

**Advanced  
Research Projects  
Agency - Energy**

**Advanced Research Projects Agency – Energy (ARPA-E)**

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**Advanced Research Projects Agency - Energy  
Proposed Appropriation Language**

For Department of Energy expenses necessary in carrying out the activities authorized by section 5012 of the America COMPETES Act (Public Law 110-69), as amended, [\$291,000,000] *\$350,000,000*, to remain available until expended: Provided, that of such amount [\$29,250,000] *\$32,000,000* shall be available until September 30, [2017] *2018* for program direction.

**Explanation of Changes**

The \$350,000,000 request for FY 2017 is a \$59,000,000 increase over the FY 2016 enacted level. The increase in funding will enable ARPA-E to fund additional early-stage, innovative energy technologies as well as exploit the technological opportunities developed in previous ARPA-E programs, leading to transformational energy technologies.

This discretionary funding request is coupled with a legislative proposal to create an ARPA-E Trust that would provide an additional \$1,850,000,000 in mandatory funding over five years. \$150,000,000 of this mandatory funding is requested for FY 2017. This legislative proposal will add specific targeted activities to create investable outcomes from ARPA-E's continued support of transformational energy technologies.

**Public Law Authorizations**

P.L. 95-91, "Department of Energy Organization Act" (1977)

P.L. 109-58, "Energy Policy Act of 2005"

P.L. 110-69, "America COMPETES Act of 2007"

P.L. 111-358, "America COMPETES Reauthorization Act of 2010"



## Advanced Research Projects Agency - Energy

(\$K)

| FY 2015 Enacted | FY 2015 Current | FY 2016 Enacted | FY 2017 Request |
|-----------------|-----------------|-----------------|-----------------|
| 279,982         | 279,982         | 291,000         | 500,000         |

### Overview

As defined by its authorization under the America COMPETES Act, the Advanced Research Projects Agency-Energy (ARPA-E) catalyzes transformational energy technologies to enhance the economic and energy security of the United States. ARPA-E funds high-potential, high-impact energy projects that are too early for private sector investment but could significantly advance the ways we generate, store, distribute and use energy. ARPA-E plays a unique role in DOE's research and development R&D organization, complementing and expanding the impact of DOE's basic science and applied energy programs.

ARPA-E focuses on energy technologies that can be meaningfully advanced with a targeted investment over a defined period of time. ARPA-E's rigorous program design, close coordination with other DOE offices and federal agencies, competitive project selection process, and hands-on engagement, ensure thoughtful expenditures while empowering America's energy researchers with funding, technical assistance, and market awareness.

ARPA-E was established by the America COMPETES Act of 2007 following a recommendation by the National Academies in the *Rising above the Gathering Storm* report. As of December 2015, ARPA-E has funded over 450 projects with approximately \$1.3 billion through 29 focused programs and open funding solicitations.

### Highlights and Major Changes in the FY 2017 Budget Request

Under the Budget Request for FY 2017, ARPA-E expects to release funding opportunity announcements (FOA) for seven to eight focused technology programs, slightly increase funding for Innovative Development in Energy-Related Applied Sciences (IDEAS) proposals, and potentially run a technology prize competition. In addition, funding will support opportunities for qualification and field testing, thereby further de-risking these technologies and increasing the likelihood that projects will receive private sector investment. In keeping with a multi-year cycle for OPEN solicitations (2009, 2012, and 2015), ARPA-E does not anticipate an open solicitation in FY 2017. In FY 2017, ARPA-E will continue its stand-alone Small Business Innovation Research / Small Business Technology Transfer (SBIR/STTR) program to provide additional support to small businesses beyond the significant number of awards that go to small businesses via ARPA-E's standard FOA process.

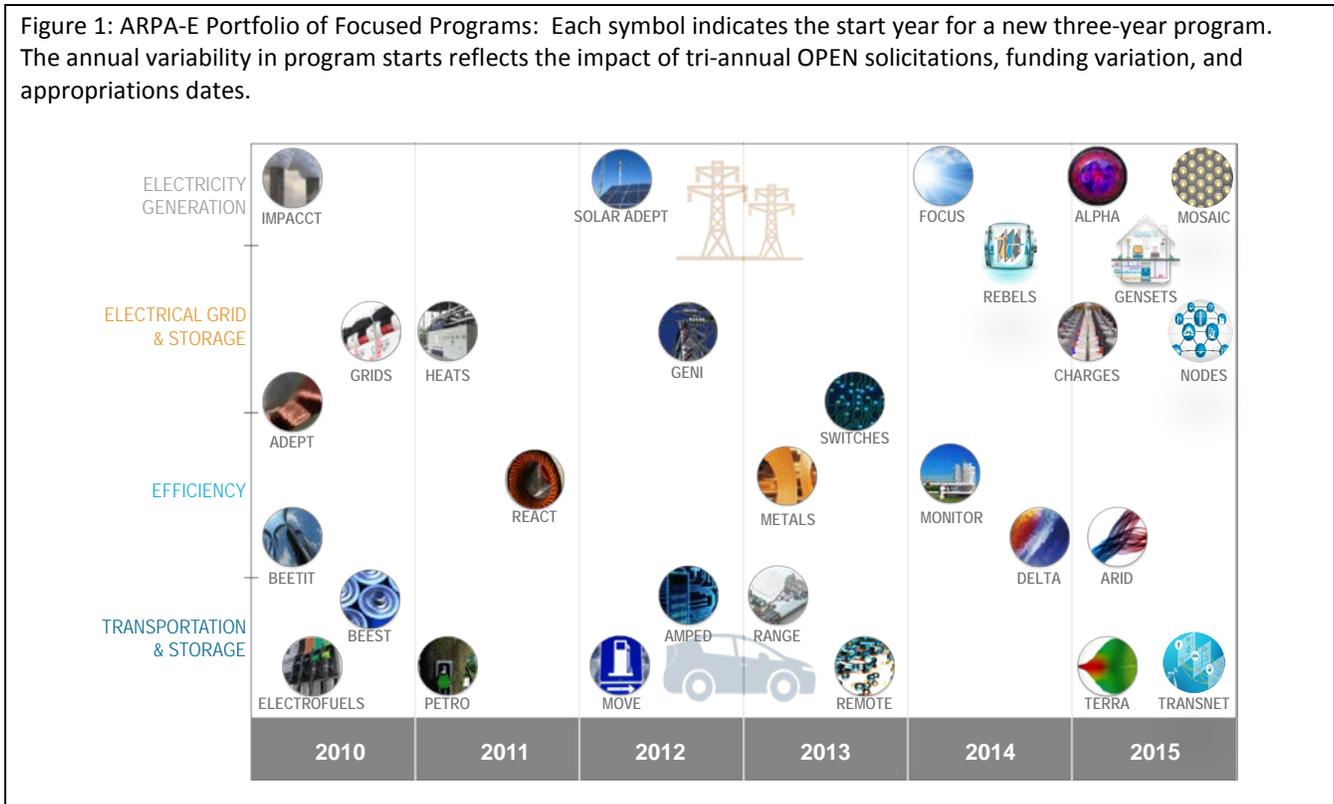
In addition to the FY 2017 Budget Request, an authorization proposal of \$150 million in mandatory funding in 2017 as part of a larger, new legislative proposal, the "Advanced Research Projects Agency – Energy Trust" program, will be transmitted to Congress. This would provide a total FY 2017 Budget of \$500 million. The full authorization proposal would seek \$1.85 billion for ARPA-E over 5 years. In addition to the \$150 million in FY 2017, this would include \$250 million in FY 2018, \$350 million in FY 2019, \$450 million in FY 2020, and \$650 million in FY 2021. These funds will provide a reliable stream of funding to create a complementary new effort that will expand ARPA-E's impact. A significant focus of this expanded effort will be on accelerating technologies that have demonstrated significant early-stage success toward readiness for private-sector investment. Combined with ARPA-E's annual appropriations, this will result in a total funding level of approximately \$1 billion in 2021.

