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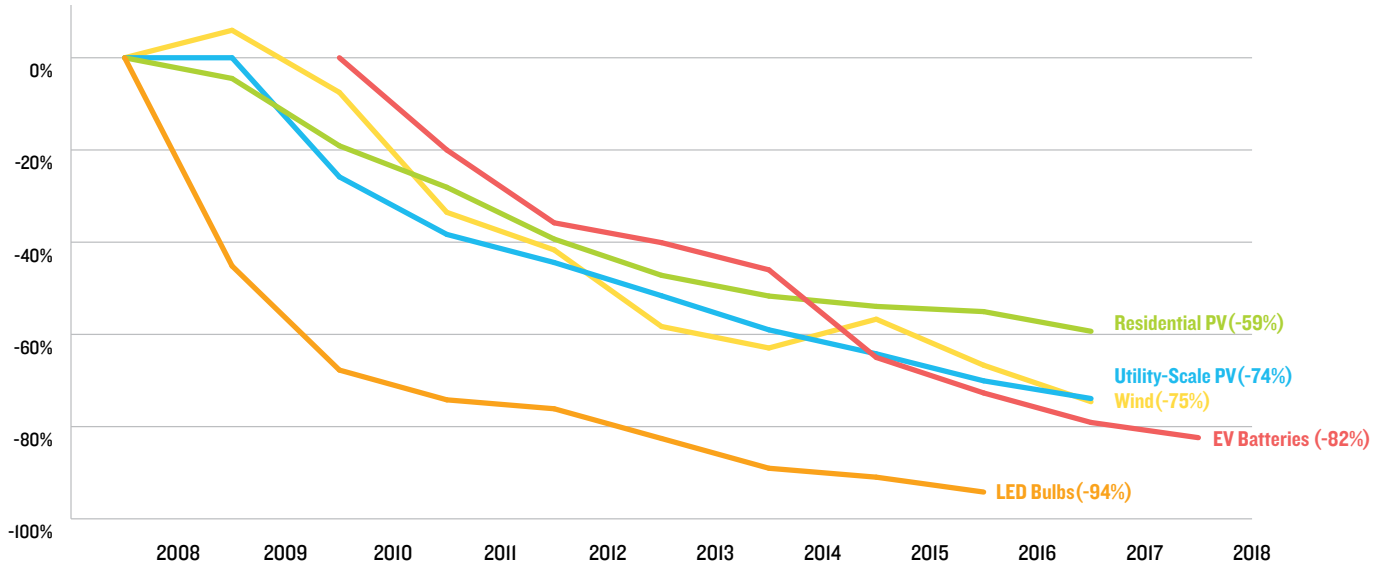
ISSUE BRIEF

THE DEPARTMENT OF ENERGY'S CLEAN ENERGY INVESTMENTS ARE CATALYZING INNOVATION NATIONWIDE

The U.S. Department of Energy (DOE) allocated more than $860 million in 2018 to support energy efficiency, renewable energy, and clean transportation research and development (R&D) through grants to 600-plus small businesses, industrial partners, and academic institutions across almost every state.[1] Funding from the DOE helps drive down the costs of clean energy innovation, from solar and wind power to electric vehicles, making these technologies more affordable while accelerating market adoption (see Figure 1).[2] These investments also spur job growth in emerging industries and help reduce harmful pollutants. The DOE enables the nation's top innovators to help the country achieve a cleaner, safer, and lower-cost energy system. Last year, in a show of bipartisan support, Congress increased funding to record levels for the DOE's clean energy innovation programs.[3] This Issue Brief showcases examples of last year's R&D funding across major clean energy categories to reinforce why policymakers should continue supporting American clean energy advancements by increasing the DOE's innovation budgets.

FIGURE 1: COST REDUCTIONS[4] IN MAJOR CLEAN ENERGY TECHNOLOGIES



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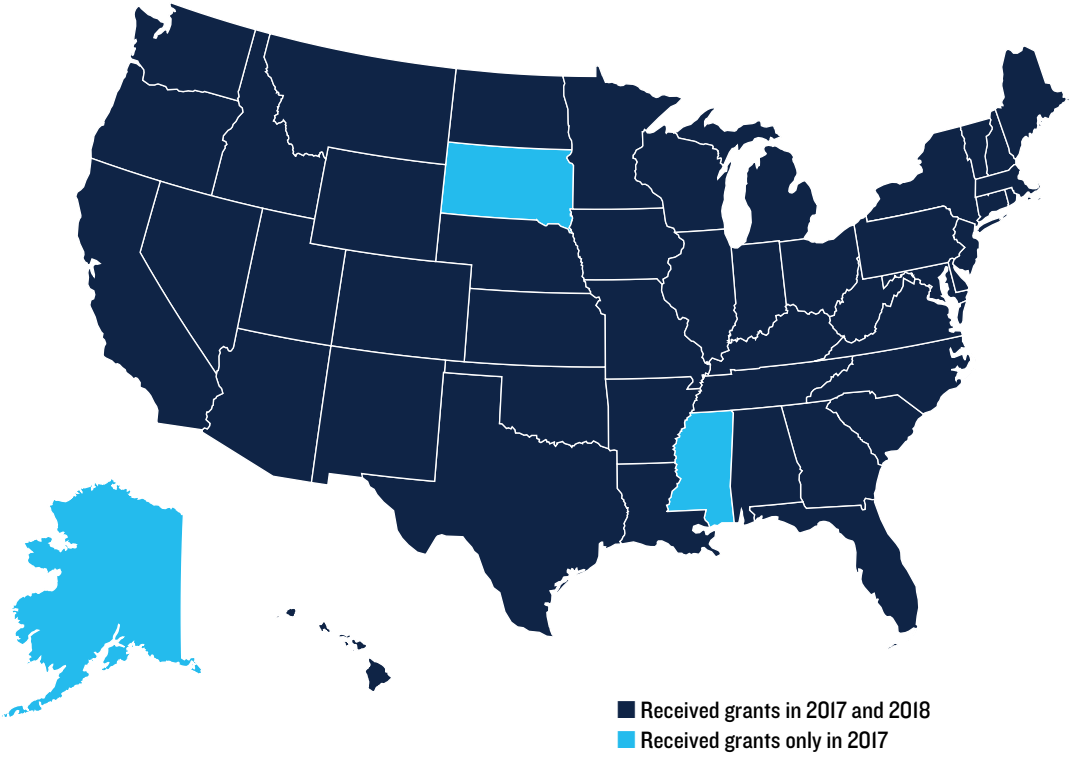
All of America stands to benefit from maintaining and growing the DOE's innovation budget. Figure 2 shows just how widespread federal clean energy investments have been across the country.[5] Researchers in all 50 states and the District of Columbia received funding from the Office of Energy Efficiency and Renewable Energy (EERE) and the Advanced Research Project Agency–Energy (ARPA-E) in 2017 and 2018. Innovation supported by EERE has contributed to making energy more affordable, creating jobs, and cleaning up the air we breathe, while ARPA-E has funded early-stage, high-impact projects that have the potential to radically improve the way we obtain and use energy altogether. U.S. Secretary of Energy Rick Perry acknowledges that "innovation works," and it is essential that this crucial DOE funding continue to reach U.S. innovators, and that the DOE be given the resources it needs to continue supporting U.S. clean energy breakthroughs.[6]

