring innovators to flourish under the guidance of the Lab-Embedded Entrepreneurship Program.

Thanks to these investments, aspiring tech entrepreneurs are converting into life-long clean energy entrepreneurs, overcoming the barriers that so often stifle breakthrough innovations, and reaching new heights with their ideas—from the lab to the commercialization pathway. Our clean energy future couldn't be more promising.



## Charting the Path for a Cost-Competitive Bioeconomy

Committed to supporting the development of a sustainable, cost-competitive bioeconomy of biofuels, bioproducts, and biopower, with landmark national biomass assessments and dedicated research and development, BETO has reached several milestones in the last eight years.

These milestones depict that a commercially viable bioeconomy is possible—and sustainable—with our nation’s biomass resources. It can also be cost competitive with petroleum-derived fuels and products.

In 2011 and 2016, BETO and Oak Ridge National Laboratory released two national resource assessments that calculated the potential supply of biomass in the United States. Both were updates to the original 2005 *Billion-Ton Study* and verified the conclusion that the United States has the potential to produce at least 1 billion dry tons of biomass resources on an annual basis without adversely affecting the environment.

In 2014, the Regional Feedstock Partnership—composed of land grant universities, the Energy Department, the U.S. Department of Agriculture, and industry—culminated seven years of work that began in 2008 to validate assumptions for advancing biomass feedstock research and development.

This work, and the *Billion-Ton* reports, provide a clear and credible perspective that the United States is capable of producing a significant amount of energy from biomass resources.



## 2020—A Benchmark Year for Goals

In order to keep innovation moving forward, as well as to track progress, the federal government sets benchmark goals for its agencies. EERE has been striving to conquer goals, some set under the White House’s Climate Action Plan, along with many of its own technology office goals. In some cases, they’ve already exceeded these goals; in others, offices are on track to meet theirs.

Many of these goals were set by Energy Secretaries Steven Chu and Ernest Moniz, and progress to meet the goals has led the Energy Department, the President, and the Secretary, to seek even higher, more ambitious goals for energy efficiency and reduction of greenhouse gas (GHG) emissions looking to 2020 and even 2030.

For example, since 2008, solar energy is much more affordable. The SunShot Initiative is already 70% of the way toward its goal of reducing the cost of solar electricity to \$.06 per kilowatt-hour by 2020. Given the rapid progress to date, SunShot expects to meet its

goal ahead of schedule as the solar industry’s pace of innovation fosters further cost reductions.

The Better Buildings Initiative has a similar story.

The federal government, a key pillar of the Initiative, is extending 2020 goals to go out to 2025, and there are new targets: 40% reduction in GHG emissions; 30% increased use of renewable electricity; and 25% improved building efficiency by 2025.

But that’s not all. The Vehicles Technologies Office has set many goals of its own through the SuperTruck Initiative, which launched in 2010. SuperTruck I already reached its initial goal of improving freight efficiency by 50%.

Following this success, SuperTruck II set its goal even higher, to 100% system-level efficiency gains for Class 8 trucks (based on 2009 baseline vehicles), and the Energy Department selected four projects this summer.

“These investments will accelerate the development of innovative

vehicle technologies that will save businesses and consumers money at the pump, cut carbon emissions, and strengthen our economy,” said Acting Assistant Secretary David Friedman. “SuperTruck II builds on the successful SuperTruck I program, which has already led to fuel saving technologies that have reached the commercial market.”

Similarly, the Fuel Cell Technologies Office has funded research to reduce high-volume automotive fuel cell costs by 50% since 2007. The office modeled the cost of automotive fuel cell systems to be \$53 per kilowatt (kW) when projected to 500,000 units per year (\$60 per kW at 100,000 units per year) when using state-of-the-art laboratory technology. This is only \$13 per kilowatt-hour (kWh) away from the office’s 2020 target of \$40 per kWh.