### Background Narrative

In its first six years, ARPA-E has established a nimble, effective management structure and developed a portfolio of technical programs that is delivering innovative, investable opportunities to the commercial sector. ARPA-E will continue to deliver value to the US economy with continued emphasis on maintaining a healthy portfolio of projects. These projects cover a broad range of energy topics, with a growing focus on additional scale-up of the most promising projects that have demonstrated success in technical development, project management and definition of commercial pathways. Under the proposed mandatory funding, ARPA-E will add a new focus on innovative systems level development that will deliver larger, more rapid impacts from the transformational energy technologies developed under ARPA-E's existing core programs, while the dynamic core program activities will continue to be supported under discretionary funding.

Breadth and Increased Value Opportunity of the ARPA-E Portfolio

ARPA-E is tasked to identify and support revolutionary energy inventions and transformational energy technology advances, which requires constant evolution of its programmatic focus. This is accomplished by establishing dynamic technical programs (each lasting about 3 years) designed to accelerate innovation in high-potential areas. ARPA-E’s FY 2016 funding level of \$291 million can support development of about five to seven new \$25-35 million programs per year and one \$125 million to \$175 million OPEN solicitation every three years. The breadth of the program portfolio that has developed over ARPA-E’s lifetime is shown below, where new programs address different parts of the energy technology space from year to year. Each of the programs illustrated, as well as the OPEN programs, supports a range of individual projects that form a sustained investment in early-stage, innovative technologies that advance from early stage concepts to prototype levels of readiness under ARPA-E support.



ARPA-E addresses its establishment purpose, ‘to overcome the long-term and high-risk technological barriers in the development of energy technologies,’ by using a project portfolio funding approach to ‘de-risk’ areas of technological opportunity. To accomplish this, each program contains a portfolio of different, high-risk projects taking different approaches to the aggressive technical goals set by the program. Over the course of project execution, the most effective approaches emerge based on their technical performance. During the rigorous award selection process, significantly more projects that have the potential to add high value to the portfolio are identified than can be funded, which limits the number of technical options available to achieve the program goals. ARPA-E engages in an initial down-select process whereby only a subset of submitted concept papers is recommended for full applications. Within this more promising cadre of applications:

- Of 28 Focused FOAs: 34% of the submitted concept papers were selected for full applications and only 1/3 of the resulting full applications were selected for funding;
- Of 3 OPEN FOAs: 11% of the submitted concept papers were selected for full applications and only one eighth of the resulting full applications were selected for funding.

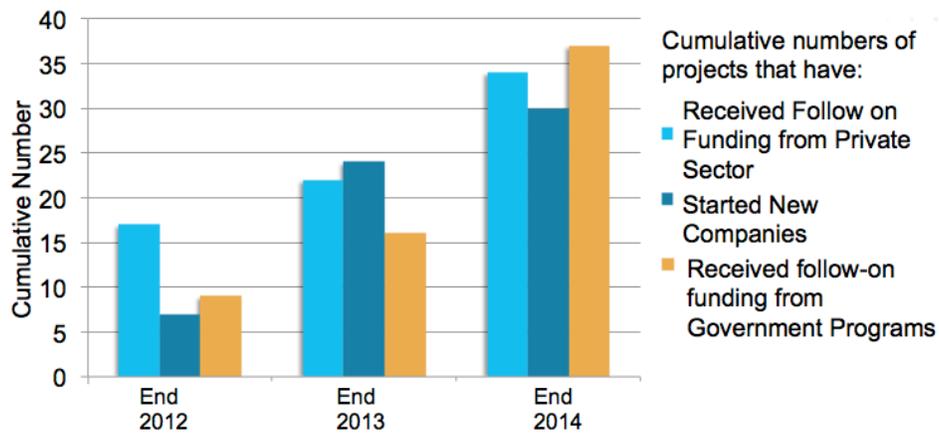
Sustaining project breadth is possible because of the opportunities presented by the U.S. energy entrepreneurs that ARPA-E (and the country as a whole) draws on for innovation. In parallel, the value proposition of sustaining breadth in ARPA-E’s program and project portfolios includes strengthening opportunities for US innovation in energy technologies.

As ARPA-E identifies continuing areas of innovation, there are increasing opportunities to expand the breadth of topical areas to include technical opportunities that require more significant technical investments, such as innovations in manufacturing scale-up and new opportunities from unconventional integration of component-level advances. Maintaining a dynamic, broad portfolio of innovative programs that includes more complex projects, and further advancing successful mature projects toward investment-readiness, are essential to drawing full value from ARPA-E’s investment in high-potential projects.

Depth and Increased Value Delivery of ARPA-E Investments

A significant component of ARPA-E’s mission and goals involves accelerating the economic impact of US investments in energy R&D, and advancing the commercialization readiness of successful projects (depth of investment) is essential in doing so. Developing the pathway to commercial applications is an intrinsic component of all projects, and project teams are required to spend at least 5% of their budgets on activities such as techno-economic analysis, market research, intellectual property protection, and engagement with potential customers and investors. As project teams demonstrate success, ARPA-E’s Technology-to-Market Advisors and Program Directors work closely with the teams to help identify pathways toward commercial deployment. Many of ARPA-E’s alumni projects have been able to obtain follow-on funding from private investors, state agencies and/or federal programs, and ARPA-E’s maturing portfolio is offering increasing opportunities for commercialization of ARPA-E funded technologies.

**Figure 2: Early Success Metric:** Between its inception in 2009 and February 2015, ARPA-E had invested approximately \$1.1 billion across more than 400 projects through 23 focused programs and two open funding solicitations and 141 of those projects had completed their work under ARPA-E support. Some 34 ARPA-E projects had attracted more than \$850 million in private-sector follow-on funding



However, as ARPA-investments have developed a healthy portfolio of mature, high-potential projects, the Agency is finding increasing needs for depth of investment – that is additional funding to continue to ‘de-risk’ projects to the point where they are ready for private-sector investment. Some highly innovative projects began at such an early stage that the project duration is not sufficient to reach a viable prototype. Other projects require significant qualification studies, field-testing, or scale-up assessment before private investors will consider investment. Furthermore, limited program size limits the important development of larger-scale systems solutions, which would, for instance, integrate opportunities from multiple programs for increased impact. Without additional support, promising technologies developed by ARPA-E risk being ‘orphaned’ before they have a chance to demonstrate their full potential. Expanding the depth to which ARPA-E can support more of its projects and thus deliver more economic impact, more rapidly is a key value opportunity for increased funding.

To sustain the potential economic value of the most promising technical projects, ARPA-E has begun creating opportunities for project teams to demonstrate the investment readiness of their prototypes through qualification and field testing. As an example of such a depth investment, in 2015 ARPA-E created a small program, CHARGES, to provide project teams with opportunities for the test and evaluation needed to advance their technologies for grid storage at scale and qualify them under utility regulations.

#### Funding Path to \$1 Billion Annual Budget in Five Years

A funding path to an annual budget of \$1 billion was proposed in the original Gathering Storm report that recommended the formation of ARPA-E. ARPA-E's discretionary funding along with ARPA-Energy Trust would provide approximately \$1 billion in funding in 2021 and position ARPA-E to deliver expanded impact based on its nimble operational structure and growing opportunities created from its maturing portfolio of technical programs. Under the expanded budget, ARPA-E would add both breadth and depth, add some focused programs involving larger and more complex technical outcomes, and add more funds for developing commercial impact.