Despite unusual delays in getting money out the door, the DOE still supported several exciting and important clean energy research projects in 2018, as explored in detail in the following sections.[7] This Issue Brief is intended to help policymakers identify the groundbreaking federally sponsored clean energy R&D being done in communities across the country, and to emphasize the impact and need for a strong, federal clean energy R&D budget. Following are selected innovation funding projects from clean energy market sectors across the country. For a full list of the awards, see NRDC's dataset.[8]

FIGURE 2: EERE + ARPA-E GRANTS



SOLAR ENERGY TECHNOLOGIES OFFICE AWARDS $145.2 MILLION IN 2018

Support Includes $27.7 Million for Photovoltaic Innovation

The cost of utility-scale solar generation declined by 74 percent from 2008 to 2017. This allowed large solar systems to become more prevalent, producing enough electricity to power 11 million homes and providing 350,000 jobs across the solar industry by 2016.[9] This progress was spurred by continuous investment from the Solar Energy Technologies Office (SETO), which set ambitious goals for cost reductions and then provided funding to solar manufacturers and installers, small businesses, national labs, and universities.[10]

In 2018, the Solar Office committed $27.7 million, requiring an additional $8.9 million in supplementary funds from other sources, for photovoltaic (PV) research and development. This money will fund efforts to improve the affordability, reliability, and manufacturability of solar photovoltaic systems. The vast majority of solar cells that are deployed on rooftops and for utility-scale systems use silicon photovoltaic cells, and a portion of this funding will go toward further reducing their cost. But seven of the 31 funded projects will explore perovskites, a new class of solar cell materials whose efficiencies have improved dramatically in recent years and have the potential to be much cheaper than silicon-based solar cells. However, perovskites are currently limited by their poor stability, compared with traditional silicon solar cells.

SELECTED FUNDING HIGHLIGHT:

kWh Analytics, San Francisco, California

SETO's 2018 PV Innovation Roadmap reported that the single biggest need for improving solar reliability is a better understanding of the degradation rate, or the decrease in efficiency, of solar cells over their lifetimes.[11] The potential impact of degradation uncertainty was valued at $17 per megawatt hour by the National Renewable Energy Laboratory. This value is even greater than the initial cost of a solar power plant. To attract widespread investment, it is crucial to reduce this uncertainty.

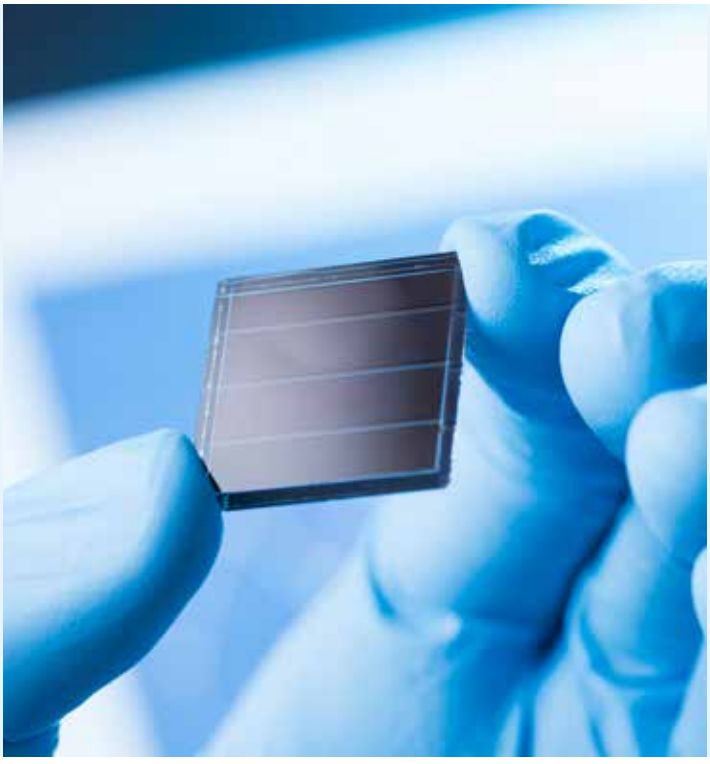
San Francisco–based kWh Analytics, which provides solar risk-management software and services, received a $1.25 million grant from SETO to utilize real-world data and machine learning to quantify the degradation rate and to increase the affordability and reliability of photovoltaics.[12] kWh Analytics is well positioned to address this challenge since it has data on 20 percent of total American solar assets, which will help inform the machine learning model. The company hopes to enable the solar industry to accurately price quality by putting a dollar value on reliability, and to help buyers understand how to value their solar power assets before and after purchase. Ultimately, kWh Analytics aims to make its machine learning model available to the public.