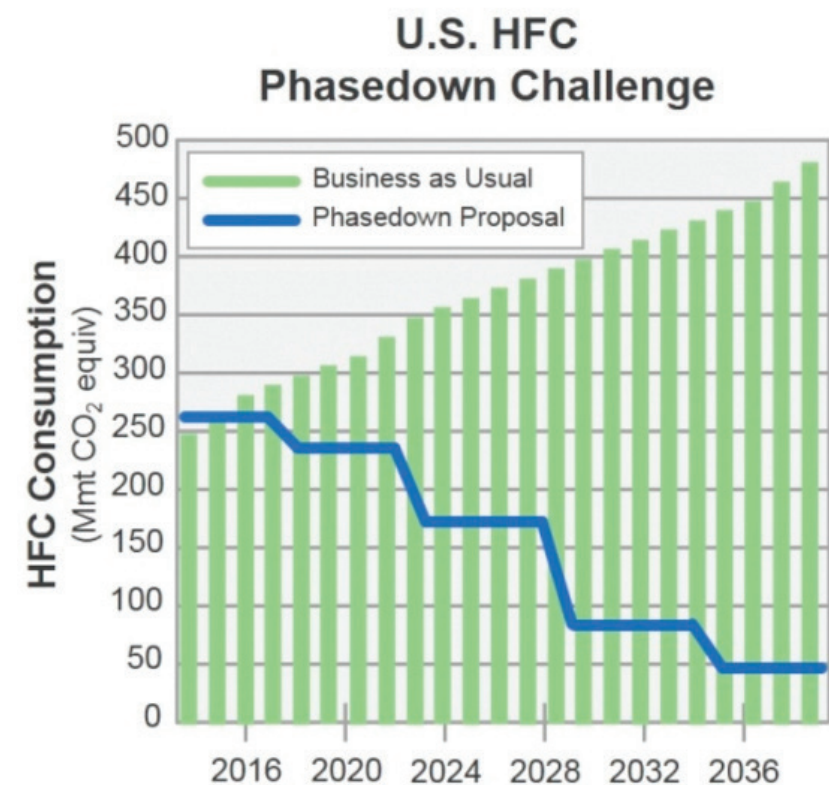
EERE’s achievements are vast, but there is still more work to do. EERE’s technology offices are continuing to work hard to finish the year and the decade strong to fulfill EERE’s mission.

## Industry Partners Lead Charge in Developing Next Generation Refrigeration Technology

Global energy consumption from air conditioning and refrigeration may increase more than 450% by 2050, and the Energy Department’s Building Technologies Office (BTO) is looking for ways to reduce this energy usage while improving performance.

Most systems currently rely on a process called vapor compression to cool and heat buildings, using a compressor to circulate liquid refrigerants—typically hydrofluorocarbons (HFCs). Phasing down HFCs, which are hundreds to thousands of times more potent than carbon dioxide and can last for centuries when released into the atmosphere, could avoid up to 0.5 C of global warming by the end of the century.

Buildings in the United States consume 38.5 quads of energy annually, of which, nearly half is used for heating, ventilation, air conditioning, and refrigeration (HVAC&R). In October, the global community committed to the Kigali Agreement, an amendment to the Montreal Protocol that will avoid rampant growth of HFC emissions and phase out their usage over time, replacing them with climate-friendly, energy-efficient alternatives.



BTO conducted performance testing of low global warming potential (GWP) alternative refrigerants in very hot climates, providing evidence to the international community that they could use viable replacements without affecting HVAC&R energy efficiency or cooling performance.

“Our performance testing work was just a part of BTO’s comprehensive strategy to advance HVAC&R technologies,” said Tony Bouza, technology manager for BTO’s HVAC, Water Heaters, and Appliances program. “We’re working to create a revolutionary new class of technologies that are energy efficient, and have it become common across the world. We’ve already seen some success.”

BTO’s strategy seeks to bring low-GWP refrigerants to market, improve the performance and costs of existing technologies, and develop next-generation technologies that push the United States toward a zero-GWP refrigerant future.

Several energy-saving, climate-friendly refrigeration technologies developed through BTO-funded industry lab partnerships are already available on the market.

For example, in 2014, Hillphoenix and Oak Ridge National Laboratory debuted their Second Nature® Advansor System—a supermarket refrigeration system that lowers energy consumption by 25% and uses climate-friendly alternative refrigerants, reducing greenhouse gas emissions by 78%.

Further, BTO is supporting next-generation technologies, such as the first home water heater that uses zero-GWP refrigerants. Xergy’s electrochemical compressor prototype is a potentially transformative technology that uses water, which has no global warming impact, as the refrigerant.



## Appliance Standards Affect Our Everyday Lives

If you really want to know the impact of the Energy Department’s Appliance and Equipment Standards Program, just take a look around your house.

More than 90% of your home’s energy use is touched by this program—from to kitchen appliances to heating and cooling systems—they’re all affected by the minimum efficiency levels set forth by the Standards Program.

This may not sound like much individually, but rules issued since the 1980s collectively saved American consumers \$63 billion in 2015 and reduced three billion tons of carbon dioxide emissions in the process. This is the equivalent of taking more than 631 million automobiles off the road for an entire year.

“At the end of the day, this program is saving real people real money, without compromising what people expect to get out of their appliances,” said John Cymbalsky, program manager for the Standards Program.