To manage the proposed expansion, ARPA-E will add a new focus on innovative systems level development that will deliver larger, more rapid impacts under the Trust Fund (see pages 21-28) that complements and builds on its on-going activities under the America Competes Act (discretionary funds, see pages 7-20). The new activities under the ARPA-E Trust will be implemented in stages that draw from the outcomes of the core program and, in the years after 2017, the outcomes of the previous years' Trust investments. In this way, the planned growth in funding requirement over the five year period will enable ARPA-E to scale up this new effort to deliver the maximum impact, while maintaining the agency's central focus on accelerating transformational energy technologies from concept to market. Expanding ARPA-E's budget will deliver high-yield, high value gains by accessing a greater breadth of the demonstrated U.S. entrepreneurial opportunities in energy technologies, and investing sufficiently to de-risk the most promising projects to the point that they are ready to move forward with private-sector investment.

**Advanced Research Projects Agency - Energy  
Funding by Congressional Control (\$K)**

|   | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|---|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| ARPA-E Projects   | 252,000                    | 252,000                    | 261,750                    | 318,000                    | +56,250                       |
| Program Direction   | 28,000                     | 28,000                     | 29,250                     | 32,000                     | +2,750                        |
| <b>Subtotal, Advanced Research Projects Agency - Energy</b>         | <b>280,000</b>             | <b>280,000</b>             | <b>291,000</b>             | <b>350,000</b>             | <b>+59,000</b>                |
| Rescission of Prior Year Balance                                    | -18                        | -18                        | 0                          | 0                          | +0                            |
| <b>Total, Advanced Research Projects Agency - Energy</b>            | <b>279,982</b>             | <b>279,982</b>             | <b>291,000</b>             | <b>350,000</b>             | <b>+59,000</b>                |
| <b>Federal FTEs</b>   | <b>49</b>                  | <b>49</b>                  | <b>56</b>                  | <b>56</b>                  | <b>+0</b>                     |
| <b>Advanced Research Projects Agency – Energy Trust<sup>1</sup></b> | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>150,000</b>             | <b>+150,000</b>               |

SBIR/STTR<sup>2</sup>:

- FY 2015 Current: \$12,270 total (SBIR \$11,380 / STTR \$890)
- FY 2016 Projected: \$9,030 total (SBIR \$7,853 / STTR \$1,177)
- FY 2017 Request: \$11,607 total (SBIR \$10,176 / STTR \$1,431)

<sup>1</sup> Mandatory funding under legislative proposal, not subject to discretionary appropriations.

<sup>2</sup> In FY 2017, ARPA-E will continue its stand-alone Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program to provide additional support to small businesses beyond the significant number of awards to small businesses via ARPA-E's standard non-SBIR/STTR solicitations.



## ARPA-E Projects – Discretionary Budget Request

### Overview

The Advanced Research Projects Agency-Energy (ARPA-E) catalyzes transformational energy technologies to enhance the economic, environmental, and energy security of the United States by advancing high-potential, high-impact energy projects that are too early for private sector investment.

ARPA-E draws upon the Defense Advanced Research Projects Agency's successful model of program management, with targeted modification to meet ARPA-E's unique requirements for US economic impact through a strong focus on the commercialization potential of new energy technologies. The major adaptation in ARPA-E's model is the implementation of a strong Technology-to-Market (T2M) focus. ARPA-E offers funding opportunities to the nation's research and development community with a requirement of a clear techno-economic focus. This approach complements and seeks to extract maximum value from the nation's existing investments in fundamental energy research, including those of the DOE Office of Science.

In its first five years of program funding, ARPA-E has demonstrated the efficacy of its model for accelerating high-potential, novel technical approaches to existing and emerging US energy challenges. Program Directors, recruited for their technical expertise and experience in energy issues, are given significant autonomy in identifying potential high-impact areas for R&D investment. ARPA-E's Program Directors work to develop their proposals in the context of both private sector and federally funded work in the technical space, and ultimately propose a program designed to accelerate research and commercial development in the topic area. The T2M Advisors ensure the T2M focus is included throughout the development process and the execution of projects. As a complement to its focused technology programs, ARPA-E also supports OPEN and IDEAS solicitations. OPEN solicitations seek the most innovative new ideas in energy technology across the full spectrum of energy applications, allowing the Agency to support the development of important technologies that otherwise would fall outside the scope of its focused programs. OPEN solicitations were run in 2009, 2012, and 2015. The IDEAS solicitation was launched in 2013 and is continuing to provide small, short-term grants to develop proof-of-concept for innovative but unproven technical concepts.

Selection of project awards within each program occurs by a rigorous process of proposal and reviews. Selection criteria include the transformative character of the technology, the potential impact of the technology on ARPA-E's energy missions as defined in its authorizing statute, and the potential for the project to yield commercial applications that benefit US economic and energy security. Within these criteria the most highly rated proposals are selected for award negotiations. The majority of the funded projects involve more than one institution, and the lead institutions are distributed among universities, businesses, federally funded research and development centers (FFRDCs), and non-profit organizations.

The resulting portfolio of alumni and active R&D projects broadly covers the US energy technology landscape, from transportation fuels and energy storage, through residential, commercial and manufacturing efficiency to the storage, distribution and generation of electrical power. The programs are designed to deliver value given a targeted investment over a defined period of time. The projects are structured in a portfolio funding approach to 'de-risk' areas of technological opportunity by supporting multiple high-potential approaches to the program goals to the point where their relative value for further applications can be determined. This allows the most effective approaches to emerge based on their technical performance and potential. Under ARPA-E's rigorous project management process, project teams work to quarterly milestones for both technical and commercialization goals. Projects that prove unable to meet the goals are terminated.

### Highlights of the FY 2017 Appropriations Budget Request

The selection of areas for new programs follows a rigorous evaluation and development process to assure that all new programs meet the following criteria:

- 1) A new program must be based on significant potential for transformational technological innovation. The technical opportunity must be too early stage or too high-risk for commercial investment.
- 2) The technical area must have the potential to have substantial impact on ARPA-E's legislated mission areas, which are Improving Energy Efficiency, Reducing Dependence on Energy Imports, and Reducing Harmful Energy Emissions, specifically and critically including reduction of greenhouse gas emissions.

- 3) Investment in the technical opportunity addresses DOE's energy mission and goals, but does not duplicate investment being carried out in other parts of DOE or other federal agencies.
- 4) There must be a pathway for advancing the technology toward hand-off to the private sector for commercial development and corresponding benefits to the economic and energy security of the U.S.

Program development includes input from the outcomes of previous programs and program assessments. The majority of the presently active programs were initiated in FY 2014 and 2015, when ARPA-E developed a strong cluster of programs in the power space, including carbon-free power generation, distributed generation, and grid integration, along with programs addressing natural gas emissions and the impacts of water scarcity on power-generation efficiency. New programs are being added in 2016, as older projects and programs end. As described in more detail in the 'Activities and Explanations of Changes' table, the following areas are in the final stages of assessment as new programs in FY 2016: building efficiency, biological carbon sequestration, zero-carbon fuels, improved transportation energy efficiency, reducing transportation demand, strategic materials for energy storage, and energy efficient data centers.

In FY 2017 ARPA-E expects to release funding opportunity announcements (FOAs) for seven to eight focused programs each funded in the range of \$10 - \$40 million. Those programs will be defined to address new areas not represented in the present portfolio, and to develop new opportunities opened by the outcomes of previous programs. The assessment process for the new programs is now underway as described below, and is structured to deliver strategic balance and strong opportunities for growth through emphasis on:

- exploiting advances in power electronics, systems and controls to accelerate the integration of storage, distributed generation and intermittent renewable sources into the grid
- integrating innovations across sectors to enable new routes to energy products or improve industrial energy efficiency while also improving economic competitiveness
- exploiting new approaches to materials discovery and development to target key technical barriers in areas including building and industrial efficiency, efficient power distribution, zero-carbon power, and zero-carbon fuels
- leveraging new data management and communications trends to discover new methods for energy savings

These opportunity areas are outlined in more detail in the 'Activities and Explanations of Changes' table. This careful assessment process is necessary to insure that ARPA-E meets its statutory requirement to identify and promote revolutionary advances in fundamental and applied energy research and development. In order to fund a broader range of possible technical solutions and thereby enhance the probability of program success, some of these programs may need to be initiated at up to \$40 million.