SELECTED FUNDING HIGHLIGHT:

University of Washington, Seattle, Washington

The University of Washington received a $1.5 million grant from SETO, with a requirement to source an additional $375,000 in supplementary funds, to focus on how the composition, structure, and environmental exposure of perovskites can affect their stability and performance.[13] Led by Professor of Chemical Engineering Hugh Hillhouse, the project will use machine learning methods to extract new information from vast data sets, which could reveal the fundamental connections between nanoscopic and microscopic material features and macroscopic solar cell performance and stability.

With improved stability, perovskite solar cells can leverage the many advantages they have over traditional silicon solar cells.[14] They use inexpensive raw materials, can be made flexible, and have undergone dramatic improvements in efficiency in recent years. Eventually, perovskites could allow solar cells to be used in many new applications for a fraction of the cost.



SOLAR OFFICE PROVIDES $12.7 MILLION FOR WORKFORCE TRAINING

The Solar Office also provides federal support to expand and develop the solar workforce. Job training programs at the DOE have helped develop standardized curricula for solar installers and rapidly expanded the number of people working in the solar industry. The energy workforce has a larger fraction of military veterans than the national average, but it is far less diverse than the U.S. workforce as a whole. According to *The 2018 U.S. Energy & Employment Report*, only 31 percent of the solar workforce consists of women, compared with the national workforce average of 47 percent, and only 7.2 percent is African American, compared with a 12 percent national average.[15] The Solar Office has a role to play to train and increase the representation of underrepresented groups in the solar industry. Seven projects that address workforce diversity and development received support from SETO in 2018, combining $12.7 million from DOE with an additional $2.4 million in partially matching funds from other sources.

SELECTED FUNDING HIGHLIGHT:

Electric Power Research Institute, Knoxville, Tennessee

The Electric Power Research Institute (EPRI) will use $6 million from SETO, plus $1.5 million in partially matching funds, to train the future solar workforce.[16] This award is the largest of 53 DOE workforce development grants and will be used to develop the data science proficiencies and analytical skills needed to manage the future grid.

EPRI will collaborate with electric utilities and universities to launch the Grid-Ready Energy Analytics Training (GREAT) with Data initiative to address workforce skills in four key technical areas: (1) data science, including descriptive, prescriptive, and predictive analytics as well as machine learning; (2) cybersecurity; (3) information and communication technologies, with an emphasis on interoperability and standardization technologies; and (4) integration of solar photovoltaic and other distributed energy resources such as energy storage, electric vehicles, and demand response.[17]

The program will develop certifications, credentials, qualifications, and standards for the training and education needed in the electric utility industry workplace. The GREAT team will also develop five strategic regional training hubs across the United States to prioritize and guide custom content development, feedback, and training to support regional workforce needs. The five-year initiative will build on the existing GridEd program, which the institute has run for the past five years for the DOE, to train and recruit power system workers and develop university curricula for new engineers and computer scientists.

Utilities with representatives on the project development team include American Electric Power (Ohio), Austin Energy (Texas), Bonneville Power Administration (Oregon), Con Edison (New York), Duke Energy (North Carolina), Entergy (Louisiana), FirstEnergy (Ohio), Lincoln Electric System (Nebraska), Portland General Electric (Oregon), Riverside Public Utilities (California), Salt River Project (Arizona), Snohomish Public Utility District (Washington), Southern California Edison, Southern Company (Georgia), and Tennessee Valley Authority. Collaborating universities include: Stony Brook University (New York), University of California at Riverside, Virginia Tech, and Washington State University.

SETO Awards $12.4 Million for Thermal Storage Research

By using thermal storage, concentrated solar power (CSP) systems allow solar energy to overcome grid integration challenges caused by solar variability. SETO aims to push CSP technology down the same cost curve as silicon solar cells, enabling the technology to drastically scale up from the 1.8 gigawatts connected to the grid today.[18] The 15 innovative research projects funded in this field received $12.4 million in DOE funding, supplementing the requirement for a cost-share of $3.1 million, to advance the development of better reflectors, high-temperature insulators, and thermal storage solutions.

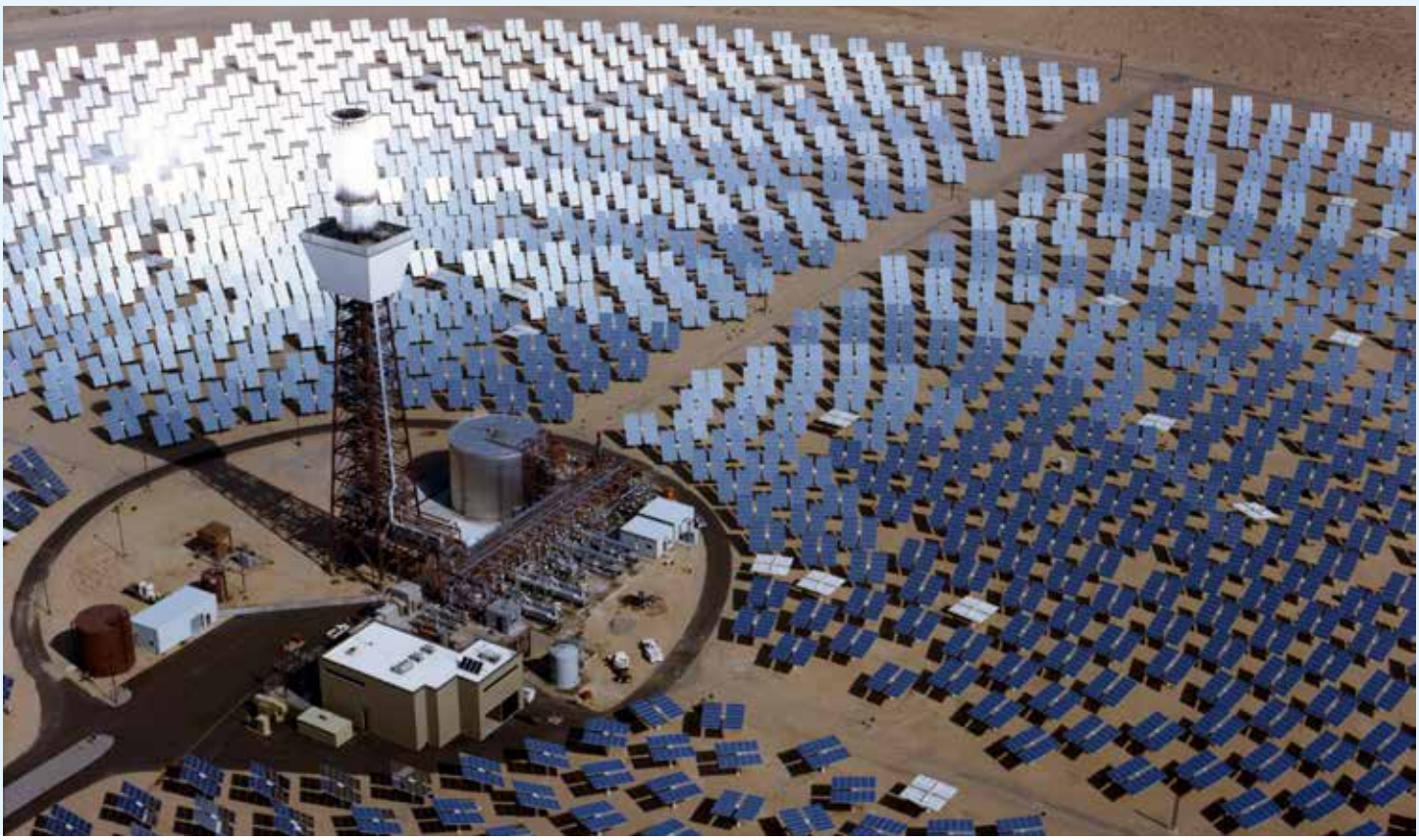
SELECTED FUNDING HIGHLIGHT:

CompRex, LLC, Madison, Wisconsin

CompRex, LLC, a Wisconsin-based small business, which specializes in compact heat exchanger and reactor solutions, received a $1.2 million award from SETO to advance CSP research and development.[19]

The two-year project will be conducted in collaboration with the University of Wisconsin–Madison and the Special Metals Corporation. Using advanced alloys and CompRex's proprietary compact design, the project aims to develop highly efficient and cost-effective heat exchangers for high-temperature and high-pressure applications such as CSP. If successful, this project can fulfill the unmet need for critical system components that can withstand high stresses due to thermal loads in CSP systems.

The chief executive officer of CompRex, Dr. Zhijun Jia, says "removal of the current performance and cost bottlenecks in these key components is not only critical to accelerating commercialization of CSP systems but also beneficial for various applications across the power industry."



WIND ENERGY TECHNOLOGIES OFFICE AWARDS $21.1 MILLION IN 2018

The average price of wind energy has dropped by 75 percent since 2008, resulting in the growth of national wind capacity from 25 gigawatts (GW) to more than 89 GW in 2017—enough to power more than 25 million U.S. homes. In 2018, the DOE's Wind Energy Technologies Office (WETO) awarded $18.5 million to fund an offshore wind research consortium and more than $2.6 million in grants to six small businesses. The Wind Office also announced a $6 million grant to identify and mitigate the wildlife impacts of onshore and offshore wind turbines, and an $8.5 million grant to develop lightweight, higher-efficiency wind turbine technologies.

SELECTED FUNDING HIGHLIGHT:

New York State Energy Research and Development Authority, Albany, New York

WETO announced in June 2018 that it would fund a national offshore wind research and development consortium to be administered by the New York State Energy Research and Development Authority (NYSERDA). Its grant, plus matching funds from NYSERDA, amount to $41 million in R&D support for innovation and research in offshore wind.[20]

This consortium brings together nine leading project developers including Deepwater Wind—which developed the first offshore wind project in the United States—and the National Renewable Energy Laboratory to accelerate the development of American offshore wind.[21] In January 2019, the consortium added the states of Virginia, Maryland, and Massachusetts; offshore wind developers EnBW North America and Vineyard Wind; and large-scale clean energy transmission developer Anbaric Development Partners. Research topics and resource challenges were identified in collaboration with the U.S. Department of the Interior. Funding will aim to catalyze technological advancements in everything from supply chain technology to wind resource and site characterization.

Breakthroughs in floating turbine technology, for instance, could allow the United States to reach capacity factors above 60 percent in deep waters, currently off-limits to fixed-bottom turbines.[22] This is much higher than the capacity factors reached by conventional onshore wind turbines, which tend to be around 40 percent. Capacity factors, typically expressed as percentages, refer to the actual energy produced over a period of time compared to the expected energy production if continuously operating at peak power. Floating wind turbines have access to more consistent and higher-speed wind, giving them the potential to be much more cost competitive than land-based systems. With 2,000 GW of offshore wind technical potential in federal waters, it is exciting to see the DOE working with industry and others to drive this domestic resource forward—making it more affordable, creating jobs, and reducing emissions.[23]

In 2018, the Wind Office also awarded more than $2.6 million in six grants to small businesses through its Small Business Innovation Research program. Awardees included Resono Pressure Systems of Laramie, Wyoming, which received $150,000 to explore wind turbine blade aerodynamics.[24] This work will be led by Jonathan Naughton, a professor of mechanical engineering and director of the Wind Energy Research Center at the University of Wyoming. It could lead to improved energy capture from wind turbines, increasing their efficiency and further reducing the cost of electricity from wind.

VEHICLE TECHNOLOGIES OFFICE AWARDS $118.3 MILLION IN 2018

More than a million electric vehicles (EVs) were on the road in the United States at the end of 2018, and R&D efforts are underway to further improve the technology and expand deployment of these emissions-free vehicles.[25] A 2017 NRDC report, *America's Clean Energy Frontier*, examined pathways to reach 80 percent decarbonization and found that the most cost-effective pathway requires, in addition to a substantial scale-up of efficiency and renewable generation, that roughly 60 percent of light-duty vehicle miles traveled be driven by electric vehicles by 2050.[26] To cut emissions from America's largest source of carbon pollution—transportation—we need to accelerate the adoption of EVs.