Those savings will live on in the coming decades thanks to recent progress. Since 2009, the program has issued 44 new or updated appliance standards on more than 50 U.S. products. A record-breaking rule for commercial air conditioners and furnaces issued in December 2015 is expected to save American businesses \$167 billion on utility bills and reduce carbon pollution by 885 million metric tons—more than any other standard to date.

With the standards issued since 2009, the Energy Department will save consumers an estimated \$550 billion on their utility bills.

The Standards Program saves consumers money and energy by being at the forefront of efficiency innovation. Refrigerators, for example, use a quarter of the energy used in 1973 and offer 20% more storage capacity at half the price. Since 1990, as a result of the program, efficiency has increased in a number of common household appliances, including the following:

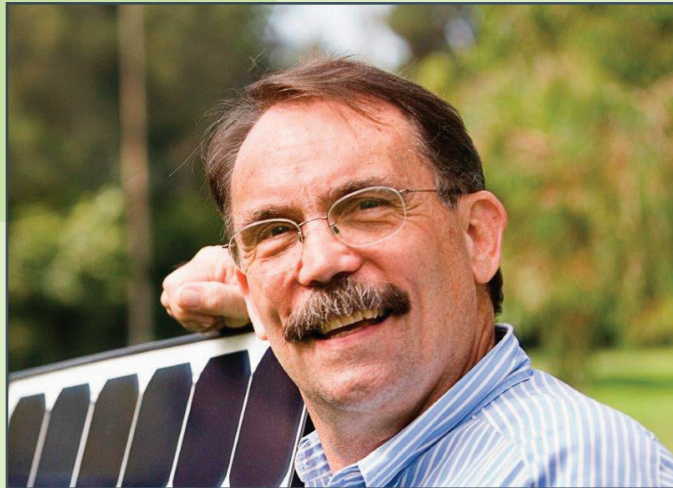
- New clothes washers – 70% less energy
- New dishwashers – more than 40% less energy
- New air conditioners – around 50% less energy
- New furnaces – around 10% less energy.

Today, the typical American household saves \$319 per year on their energy bill. As people replace their appliances with newer models, by 2030, that savings could reach \$460.

This shows consumers that efficiency and cost savings are at the head of the energy revolution, and our progress will only continue to increase as we move farther into the future.

## Q & A: SETO Director Dr. Charlie Gay

Dr. Charlie Gay, the new director of the Solar Energy Technologies Office (SETO), has witnessed solar's rise from a niche space technology to the vigorous business it is today—all from the front lines. Dr. Gay sat down with the *Amped Up!* team recently to discuss what's next for the solar industry.



**Q. You've been called a pioneer. What does that mean to you?**

A. I started in the field 42 years ago after the first oil embargo. I was just getting out of school (University of California, Riverside). I lived in Los Angeles, grew up on a farm, and thought I'd just wasted the last 10 years of my life getting a Ph.D. in physical chemistry to put steam in the ground for enhanced oil recovery. Then I saw a job for Spectrolab making solar cells that could be welded. I signed onto a two-year contract with Wright Patterson Air Force Base to develop a new way to weld solar cells for satellites.

**Q. As director, what do you see as your top priorities?**

A. To engage across a number of teams at the Department of Energy. The Advanced Manufacturing Office activities are very close to my solar roots. The Grid Modernization Initiative connects the Office of Electricity and EERE (Office of Energy Efficiency and Renewable Energy) in a collaboration essential to the future adoption of solar and all renewables. The goal is to speed cycles of learning by building bridges across the entire organization.

**Q. You not only talk the talk, but walk the walk. I read you have solar panels on your own home?**

A. Fifteen years ago, my utility bill kept increasing, and manufacturing got the cost [of solar panels] down. I love walking out every morning and seeing the meter spinning backward. I also like getting a utility bill that, in a bad month, might be a dollar.

The *Revolution...Now* report stated that to date, more than 1 million distributed solar PV systems have been installed on American homes and businesses. What does that say about where we are headed?

We have momentum and scale and are just beginning the marathon of change. Currently, we are working on next-generation 2030 that says we're going to cut cost in half. Professional power system operators around the world are modeling this, and the results show we can have up to 30% solar-generated electricity without fundamentally needing to add substantial amounts of distributed storage. Low-cost storage combined with PV [photovoltaic] in sunny locations could offer the potential to achieve up to nearly 50% of our electricity from PV.