Throughout FY 2016, workshops will be held to assess new program topics for FY 2017, building on the strategic innovation areas. Three workshops already planned are:

1. **Innovative Approaches to Ocean Cultivation and Processing of Macro Algae for the Production of Low-carbon Fuels**  
ARPA-E is interested in identifying critical R&D topics and targets, which need to be addressed to enable a successful transition from today's macro algae industry focused primarily on food and specialty chemicals to large-scale fuel opportunities. Technical areas for assessment are: advancing breeding of more productive macro algae (genomics, species selection, adaptation of terrestrial breeding techniques); new cultivation methods (site selection, cultivation system design, nutrient supply, robotics/automation); transport, storage and processing (dewatering and storage; processing/fractionation without freshwater); and ecosystem services and effects (excess nutrient removal; CO<sub>2</sub> sequestration).
2. **Advanced Materials, Sensors, and Controls Enabling Inherently Safe and Secure Designs for MW Scale Nuclear Energy**  
ARPA-E is interested in identifying how recently developed materials technologies can be combined with advanced sensors and controls to enable innovative, new designs for nuclear reactors at the 1-10 MW scale. Emphasis will be placed on how advances in materials, sensing, imaging, and controls can be incorporated into potentially transformative reactor designs with particularly careful attention to safety, security, and non-proliferation issues. Design concepts such as a solid/monolithic core with embedded heat transfer channels will be explored in a workshop bringing together experts in materials science, reactor design, non-proliferation/safeguards, and

monitoring/controls. The greenhouse gas reduction impacts for various use cases of nuclear power at this scale will also be examined. This area of assessment is being closely coordinated with the DOE Office of Nuclear Energy and non-proliferation experts in DOE NNSA, with additional input from the Nuclear Regulatory Commission.

### 3. High-Impact Building Efficiency through Data Analytics

Energy technology has the potential to become much smarter – to make judicious use of the ubiquitous, nearly free data that we can now collect. In particular, building HVAC systems – one of the biggest energy consuming applications in the United States – are constantly running in modes that are not optimized for the true occupancy state of the building. ARPA-E is investigating the development of novel sensor technologies to capture data relating to occupancy (whether by direct measures, such as image capturing and processing, or by indirect measures, such as personal device connectivity via Wi-Fi) and use it to enable HVAC systems and controls to run at more appropriate states for the actual occupancy conditions. In addition, with advanced interface and algorithm development, this will enable completely “invisible” programmable thermostats – and expand to any alternative technologies that run more efficiently via occupancy detection.

Work to develop the additional workshops for defining FY 2017 programs is in progress. Broad areas under assessment (each may yield more than one potential workshop concept) are:

**Applications in Efficient Power Conversion:** Materials and component level advances in power electronics have potential applications across the energy sector, which can be advanced by technical innovation in integrating the new components into modules with specific applications. Opportunities span the range from grid-level power flow control at transmission voltages (69 kV and higher), to efficient connections for photovoltaics to power systems, and improved electric motor drives to lower power applications, such as the technologies that deliver power to computer microprocessors.

**Hybrid Solar Systems:** Innovative combination of advances in concentrated solar photo-voltaics and solar thermal storage, with advances in power electronics can be used to create integrated products that capture more of the available solar energy, provide intrinsic storage, and optimize coupling from both distributed and centralized generation to the electric power grid.

**Expanded investments in Information and Computing Technologies (ICT):** Advances in materials, photonics, and heat management provide efficiency-enhancing opportunities for communications and computing systems of all kinds. Reducing energy needs in personal devices and wireless access networks are examples of potential focus areas.

**Light Metals in Transportation and Advanced Manufacturing:** Light metals provide a key pathway to more efficient transportation, but cost – both financial and in terms of energy use – remains a barrier. Advances in processing and recycling techniques now offer opportunities to reduce those barriers. Combining these new approaches with designed materials properties to couple into advanced manufacturing, such as creating powdered materials for use in additive manufacturing, represent high-potential opportunities to transform vehicle light-weighting.

**Innovations in production of fuels and chemicals:** New technical approaches can address the scaling issues that today mandate large, capital and energy intensive processing facilities for producing fuels and chemicals. Areas of innovation range from efficient recovery of fuels and value-added products from renewable biological sources, lower-temperature and -pressure synthesis of commodity chemicals, and flexible, low-cost chemical infrastructure that can accommodate changes in feedstock supply volume and location. The new approaches would better exploit domestic bio-feedstocks and renewable resources to produce net-zero carbon fuels, and reduce the energy intensity and greenhouse gas emissions for the production of liquid fuels and chemicals.

In addition to the primary activity in new Programs, a portion of FY 2017 funding is likely to be used to supplement ongoing ARPA-E projects where a small amount of additional funding from ARPA-E could significantly advance commercial readiness, leading to future support from outside ARPA-E that will help advance the technology towards the market. In 2017, ARPA-E is evaluating a ‘prize’ competition in developing new optimization algorithms for power-flow control in

transmission and distribution systems. ARPA-E will also continue its stand-alone SBIR/STTR program to provide additional support to small businesses beyond the significant number of awards to small businesses via ARPA-E's standard non-SBIR/STTR solicitations. ARPA-E will continue the use of IDEAS, a small rolling open solicitation to rapidly support innovative applied energy research that has the potential to lead to new focused programs or that may complement portfolios in ongoing focused programs.

**ARPA-E Projects  
Funding (\$K)**

|                               | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|-------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| ARPA-E Projects               |                            |                            |                            |                            |                               |
| Transportation Systems        | 126,000                    | 126,000                    | 104,700                    | 127,200                    | +22,500                       |
| Stationary Power Systems      | 126,000                    | 126,000                    | 157,050                    | 190,800                    | +33,750                       |
| <b>Total, ARPA-E Projects</b> | <b>252,000</b>             | <b>252,000</b>             | <b>261,750</b>             | <b>318,000</b>             | <b>+56,250</b>                |

ARPA-E Projects

Transportation Systems

Stationary Power Systems

**Total, ARPA-E Projects**

SBIR/STTR<sup>1</sup>:

- FY 2015 Current: \$12,270 total (SBIR \$11,380 / STTR \$890)
- FY 2016 Projected: \$9,030 total (SBIR \$7,853 / STTR \$1,177)
- FY 2017 Request: \$11,607 total (SBIR \$10,176 / STTR \$1,431)

<sup>1</sup> In FY 2017, ARPA-E will continue its stand-alone Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program to provide additional support to small businesses beyond the significant number of awards to small businesses via ARPA-E's standard non-SBIR/STTR solicitations.