Federal research has brought down the costs of EV lithium-ion batteries by 79 percent since 2010. However, the price of cobalt, crucial to lithium-ion batteries because it improves stability as the battery is charged and discharged, is rising due to increased demand and supply shortages. Without cobalt, batteries might not last more than a few cycles.

Solving that challenge through federal R&D is one focus of DOE's Vehicle Technologies Office (VTO), which in September 2018 announced $80 million in awards for advanced vehicle technologies research. These funds will support 42 recipients in 20 states, including universities, national laboratories, and corporations like Nexceris in Lewis Center, Ohio. Multiple federal agencies recognize the importance of vehicle technology innovation and have contributed to this collaborative fund, including around $7 million from the Bioenergy Technologies Office and the U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC). This set of awards aims to address five areas of focus: batteries and electrification, materials for vehicle light-weighting and high-temperature environments, technology integration, engines and fuels, and off-road and fluid power systems.

Vehicle Office Provides $17 Million for Low-Cobalt Batteries

The United States imported more than 12,000 metric tons of cobalt in 2017. TARDEC and the DOE recognize the strategic importance of reducing our dependence on this element. Together they have dedicated $17 million to develop low-cobalt cathodes for next-generation lithium-ion batteries.[27] This will be essential in order to sustainably scale up electric vehicles. There are seven award recipients within this category, including three that aim not only to reduce cobalt use in cathodes but also to develop cobalt-free batteries. They are:

- Nexceris in Lewis Center, Ohio ($2.5 million)
- Oak Ridge National Laboratory, Knoxville, Tennessee ($2.1 million)
- University of California, San Diego, La Jolla, California ($2.5 million)

Funds for all seven projects require at least a 20 percent cost share from the grant recipients, ensuring that additional resources are dedicated to developing low-cobalt cathodes.

SELECTED FUNDING HIGHLIGHT:

Nexceris, Lewis Center, Ohio

In September 2018, the DOE and the U.S. Army announced $80 million in research funding for vehicle efficiency and electrification. Although cobalt is a critical part of today's electric vehicle batteries, helping to retain battery life and manage heat, it is expensive and often mined in unsafe conditions. Given these challenges and the huge growth of the EV market, researchers and the auto industry are racing to find alternatives to cobalt.

One awardee, Nexceris, received $2.5 million to develop cobalt-free components for lithium-ion batteries in partnership with Navitas Advanced Solutions Group and researchers at Ohio State University.[28] Nexceris is an Ohio-based provider of products and services for fuel cells and energy storage, and Navitas designs and manufactures energy storage products and systems for private- and public-sector customers.[29] This project will require cathode materials to be developed from scratch, and subsequently tested in lithium ion batteries. The goal of the project is to develop cobalt-free batteries that demonstrate higher capacities, or duration of storage, which will allow EVs to drive farther per charge without relying on risky supply chains.

This is the second recent DOE award for Nexceris, following ARPA-E's announcement in March 2018 that Nexceris won a $2.1 million award to develop a highly efficient fuel cell for power generation.[30]

VTO Awards $6.2 Million for Charging Infrastructure

A key component of transforming the transportation sector is developing sufficient charging infrastructure to reduce range anxiety, the concern drivers have that their vehicle battery will run out before they can get to their destination or to a charger. Although the DOE has been supporting research in this field for years, this latest batch of grants includes a focus on cybersecurity of charging infrastructure, with a total of $6.2 million awarded.

States and manufacturers are accelerating the deployment of electric vehicles, driven by policies such as California's executive order that sets a goal of 5 million zero-emission vehicles by 2030 and dedicates $2.5 billion for infrastructure, and it is imperative that the infrastructure built nationwide in the coming years be robust and secure from future risks.[31] Vulnerable charging infrastructure could allow drivers' personal information to be stolen, cause vehicles to be damaged, and even allow the electric grid to be attacked.[32] According to the Alliance to Save Energy's *50 x 50: Reinventing U.S. Mobility* report, the DOE and other federal agencies should assess critical infrastructure needs, develop model building codes for EV-ready parking infrastructure, and establish incentives to support charging station access, particularly for innovative, high-power charging applications.[33]

These research sites received funding to advance the protection of electric vehicles, charging stations, and the grid from cyberattacks:

- ABB Inc., Raleigh, North Carolina ($1.7 million)
- Electric Power Research Institute, Knoxville, Tennessee ($2 million)
- Virginia Polytechnic Institute and State University, Blacksburg, Virginia ($2.5 million)

In addition to the DOE's support for technologies that will accelerate electric vehicle deployment, the Vehicle Office has partnered with the Bioenergy Office to fund the development of co-optimized engines and fuels for light-duty vehicles and bio-derived blend stocks for diesel engines for medium- and heavy-duty vehicles. The $10.2 million awarded in this field supports the work of six grant recipients to improve fuel economy and reduce carbon emissions in internal combustion engines, including:

- Hyundai-Kia America Technical Center, Superior Township, Michigan ($2.2 million), which is developing a mixed-mode co-optimized engine
- Stony Brook University, Stony Brook, New York ($1.5 million), which is working on an optimized biofuel-diesel blend

While vehicle efficiencies must continue to improve, challenges in decarbonizing the broader transportation sector will also require electrification and decarbonized fuels. The Vehicle Office can lead the development of decarbonized rail, freight, aviation, and maritime technologies.

BUILDING TECHNOLOGIES OFFICE AWARDS $47.7 MILLION IN 2018

Building Office Provides $42 Million for Lighting Innovation and Building Efficiency

Buildings account for 41 percent of U.S. energy consumption and almost 40 percent of U.S. carbon emissions.[34] The DOE's Building Technologies Office (BTO) aims to reduce building energy consumption and emissions by supporting research and development, market stimulation, and building codes and standards. It has contributed to improvements in building insulation, HVAC systems, and lighting.