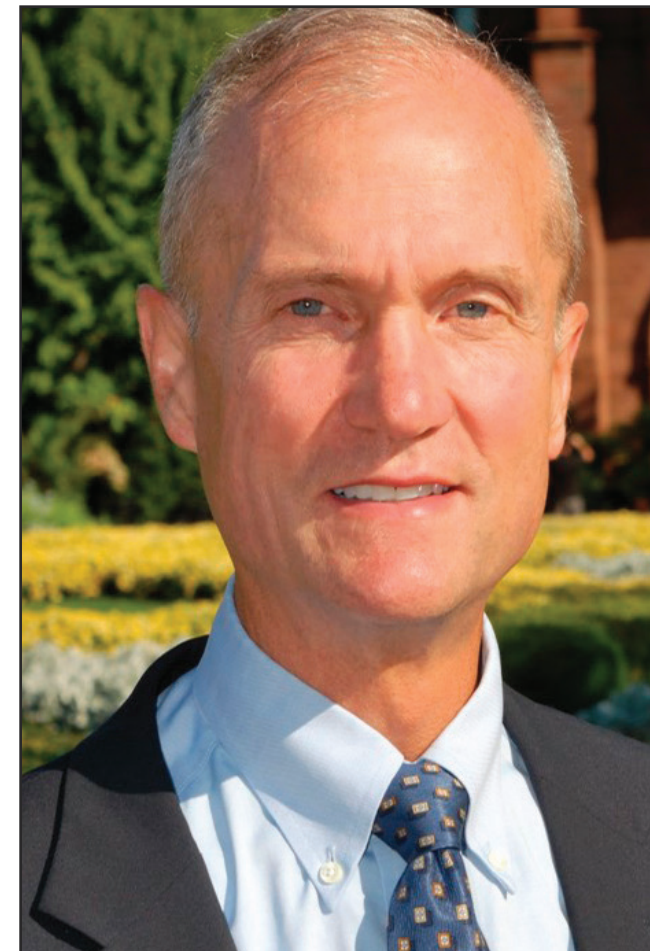
**Q. What do you hope your children have gained by your efforts in energy conservation?**

A. I have seven grandchildren, one great grandchild, and four children. I want them to have a better quality of life and leave the world a better place the same way my parents encouraged me to get off the farm and go to school. I want to leave them a cleaner, more stable environment so stressors on our planet can be replaced by cleaner, healthier power systems that expand the range of life's opportunities.

## Q & A: WPTO Acting Director Jim Ahlgrimm

Jim Ahlgrimm has spent more than a decade working across the Energy Department's renewable energy portfolio to make America's transition to clean, renewable energy a success. Now, as the head of EERE's Water Power Technologies Office, he looks to continue that progress. The *Amped Up!* team recently sat down with Jim to talk about his career and his vision.

**Q. What did you do prior to being named acting director of EERE's Water Power Technologies Office?**



A. My tenure at DOE began in 2002 as manager of the hydropower program, where I oversaw the most widely developed renewable source in the United States. In 2005, I shifted from working exclusively on water to heading both wind and water, where I handled test facilities and standards R&D (research and development).

**Q. As acting director, what are your top priorities/goals?**

A. Growing hydropower and deploying more innovative concepts for pumped-storage are my top priorities. The first step is getting things operational at our new Water Power Technologies Office by making sure we're properly staffed with the right balance of talented federal employees and contract support. Next, I want to implement a strategic plan for our hydro program that will build on the *Hydropower Vision* we released in July. The goal is to bring down R&D costs while facilitating development and advancing technologies.

**Q. What's the biggest challenge facing the your office?**

A. The biggest challenge we face is cost competitiveness in traditional hydropower, pumped-storage hydropower, and ocean energy. For a long time, we haven't had the right technologies in place. The good news, however, is that

overcoming this barrier is a very attainable feat. For instance, there's a lot of opportunity in hydropower with non-powered dams, which are used for water reservoirs that don't have power plants.

**Q. What are some of the things you enjoy doing when you're not working?**

A. In my free time, I love being with my family. I also enjoy coaching sports, volunteering with the Boy Scouts of America, and sailing the Chesapeake with my two sons.

**Q. If you weren't in your current role what would you be doing?**

A. I truly couldn't envision myself working anywhere else. I've always been interested in energy, so the opportunity to help our country move the needle forward on clean energy every day makes this a dream job for me.

U.S. DEPARTMENT OF  
**ENERGY**

---

Energy Efficiency &  
Renewable Energy

For more information, visit [energy.gov/eere](https://energy.gov/eere)

For questions regarding this newsletter and future newsletters,  
please email [eeAmpedUp@ee.doe.gov](mailto:eeAmpedUp@ee.doe.gov)

DOE/EE-1503