**ARPA-E Projects**  
**Explanation of Major Changes (\$K)**

|  | <b>FY 2017 vs<br/>FY 2016</b> |
|--|-------------------------------|
| <p><b>Transportation Systems:</b> Based upon six years of experience in the development of focused technology programs and noting the distribution of applications to and awards made in the competitive OPEN solicitations in 2009, 2012 and 2015, ARPA-E anticipates a shift from an equal funding distribution between Stationary Power Systems and Transportation Systems to approximately a 60:40 split in FY 2016 and FY 2017.</p>   | <b>+22,500</b>                |
| <p><b>Stationary Power Systems:</b> Based upon six years of experience in the development of focused technology programs and noting the distribution of applications and awards made in the first two competitive OPEN solicitations in 2009, 2012 and 2015, ARPA-E anticipates a shift from an equal funding distribution between Stationary Power Systems and Transportation Systems to approximately a 60:40 split in FY 2016 and FY 2017. A component of the shift is due to increasing effort in residential, commercial and industrial efficiency, which is included in the Stationary category.</p> | <b>+33,750</b>                |
| <b>Total, ARPA-E Projects</b>  | <b>+56,250</b>                |

**ARPA-E Projects**

**Activities and Explanation of Changes**

| FY 2016 Enacted   | FY 2017 Request   | Explanation of Changes<br>FY 2017 vs FY 2016   |
|---|---|--|
| <b>\$261,750,000</b>  | <b>\$318,000,000</b>  | <b>+ \$56,250,000</b>  |
| <p>In FY 2016 ARPA-E plans to release funding opportunity announcements for five to six focused programs.</p> <p>The funding opportunities to be supported in 2016 are in different stages of assessment, as noted below for each. It is likely, but not guaranteed, that FOAs will be released in each of these areas in FY 2016:</p> <p>Building efficiency: Re-inventing the single-pane window using advanced materials for either retrofit window coatings or new windows that provide thermal insulation and excellent optical quality while preventing condensation. Existing single-pane window stock constitutes a significant loss of heating energy in the U.S. and this program takes on the significant technical challenges in developing cost-effective retrofits or replacements. A FOA has been released in this area.</p> <p>Biofuel plant root phenotyping for improved growth properties and thereby provide a scalable approach to atmospheric carbon sequestration through plant roots to the soil. New technologies that measure structural and functional properties of plant roots and soils that lead to the development of improved root traits, which improve the sustainability of biofuel crop production by increasing soil carbon storage and improving fertilizer efficiency. These traits will reduce greenhouse gas emissions and are expected to create grower value by improving soil quality, nutrient use efficiency and water use</p> | <p>In FY 2017 ARPA-E plans to release funding opportunity announcements for seven to eight focused programs.</p> <p>ARPA-E anticipates new focused programs in both Transportation Systems and Stationary Power Systems (including energy efficiency). The assessment process to define the new program is underway, and will proceed through FY 2016, as described in the previous text section, 'Highlights of the FY 2017 Budget Request.'</p> <p>The assessment of new programs is taking place in the context of ARPA-E's identified technological innovation opportunities:</p> <p>Innovation opportunity: integration of storage, distributed generation and intermittent renewable sources for improved, more economical grid operations. New potential in this area arises from advances in power electronics, systems and controls, as well as the development of new capabilities in storage.</p> <p>Innovation opportunity: integrating cross-sector innovations to enable new routes to energy products or improve industrial energy efficiency. An example of such integration is combining innovative power electronics components to address specific power conversion needs such as low cost, high-speed, energy efficient battery chargers for electric vehicles. Similar new</p> | <p>The increase in funding will enable ARPA-E to fund approximately two more focused programs, and support proportional increases in SBIR, and IDEAS. The increase will also enable individual programs to be funded at a higher level, enabling the selection of additional projects and/or provision of additional funding for qualification and field testing of the most promising projects.</p> <p>The changes in Program focus between FY 2016 and 2017 are both essential to update ARPA-E's portfolio to address new developments in technical innovation.</p> <p>The exploitation of new developments in technical innovation will include greater (but not exclusive) focus on integrating the use of large-scale data, optimization, and distributed sensors and actuators to draw the greatest value from implementation of new technologies.</p> <p>A prize competition is under assessment for 2017 to incentivize development of optimized power control algorithms for energy transmission and distribution.</p> |

| FY 2016 Enacted   | FY 2017 Request   | Explanation of Changes<br>FY 2017 vs FY 2016 |
|---|---|--|
| <p>productivity. To select and breed for these traits, innovative technology platforms for the characterization of below ground plant growth and development will be required with demonstrated utility for field deployment. Final stages of assessment and development are underway prior to final decision on releasing a FOA.</p> <p>Renewable electricity to zero-carbon liquid fuels for transportation and stationary energy storage: Development of novel technologies to transform the way renewable electricity is stored and transported from remote generation sites to the end point customer to increase utilization of intermittent renewable energy and reduce carbon emissions. These include cost- effective and energy-efficient technologies that use renewable electricity to create energy dense liquid fuels from water, and CO<sub>2</sub> and/or N<sub>2</sub> from air. These fuels will be used for storage and subsequent conversion to electricity or as a clean fuel for zero-emission vehicles. Final stages of assessment and development are underway prior to final decision on releasing a FOA.</p> <p>New approaches to transportation energy efficiency: New vehicle and powertrain control technologies that can reduce the energy use associated with automotive transportation. These may include advanced vehicle and powertrain control concepts, optimization of individual vehicle operation facilitated by connectivity, and the reduction of the fuel and/or energy consumed by future vehicles undergoing either human operation or automated operation. An RFI has been released as part of</p> | <p>potential in this area arises from advances in biotechnology, distributed sensing, automation/robotics and new materials, as well as advanced manufacturing capabilities such as additive manufacturing.</p> <p>Innovation opportunity: exploiting new approaches to materials discovery and production to target technical barriers across all energy sectors. New potential in this area arises from the growing power of computational design of materials, new approaches to materials fabrication, and advances in high-throughput characterization.</p> <p>Innovation opportunity: leveraging new data management and communications trends to discover new methods for energy savings. New potential in this area arises from rapid developments in Information Technology and Telecommunications. Potential applications in this area can be used to support the improved development of energy systems from the components developed in previous programs.</p> <p>On-going assessments of the potential new programs in which combinations of these innovation opportunities would be applied are presented in the earlier text (Highlights of the FY 2017 Discretionary Budget Request).</p> |  |

| FY 2016 Enacted | FY 2017 Request | Explanation of Changes<br>FY 2017 vs FY 2016 |
|-----------------|-----------------|--|
|-----------------|-----------------|--|

completing the assessment for this area prior to the final decision on releasing a FOA.

Strategic development of solid-ion conductors for electrochemical technologies: Transform the properties of solid ion conductors for devices using alkaline exchange membranes (e.g., fuel cells and electrolyzers), lithium metal batteries, flow batteries, and other electrochemical technologies. Alleviate key deficiencies in solid ion conductors through co-optimization of ionic conductivity, selectivity, chemical stability, electronic conductivity, thermal stability, mechanical properties, processing, device integration, and cost. Final stages of assessment and development are underway prior to final decision on releasing a FOA.

New technologies for energy efficient data centers: Integrated photonic interconnects and novel new switching networks to provide fundamentally more energy efficient manipulation and movement of data. Final stages of assessment and development are underway prior to final decision on releasing a FOA.

Virtual transportation: Significant increases in the use of telecommunications could reduce the demand for human transportation, with benefits for energy imports, emissions and effective transportation efficiency. Significant reduction in the bandwidth of high-quality video transmission is needed to make this possible. A workshop is planned to assess the technical opportunities, and the magnitude of energy impact possible in this area.

| FY 2016 Enacted | FY 2017 Request | Explanation of Changes<br>FY 2017 vs FY 2016 |
|-----------------|-----------------|--|
|-----------------|-----------------|--|

The technologies being developed under MONITOR (natural gas leak detection) will require qualification and field testing before they are accepted by regulatory agencies and commercial users. An RFI has been released to assess testing needs, and final stages of assessment are underway prior to final decision on creating a funding opportunity for a test facility.