In the lighting sector, we have seen remarkable improvements over the past decade, thanks to light-emitting diodes (LEDs). The cost of LEDs has dropped by 94 percent since 2008, and the number of installed LEDs has increased from less than 400,000 to more than 400 million as of 2016.[35] In 2018, the Building Office continued to support innovation in building efficiency and lighting with more than $42 million in funding.[36]

In a continuation of its annual solid-state lighting (SSL) R&D funding, the BTO announced the recipients of 2018 SSL awards in January 2019.[37] Eleven projects received $11.3 million from BTO and more than $15 million in total with public-private partnerships included. Several topic areas were represented, with six of the awards and $7.7 million in public-private funding going to projects focused on organic light-emitting diodes (OLEDs), which may allow for cheaper, brighter, and possibly even foldable lighting technology.

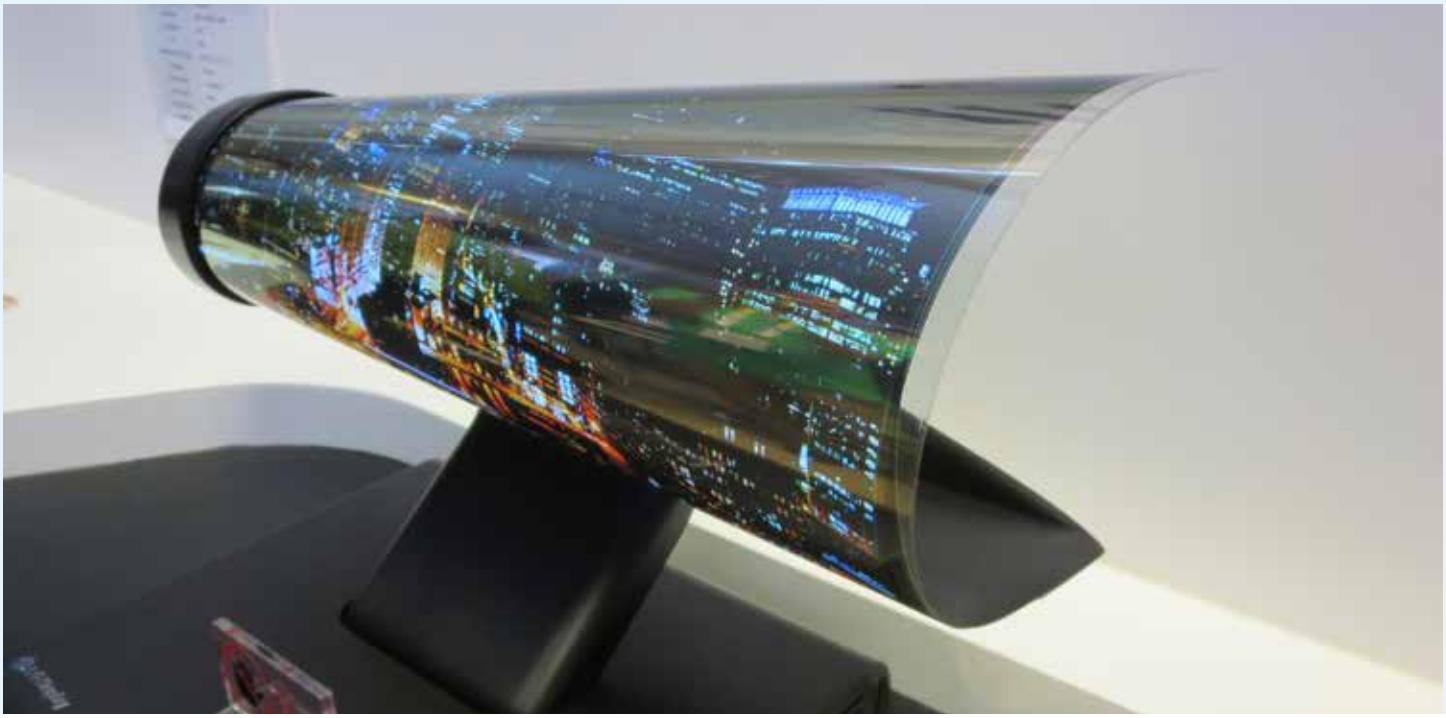
SELECTED FUNDING HIGHLIGHT:

ElectronInks, Austin, Texas

ElectronInks is a Texas-based small business that received a $150,000 BTO Small Business Innovation Research (SBIR) grant.[38] ElectronInks aims to develop flexible OLEDs by using microfluidic printing of metal microgrids at low temperature. If OLEDs can be made reliably at lower cost, this energy-efficient technology could someday enable wafer-thin televisions, light sources that can be embedded in fabrics, and new ambient-lighting applications that have been inaccessible.

The main innovation of the proposed technology is enabling micro-scale grids with small widths and large thicknesses to be printed rapidly and reliably at low temperatures. These grids are embedded into substrates that allow for subsequent organic layer deposition. The researchers at ElectronInks will collaborate with OLEDWorks, a developer and manufacturer of OLEDs based out of Rochester, New York, on integrating, testing, and characterizing the microgrids with state-of-the-art OLEDs.

This is the third SBIR grant that ElectronInks has received in the past four years, bringing its total SBIR support to more than $1 million.[39]



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Moving forward, BTO can consider several promising initiatives, including heat pump technologies that perform at higher efficiencies even at very low temperatures, and use refrigerants with low global-warming potential. NRDC's *America's Clean Energy Frontier* report found that cost-effective deep decarbonization will require us to electrify 75 percent to 100 percent of space and water heating in the residential and commercial sectors by 2050.[40] Advanced, grid-integrated heat pumps can dramatically increase building efficiency and provide valuable grid services, such as reducing peak electricity consumption and helping to integrate more renewable energy onto the grid.