**ARPA-E Projects  
Performance Measures**

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

|                            | FY 2015  | FY 2016 | FY 2017        |
|----------------------------|--|---------|----------------|
| Performance Goal (Measure) | <b>Award Funding</b> - Cumulative percentage of award funding committed 45 days after award selections are announced   |         |                |
| Target                     | 70%  | 70%     | 70%            |
| Result                     | 100%   | TBD     | Not applicable |
| Endpoint Target            | No endpoint - continuous measure of efficiency in awarding funds   |         |                |
| Performance Goal (Measure) | <b>New Company Formation</b> – Number of new companies formed as a direct result of ARPA-E funding. As of February 2015, ARPA-E funded research has led to the formation of at least 30 new companies. |         |                |
| Target                     | ≥+3  | ≥+3     | ≥+3            |
| Result                     | Met <sup>1</sup>   | TBD     | Not applicable |
| Endpoint Target            | No endpoint – continuous measure of impact of ARPA-E awards on creating new jobs and industries  |         |                |

<sup>1</sup> Final quantitative metrics for FY 2015 will not be available until February 2016



## **Program Direction – Discretionary Budget Request**

### **Overview**

Program direction provides ARPA-E with the resources required to execute ARPA-E's mission. Program direction funds are utilized for salaries and benefits of federal staff; travel; support services contracts to provide technical advice and project management assistance; and other related expenses, including the DOE Working Capital Fund.

The key components of the ARPA-E model are the team, particularly the Agency's Program Directors and Technology-to-Market (T2M) advisors, and their hands-on engagement with awardees. ARPA-E Program Directors provide awardees with technical guidance that combines scientific expertise and real-world experience, while ARPA-E T2M advisors supply critical business insight and direction to enable awardees to develop strategies to move technologies towards the market. Each ARPA-E project includes clearly defined technical and commercial milestones that awardees are required to meet throughout the life of a project. Program Directors and T2M advisors work closely with each awardee, through regular meetings and on-site visits, to ensure that milestones are being achieved in a timely fashion. When a project is not achieving the goals of the program, ARPA-E works with the awardee to rectify the issue or, in cases where the issue cannot be corrected, ARPA-E discontinues funding for the project. To ensure the efficiency of ARPA-E's hands-on engagement with awardees, ARPA-E has in-house legal, procurement, and contracting staff, co-located with the Program Directors and T2M advisors, to provide direct access and timely communication. Finally, to help enable ARPA-E to rapidly move into new technology areas in response to scientific discoveries and breakthroughs, ARPA-E utilizes support contractors for technical advice and program management assistance.

### **Highlights of the FY 2017 Budget Request**

The FY 2017 Request for program direction is \$32 million, a \$2.75 million increase over the FY 2016 Enacted level. The increase is needed to cover additional oversight and management of projects in ARPA-E's portfolio due to the requested increase in projects funding, as well as inflationary increases for salaries, overhead, and other expenses.

**Program Direction – Appropriations Request  
Funding (\$K)**

|  | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|--|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| <b>Program Direction Summary</b>                   |                            |                            |                            |                            |                               |
| <b>Washington Headquarters</b>                     |                            |                            |                            |                            |                               |
| Salaries and Benefits                              | 9,315                      | 9,315                      | 10,103                     | 10,497                     | +394                          |
| Travel   | 1,003                      | 1,003                      | 1,316                      | 1,500                      | +184                          |
| Support Services                                   | 12,895                     | 12,895                     | 12,858                     | 14,730                     | +1,872                        |
| Other Related Expenses                             | 4,787                      | 4,787                      | 4,973                      | 5,273                      | +300                          |
| <b>Total, Program Direction</b>                    | <b>28,000</b>              | <b>28,000</b>              | <b>29,250</b>              | <b>32,000</b>              | <b>+2,750</b>                 |
| <b>Federal FTEs</b>                                | <b>49</b>                  | <b>49</b>                  | <b>56</b>                  | <b>56</b>                  | <b>+0</b>                     |
| <b>Support Services and Other Related Expenses</b> |                            |                            |                            |                            |                               |
| <b>Support Services</b>                            |                            |                            |                            |                            |                               |
| Technical Support                                  | 4,513                      | 4,513                      | 4,500                      | 5,155                      | +655                          |
| Management Support                                 | 8,382                      | 8,382                      | 8,358                      | 9,575                      | +1,217                        |
| <b>Total, Support Services</b>                     | <b>12,895</b>              | <b>12,895</b>              | <b>12,858</b>              | <b>14,730</b>              | <b>+1,872</b>                 |
| <b>Other Related Expenses</b>                      |                            |                            |                            |                            |                               |
| Rental payments to GSA                             | 2,202                      | 2,202                      | 2,283                      | 2,324                      | +41                           |
| Communications, utilities, and misc. charges       | 500                        | 500                        | 550                        | 560                        | +10                           |
| Printing and reproduction                          | 10                         | 10                         | 10                         | 10                         | +0                            |
| Other services from non-Federal sources            | 465                        | 465                        | 475                        | 484                        | +9                            |
| Other goods and services from Federal sources      | 1,510                      | 1,510                      | 1,550                      | 1,788                      | +238                          |
| Supplies and materials                             | 100                        | 100                        | 105                        | 107                        | +2                            |
| <b>Total, Other Related Expenses</b>               | <b>4,787</b>               | <b>4,787</b>               | <b>4,973</b>               | <b>5,273</b>               | <b>+300</b>                   |

**Program Direction – Appropriations Request**

**Activities and Explanation of Changes**

| FY 2016 Enacted   | FY 2017 Request   | Explanation of Changes<br>FY 2017 vs FY 2016   |
|---|---|--|
| <b>Program Direction \$29,250,000</b>   | <b>\$32,000,000</b>   | <b>+\$2,750,000</b>  |
| <b>Salaries and Benefits</b>  |   |  |
| At the FY 2016 Enacted level, ARPA-E anticipates needing up to 56 Federal FTEs.   | At the FY 2017 Request level, ARPA-E anticipates needing up to 56 Federal FTEs.   | +\$394,000: At a constant level of FTEs, salaries and benefits are projected to escalate 3.9% between FY 2016 and FY 2017.   |
| <b>Travel</b>   |   |  |
| At the FY 2016 Enacted level ARPA-E Program Directors and Technology-to-Market advisers will continue to visit performers regularly as part of ARPA-E’s hands-on engagement, which is the primary component of ARPA-E travel. The number of site visits will continue to be commensurate with the number of ongoing projects.   | At the FY 2017 Request level ARPA-E Program Directors and Technology-to-Market advisers will continue to visit performers regularly as part of ARPA-E’s hands-on engagement, which is the primary component of ARPA-E travel.   | +\$184,000: The increase in travel is commensurate with the increased number of projects expected in ARPA-E’s portfolio.   |
| <b>Support Services</b>   |   |  |
| At the FY 2016 Enacted level ARPA-E anticipates maintaining the use of support service contractors to support ARPA-E federal staff in the management and oversight of projects and other required functions. The level of support is commensurate to the number of ongoing and anticipated projects. ARPA-E will continue to optimize federal staff and contractor support based on funding levels and the number of projects under management. | At the FY 2017 Request level ARPA-E anticipates increasing support service contractors to support ARPA-E federal staff in the management and oversight of projects and other required functions. ARPA-E will continue to optimize federal staff and contractor support based on funding levels and the number of projects under management. | +\$1,872,000: Additional supports services are needed to support federal staff in the oversight of projects in ARPA-E’s growing portfolio.                           |
| <b>Other Related Expenses</b>   |   |  |
| The FY 2016 Enacted level for other related expenses primarily consists of Working Capital Fund and Information Technology support costs, which are commensurate with the level of FTEs and support services requested.   | The FY 2017 Request level for other related expenses primarily consists of Working Capital Fund and Information Technology support costs, which are commensurate with the level of FTEs and support services requested.   | +\$300,000: Assumed constant level of other related expenses between FY 2016 and FY 2017. Most FY 2017 Budget Request miscellaneous expenses were escalated at 1.8%. |



## Advanced Research Projects Agency - Energy Trust

### Overview

The Advanced Research Projects Agency-Energy Trust will provide a total of \$1.85 billion in mandatory funds over five years to ARPA-E. These funds will provide a reliable stream of funding to expand the work of ARPA-E. This mandatory funding includes \$150 million in FY 2017, \$250 million in FY 2018, \$350 million in FY 2019, \$450 million in FY 2020, and \$650 million in FY 2021.