ADVANCED MANUFACTURING OFFICE AWARDS $77.1 MILLION IN 2018

Manufacturing accounts for about 28 percent of U.S. energy consumption and is a significant contributor to carbon emissions.[41] The Advanced Manufacturing Office (AMO) aims to catalyze research, development, and adoption of advanced energy-related manufacturing technologies to enhance U.S. competitiveness and productivity. In FY18, AMO had a budget of $305 million to spend toward these goals, and much of this money was distributed across the DOE's national laboratories and research institutes.

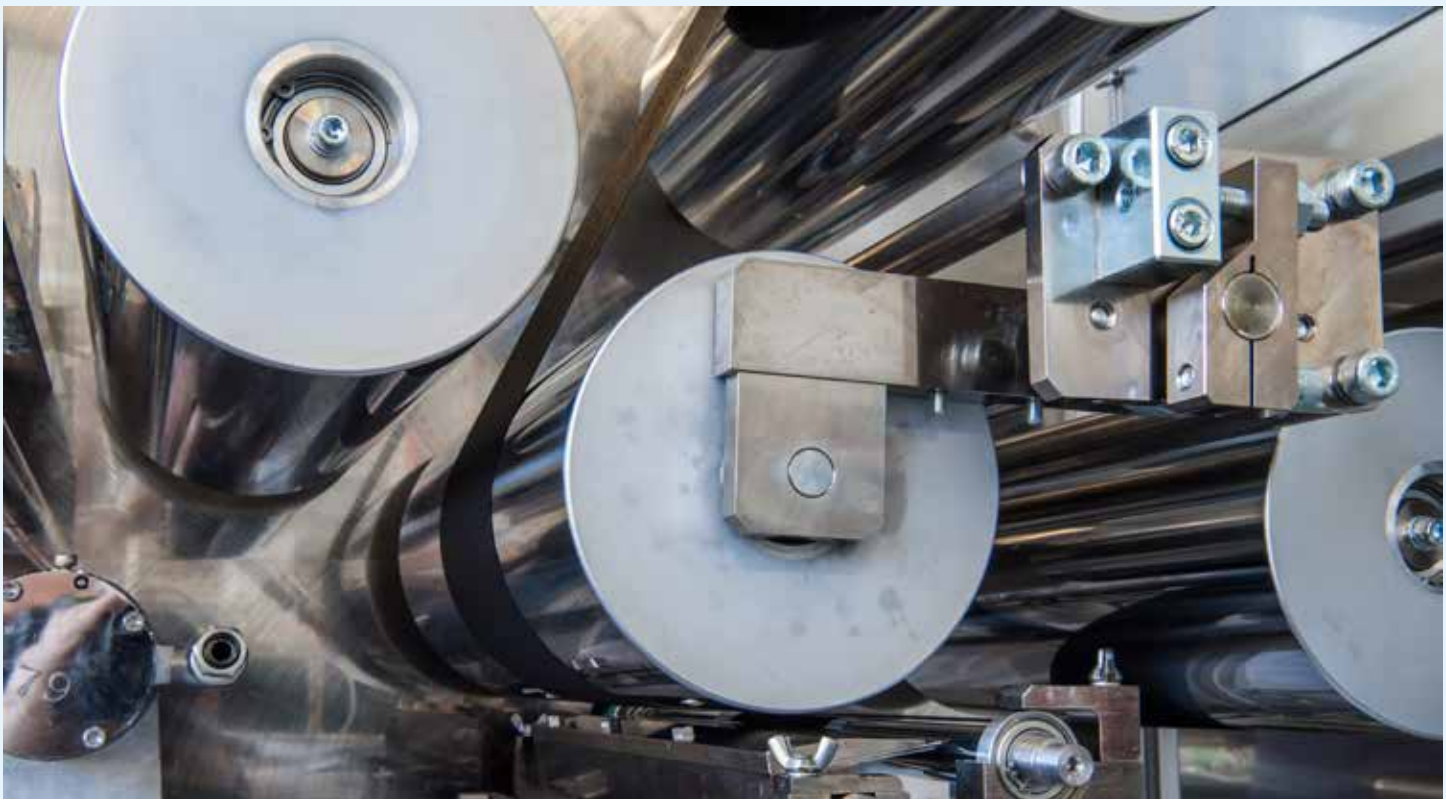
In January 2018, AMO provided $35 million to 24 early-stage recipients to research a wide variety of innovative technologies. The projects selected address topics including advanced materials for clean energy and for operating in harsh conditions, advanced manufacturing processing utilizing hydrogen and low-cost waste heat, and modeling tools to improve manufacturing efficiency. These potential breakthrough technologies can improve the competitiveness of the U.S. manufacturing industry by improving efficiencies and reducing costs, all while mitigating carbon emissions.

SELECTED FUNDING HIGHLIGHT:

Saint-Gobain Ceramics and Plastics, Malvern, Pennsylvania

Saint-Gobain Ceramics and Plastics manufactures and distributes building and high-performance materials for several sectors. In 2018 it received an AMO award for more than $820,000 to develop an advanced roll-to-roll manufacturing technique for devices including solar cells, batteries, and fuel cells.[42] The company's unique approach is to use a simultaneous multilayer coating that can potentially cut costs and energy consumption by reducing the number of process steps.

To assess the potential impact of this manufacturing technique, Saint-Gobain is partnering with Oak Ridge National Laboratory. If costs decrease, these manufacturing techniques may lead to more rapid deployment of electric vehicles and solar cells and enable new technologies, such as solar control windows that can adjust how much light enters your home.



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In September 2018, AMO awarded a total of $10 million to seven recipients for research on combined heat and power (CHP), or cogeneration. This grant is meant to enable small to midsize manufacturers to use CHP systems to provide services to the electric grid. One awardee, GE Global Research in Niskayuna, New York, will develop a grid-interface converter system and control solutions to interconnect small to midsize CHP engines to the low- to medium-voltage utility grid. The controller would allow the CHP operator to better interface with the grid operator.

ADVANCED RESEARCH PROJECTS AGENCY–ENERGY AWARDS $259.3 MILLION IN 2018

The Advanced Research Projects Agency–Energy (ARPA-E) aims to support high-potential, early-stage technologies that may have great impact—for instance, in substantially reducing emissions and improving affordability. Unlike those receiving funding from the technology-specific offices, ARPA-E grant recipients often are developing entirely new ways to generate, store, and use energy. In 2018, ARPA-E continued to support these transformational technologies through several funding programs.

ARPA-E Provides $28 Million for Energy Storage

In September 2018, ARPA-E awarded a total of more than $28 million to 10 projects as a part of its Duration Addition to Electricity Storage (DAYS) program. These grant recipients are all developing energy storage systems that provide power to the electric grid for durations of 10 hours to approximately 100 hours, opening significant new opportunities to increase grid resilience and performance. The extended discharge times of DAYS projects will enable a new set of grid applications including long-lasting backup power and greater integration of domestic renewable energy resources.

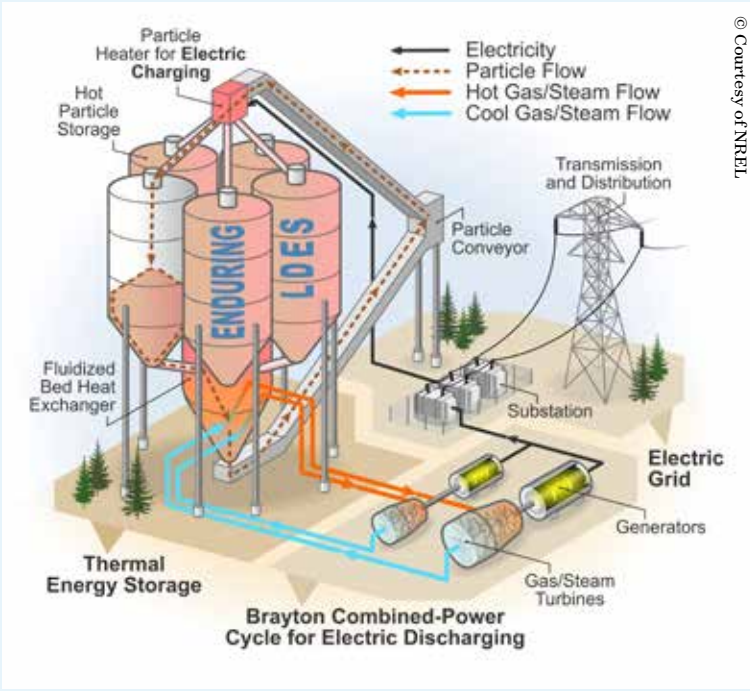
SELECTED FUNDING HIGHLIGHT:

National Renewable Energy Laboratory, Golden, Colorado

As a part of the DAYS program, the National Renewable Energy Laboratory (NREL) received a $2.8 million grant from ARPA-E to pursue long-duration energy storage.[43] NREL's unique approach includes a high-temperature charging device, low-cost thermal energy storage modules, a high-performance heat exchanger, and a closed-loop Brayton cycle turbine.

Zhiwen Ma, the lead researcher, explains that "when electric power is cheapest, electric heaters will 'charge' the storage modules by heating stable, inexpensive solid particles to more than 1,100 degrees Celsius. And when it's time to discharge this energy, the hot particles will move through a heat exchanger to heat a working fluid that drives a high-efficiency closed-loop Brayton combined cycle attached to an electric generator."

The collaborative project team includes scientists, engineers, professors, and researchers from NREL, GE Global Research, Greenway Energy, Allied Mineral Products, Inc., Purdue University, Colorado School of Mines, and Power Engineers. This diverse team aims to develop energy storage systems to provide reliable, affordable power to the electric grid while focusing on scalability.



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ARPA-E Awards $44 Million for OPEN+ Award

Through late 2018 and early 2019, ARPA-E has been gradually announcing the recipients of its 2018 OPEN+ grant, which is being distributed across topics including agriculture, energy/water, and methane. To date, $44 million has been awarded to this diverse set of high-potential projects, including a $3.5 million grant to Nanocomp Technologies in Merrimack, New Hampshire. Nanocomp is working to produce clean hydrogen from methane in a process that converts the methane into a high-value carbon solid, thus reducing the carbon emissions involved in conventional hydrogen production. Another OPEN+ award is providing the University of Oklahoma with more than $600,000 to explore methods of removing salt from contaminated water by freezing it instead of using the conventional, energy-intensive method of evaporation.

CONCLUSION

These examples represent only a small fraction of the research that the DOE is supporting with its clean energy innovation funding. We encourage policymakers to visit these innovators, learn more about their work, and ask them what more can be done to maintain U.S. clean energy leadership. The DOE's career staff have continued to leverage their nonpartisan technology expertise to enable U.S. innovators as they bring us closer to a cleaner, more affordable energy future. The bipartisan support for clean energy innovation is encouraging, and we hope this translates to increases in the DOE's innovation budget, as has been requested by members of the academic, public, and private sectors.[44]

ENDNOTES

1 This funding number does not include funds provided through lab calls, which are EERE grants competed for solely by the national labs. Hundreds of other clean energy research projects were sponsored by DOE's Office of Electricity (grid modernization and storage), Office of Fossil Energy (carbon capture and sequestration), Office of Nuclear Energy (nuclear power), and Office of Science (fundamental energy sciences). These are not included in the scope of this report, which focuses on the primary clean energy offices of EERE and ARPA-E.

2 Natural Resources Defense Council (hereinafter NRDC), "Revolution Now: The Future Is Here for Clean Energy Technology," https://www.nrdc.org/revolution-now (accessed January 20, 2019).

3 Elizabeth Noll, "Congress Agrees to Strong Funding for Clean Energy," NRDC, September 18, 2018, https://www.nrdc.org/experts/elizabeth-noll/congress-agrees-strong-funding-clean-energy.

4 Cost reductions are relative to 2008 except for EV batteries, which are compared with 2010.

5 States in dark blue received awards either in 2018, or in early 2019 for funding opportunities that were announced in 2018. Based on publicly available information on competitive grants, states in light blue received funding in 2017 but did not receive funding in 2018.

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