### Highlights of the FY 2017 Budget Request

Under the legislative proposal to create a mandatory funding stream, ARPA-E will add a new focus on innovative systems level efforts to maximize the impact of the transformational energy technologies developed under ARPA-E's existing core programs. The dynamic core program activities will continue to be supported under discretionary funding. ARPA-E will concurrently expand its present efforts to identify the highest impact technical innovations for the US energy sectors, engaging early and often with venture capital, strategic, and social investors as well as regional development agencies, the DOE technology offices, and other Federal agencies. ARPA-E will continue its requirement that project recipients expend at least 5% of their funding on T2M activities.

ARPA-E Trust programs will support projects with techno-economic goals designed to generate large impacts on the energy system and investable large-scale outcomes. The new activities under the ARPA-E Trust will be implemented in stages that draw from the outcomes of the core program and, in the years after 2017, the outcomes of the previous years' Trust investments. The new Trust Fund activities will continue to emphasize ARPA-E's central focus as a technology agency: accelerating transformative energy technologies from concept to market. But they will emphasize larger scale, more complex energy challenges than can be supported under the core, discretionary funding. Potential Trust Fund programs will be rigorously assessed against the same criteria as the core discretionary programs: transformative potential, impact on ARPA-E's mission areas, complementarity to other DOE programs, and a clear path toward hand-off to the private sector. Examples of topics that will be assessed in developing funding opportunities under the Trust Fund in FY 2017 and subsequent years include:

#### Technical challenges in scale-up

EXAMPLE: The core GENI program supported the early stage development of transformational power flow control devices, which were demonstrated at distribution system voltages (~13kV), but significant technical challenges remain in scaling these devices to the higher voltages used in transmission systems (69 kV and higher). This scaling involves significant technical risk and may require integration of new power semiconductor technology developed under the core ADEPT, Solar ADEPT, OPEN, and SWITCHES programs.

EXAMPLE: Revolutionary approaches to wind power: ARPA-E has shown great promise for novel approaches to wind power across several projects in sub-scale proof of concept and component-level demonstrations. These approaches all entail radically different design, engineering, and deployment challenges from traditional wind turbines, and in order to gain industry acceptance will require systems integration and testing at a multi-MW scale.

#### Integration of multiple technical advances to create new functionality

EXAMPLE: Expanded integration of Grid-Scale Energy Storage: The ability to store energy generated when demand is low and deliver it at times when demand is high is essential to draw the maximum benefits from our generation and distribution of electrical power. ARPA-E programs have demonstrated multiple approaches to grid storage, with multiple ways in which they can improve economic returns. Opportunities to accelerate this process stem from the potential to integrate different storage types such as batteries and flow-cells, new options such as storage in liquid fuels, and operational approaches to create virtual storage. Larger scale programs would be developed to address the significant technical challenges of designing, scaling-up and optimizing such integrated solutions.

EXAMPLE: While individual ARPA-E core programs have demonstrated the ability to remove a key technical roadblock, there will remain significant additional technical challenges in advancing new large-scale energy projects toward readiness for commercialization. There is additional opportunity to build specific functionality, longer-scale programs

or coordinated parallel programs that combine aspects of several ongoing or previous ARPA-E programs. An example is the coupling of improved thermal energy management and heat-to-electricity conversion from the core HEATS and ARID programs with hybrid solar PV-CSP technologies developed under the core FOCUS program.

#### Systems scale challenges

EXAMPLE: Soil Carbon Capture, Utilization and Storage scaled to provide significant reduction in atmospheric CO<sub>2</sub> concentrations: Increasing the storage of nitrogen and carbon in soils to levels present before extensive agriculture has the potential to sequester atmospheric carbon at scale while also reducing fertilizer use with its related issues of greenhouse gas emissions and water pollution. Opportunities to do so derive from advances in plant breeding, automated sensing and high-throughput screening, genomics, and data management. Large-scale systems investment is needed to optimize the development of appropriate crops and create the commercial drivers for their wide-spread deployment. This work would be designed to complement, but not duplicate US Department of Agriculture efforts to advance commercial agriculture for food and feed usage and related issues of sustainability.

#### Technological innovation to drive the creation of new business models

EXAMPLE: Energy-efficient transportation systems based on automated vehicles, advanced manufacturing, ubiquitous sensing and data sharing: Managing transportation as a system of vehicles offers new opportunities to supplement the benefits of vehicle light-weighting, engine efficiency, electrification and alternative low-carbon fuels. Opportunities arising as a result of vehicle-to-vehicle communication, vehicle-to-infrastructure communication, and control and optimization for local conditions can be exploited and integrated to minimize transportation energy expenditure. This work would be designed to complement, but not duplicate the work of Department of Transportation in developing automation approaches to deliver benefits in safety and commerce.

**Advanced Research Projects Agency - Energy Trust  
Funding (\$K)**

|  | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|--|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| Advanced Research Projects Agency – Energy Trust<br>Projects   | 0                          | 0                          | 0                          | 135,000                    | +135,000                      |
| Program Direction  | 0                          | 0                          | 0                          | 15,000                     | +15,000                       |
| <b>Total, Advanced Research Projects Agency – Energy Trust</b> | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>150,000</b>             | <b>+150,000</b>               |

**Advanced Research Projects Agency - Energy Trust  
Explanation of Major Changes (\$K)**

|  | <b>FY 2017 vs<br/>FY 2016</b> |
|--|-------------------------------|
| <b>Projects:</b> The new \$150 million in mandatory funding will create the Advanced Research Projects Agency – Energy Trust. Of the \$150 million, \$135 million will be allocated towards complex, larger-scale research efforts in areas such as: technical challenges in scale-up, integration of multiple technical advances to create new functionality, systems scale challenges and technical innovation to drive new business models. | <b>+135,000</b>               |
| <b>Program Direction:</b> The new \$150 million in mandatory funding will create the Advanced Research Projects Agency – Energy Trust. Of the \$150 million, \$15 million will be allocated to program direction.  | <b>+15,000</b>                |
| <hr/> <b>Total, ARPA-E - Energy Trust</b>  | <hr/> <b>+150,000</b>         |

**Advanced Research Projects Agency - Energy Trust**

**Activities and Explanation of Changes**

| FY 2016 Enacted       | FY 2017 Request         | Explanation of Changes<br>FY 2017 vs FY 2016  |
|-----------------------|-------------------------|---|
| <b>\$0</b>            | <b>\$135,000,000</b>    | <b>+ \$135,000,000</b>  |
| No funding in FY 2016 | New funding for FY 2017 | The Trust provides a total of \$1.85 billion in mandatory funding over 5 years including \$150 million in FY 2017. The \$150 million in FY 2017 would be used to support complex, larger-scale research efforts in areas such as: technical challenges in scale-up, integration of multiple technical advances to create new functionality, systems scale challenges, coordination across multiple ongoing programs, and technical innovation to drive new business models. |



## **Program Direction – Advanced Research Projects Agency - Energy Trust**

### **Overview**

Program Direction provides the staffing resources and associated costs required to provide overall direction and execution of the ARPA-E Trust. This budget provides for salaries and benefits of new federal staff, travel expenses for federal staff and contractors, and the support services required for technical advisory and project management services. This budget further provides funding for other related expenses, including additional leased office space and increased contributions to the DOE Working Capital Fund that is related to the additional personnel needed for the ARPA-E Trust.

### **Highlights of the FY 2017 Budget Request**

ARPA-E will allocate \$15 million of the ARPA-E Trust funds to Program Direction in FY 2017 to supplement the \$32 million in appropriated Program Direction requested. With expansion of the number and size of programs supported under the Trust, the number of technical personnel will need to increase roughly proportionally. To manage the accelerated growth path associated with Trust funding in subsequent years, ARPA-E would build on its agile project management structure and adapt accordingly, while roughly maintaining the present ratio of operational costs to programmatic expansion. To manage the greater size and scope, it is likely that the agency will need to adjust its structure, possibly building multiple technical offices reporting to the agency Director. The increasing breadth of activities supported by the Trust will require a greater spread of technical expertise in the Program Directors as well as an expanded experience-base in the T2M team to include venture and strategic investment, regional (state and local) development, start-up business development and engagement with other Federal agencies.

**Program Direction – Energy Trust  
Funding (\$K)**

|  | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|--|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| <b>Program Direction Summary</b>                   |                            |                            |                            |                            |                               |
| <b>Washington Headquarters</b>                     |                            |                            |                            |                            |                               |
| Salaries and Benefits                              | 0                          | 0                          | 0                          | 1,874                      | +1,874                        |
| Travel   | 0                          | 0                          | 0                          | 703                        | +703                          |
| Support Services                                   | 0                          | 0                          | 0                          | 9,951                      | +9,951                        |
| Other Related Expenses                             | 0                          | 0                          | 0                          | 2,472                      | +2,472                        |
| <b>Total, Program Direction</b>                    | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>15,000</b>              | <b>+15,000</b>                |
| <b>Federal FTEs</b>                                | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>10</b>                  | <b>+10</b>                    |
| <b>Support Services and Other Related Expenses</b> |                            |                            |                            |                            |                               |
| <b>Support Services</b>                            |                            |                            |                            |                            |                               |
| Technical Support                                  | 0                          | 0                          | 0                          | 3,483                      | +3,483                        |
| Management Support                                 | 0                          | 0                          | 0                          | 6,468                      | +6,468                        |
| <b>Total, Support Services</b>                     | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>9,951</b>               | <b>+9,951</b>                 |
| <b>Other Related Expenses</b>                      |                            |                            |                            |                            |                               |
| Rental payments to GSA                             | 0                          | 0                          | 0                          | 1,089                      | +1,089                        |
| Communications, utilities, and misc. charges       | 0                          | 0                          | 0                          | 263                        | +263                          |
| Printing and reproduction                          | 0                          | 0                          | 0                          | 5                          | +5                            |
| Other services from non-Federal sources            | 0                          | 0                          | 0                          | 227                        | +227                          |
| Other goods and services from Federal sources      | 0                          | 0                          | 0                          | 838                        | +838                          |
| Supplies and materials                             | 0                          | 0                          | 0                          | 50                         | +50                           |
| <b>Total, Other Related Expenses</b>               | <b>0</b>                   | <b>0</b>                   | <b>0</b>                   | <b>2,472</b>               | <b>+2,472</b>                 |

**Program Direction – Energy Trust**

**Activities and Explanation of Changes**

| FY 2016 Enacted               | FY 2017 Request     | Explanation of Changes<br>FY 2017 vs FY 2016   |
|-------------------------------|---------------------|--|
| <b>Program Direction \$0</b>  | <b>\$15,000,000</b> | <b>+\$15,000,000</b>   |
| <b>Salaries and Benefits</b>  |                     |  |
| N/A                           | New FY 2017 Request | +\$1,874: Ten additional FTEs are needed in FY17 to support programs and projects funded by the ARPA-E Trust.                                  |
| <b>Travel</b>                 |                     |  |
| N/A                           | New FY 2017 Request | +\$703: ARPA-E personnel will visit performers regularly as part of ARPA-E’s hands on engagement.  |
| <b>Support Services</b>       |                     |  |
| N/A                           | New FY 2017 Request | +\$9,951: Support services are needed to support federal staff in the oversight of programs and projects in the ARPA-E Trust portfolio.        |
| <b>Other Related Expenses</b> |                     |  |
| N/A                           | New FY 2017 Request | +\$2,472: Incremental overhead and other related costs associated with the additional FTEs and support service personnel for the ARPA-E Trust. |



**Advanced Research Projects Agency - Energy  
Research and Development (\$K)<sup>1</sup>**

|                       | <b>FY 2015<br/>Enacted</b> | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> | <b>FY 2017 vs<br/>FY 2016</b> |
|-----------------------|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|
| Basic                 | 0                          | 0                          | 0                          | 0                          | 0                             |
| Applied               | 140,000                    | 140,000                    | 145,500                    | 250,000                    | +104,500                      |
| Development           | 140,000                    | 140,000                    | 145,500                    | 250,000                    | +104,500                      |
| Subtotal, R&D         | 280,000                    | 280,000                    | 291,000                    | 500,000                    | +209,000                      |
| Equipment             | 0                          | 0                          | 0                          | 0                          | 0                             |
| Construction          | 0                          | 0                          | 0                          | 0                          | 0                             |
| <b>Total, R&amp;D</b> | <b>280,000</b>             | <b>280,000</b>             | <b>291,000</b>             | <b>500,000</b>             | <b>+209,000</b>               |

**Advanced Research Projects Agency - Energy  
Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) (\$K)**

|                         | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Projected</b> | <b>FY 2017<br/>Request<sup>2</sup></b> | <b>FY 2017 vs<br/>FY 2016</b> |
|-------------------------|----------------------------|------------------------------|--|-------------------------------|
| ARPA-E Projects         |                            |                              |  |                               |
| SBIR                    | 11,380                     | 7,853                        | 10,176                                 | +2,323                        |
| STTR                    | 890                        | 1,177                        | 1,431                                  | +254                          |
| <b>Total, SBIR/STTR</b> | <b>12,270</b>              | <b>9,030</b>                 | <b>11,607</b>                          | <b>+2,577</b>                 |

<sup>1</sup> FY 2017 Congressional Budget Research and Development (R&D) table includes both discretionary and mandatory funding as well as allocated Program Direction for each funding. The FY 2016 Congressional Budget R&D table excluded Program Direction appropriations. This change is being made to better align with international standards on reporting funding for R&D. Since program direction is necessary in order for R&D to be performed, it is included in the conduct of R&D.

<sup>2</sup> In FY 2017, ARPA-E will continue its stand-alone Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program to provide additional support to small businesses beyond the significant number of awards to small businesses via ARPA-E's standard non-SBIR/STTR solicitations.



**Department Of Energy  
 FY 2017 Congressional Budget  
 Funding By Appropriation By Site  
 (\$K)**

| <b>Advanced Research Projects Agency - Energy</b>        | <b>FY 2015<br/>Current</b> | <b>FY 2016<br/>Enacted</b> | <b>FY 2017<br/>Request</b> |
|--|----------------------------|----------------------------|----------------------------|
| <b>Washington Headquarters</b>                           |                            |                            |                            |
| <b>Advanced Research Projects Agency - Energy</b>        |                            |                            |                            |
| Projects   | 252,000                    | 261,750                    | 318,000                    |
| Program Direction  | 28,000                     | 29,250                     | 32,000                     |
| <b>Total, Advanced Research Projects Agency - Energy</b> | <b>280,000</b>             | <b>291,000</b>             | <b>350,000</b>             |
| <b>Total, Washington Headquarters</b>                    | <b>280,000</b>             | <b>291,000</b>             | <b>350,000</b>             |
| <b>Total, Advanced Research Projects Agency - Energy</b> | <b>280,000</b>             | <b>291,000</b>             | <b>350,000</b>             |