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An Assessment of ARPA-E

Urgent environmental and economic challenges require greater innovation in energy technologies. The Advanced Research Projects Agency-Energy (ARPA-E) was created by Congress to identify and promote innovation in energy technologies such as renewable energies like solar and wind power, as well as thermal, chemical, and nuclear energy technologies, and to overcome the market failures that inhibit private companies from fully engaging optimally in innovation.

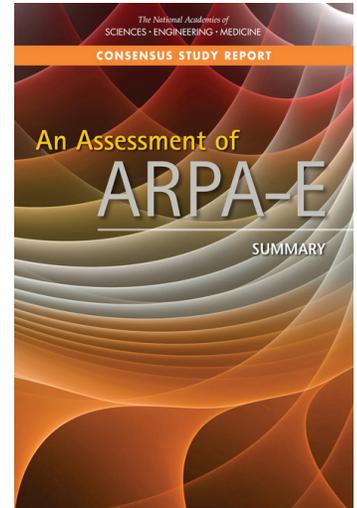
This report from the National Academies of Sciences, Engineering, and Medicine, assesses the agency's work from its inception in 2009. It concludes that ARPA-E has made progress toward its mission and goals, and that the agency has the ability to make significant contributions to energy innovation that likely would not take place without it. The report also provides guidance to strengthen ARPA-E's position in catalyzing breakthrough innovation for energy technologies. It offers a series of recommendations to ARPA-E, Congress, and the Department of Energy (DOE) - recommendations that highlight the importance of establishing and maintaining an institutional culture of innovation that ensures empowerment of program directors and other key personnel. The report also recommends that ARPA-E reconfigure its technology-to-market component, keep limited terms for Program Directors, and develop and implement a framework for assessing the agency's advancement toward achieving its mission and goals.

ASSESSING ARPA-E'S PROGRESS

Congress created ARPA-E to enhance the economic and energy security of the United States through the development of energy technologies that reduce imports of energy from foreign sources. Other goals include reductions of energy-related emissions, including greenhouse gases and improvement in the energy efficiency of all economic sectors. The agency was also assigned the goal of ensuring that the U.S. maintains technological leadership in developing and deploying advanced energy technologies.

In addition, Congress tasked ARPA-E to achieve these goals by sponsoring energy technology innovation projects that:

- identify and promote revolutionary advances in fundamental and applied sciences;
- translate scientific discoveries and cutting-edge inventions into technological innovations; and
- accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.



This report assesses ARPA-E's progress toward achieving these goals. Since the agency's structure can impact achieving its objectives, the study committee undertook both a retrospective technical assessment and an operational assessment of the agency. This allowed a more complete appraisal of ARPA-E's progress to support American energy innovation.

The committee relied on both quantitative and qualitative data, including agency data; standard innovation measures such as publishing and patenting activity along with sales data; observations at agency events; presentations by personnel from ARPA-E, DOE, and the Defense Advanced Research Projects Agency (DARPA); case studies of completed awards; consultations with current and former ARPA-E personnel; and consultations with individuals from other programs and offices at DOE.

ARPA-E'S DISTINCTIVE ORGANIZATIONAL FEATURES

The committee identified several organizational features that define ARPA-E and make the agency distinctive. Within DOE, ARPA-E stands out for its culture, methods, and focused mission and goals. The agency also benefits from three defining organizational features:

- Its agency director provides technical and leadership skills that enable and sustain a culture of empowerment.
- Program directors have the authority, responsibility, and ability to make program- and project-related decisions.
- Active project management is demonstrably important.

Collectively, these three features support ARPA-E's ability to achieve its mission and goals. They are additionally important to creating a culture that enables success.

FINDINGS AND RECOMMENDATIONS

The committee produced several key findings focused on the agency and outcomes of its programs and projects, namely:

- ARPA-E selects projects to fund through a multifaceted process that evaluates each project's potential to contribute to the agency's goals.
- ARPA-E program directors have extensive authority to develop new focused technology programs that are potentially transformative.
- ARPA-E program directors actively manage projects through technical research guidance and feedback, regular assessments of progress made toward technical milestones, and revision of milestones in response to new findings and research discoveries.
- Projects ARPA-E has funded support its statutory mission and goals.
- Six years into its existence there are clear indications that ARPA-E is making progress toward its statutory mission and goals.

The committee formulated 14 recommendations intended to help ARPA-E build upon its early success. Five of these recommendations stand out as key to positioning the agency for success in fulfilling its mission and goals:

- ARPA-E should preserve its distinctive and flexible management approach that empowers program directors and stresses active project management.
- The ARPA-E director and program directors should develop and implement a framework for measuring and assessing the agency's impact in achieving its mission and goals.
- ARPA-E should reconceptualize its "tech-to-market" program to account for the wide variation in support needed across programs and performers with respect to prospective funding, commercialization, and deployment pathways.
- ARPA-E should continue to use processes designed to identify and support unexplored opportunities that hold promise for transformational technological advances.
- The Secretary of Energy should ensure that other offices and programs within DOE continue to explore and adopt elements of ARPA-E's practices that can improve its operations.

ARPA-E has espoused the principles of an innovative culture, dynamic leadership, and program director autonomy in its organizational structure— especially by empowering program directors to take risks in project selection in line with the agency's mission. The committee's recommendations stress the importance of preserving this management approach; it is a defining organizational feature that can contribute to the agency's ability to achieve its statutory mission and goals, and it helps to dis-

tinguish ARPA-E from other public funding initiatives for energy R&D. Further, many aspects of this approach could potentially improve operations within other offices and programs of DOE. The committee encouraged the secretary of energy to support exploring adaptation and adoption where appropriate.

The nature of energy technology development means that ARPA-E's mission and goals are long-term. For its assessment the committee could best evaluate interim success and whether the agency is structured to enable continued progress. This means that ARPA-E thus has an imperative to develop a framework for success by prospectively mapping project-level data from program creation, through project selection and management, to mission success and achievement of goals.

ARPA-E views its "tech-to-market" activities as an ongoing experiment, and the committee encourages continued evolution. A key concern is a project's timeline. The roughly 3-year timeframe of an ARPA-E project is too short to expect a technology to move from concept to market. The committee also encourages experimentation with a range of approaches tailored to performer types, while cautioning against over-expanding the program. This recommendation complements the recommended need for continued focus on new and "off-roadmap" technologies and projects that could lead to real breakthroughs. Maintaining focus here, rather than pursuing "surer bets," will be one of the greatest challenges for ARPA-E in the future.

ARPA-E has the ability to make significant contributions to energy innovation that would otherwise likely not take place. Implementing the committee's recommendations would benefit the agency and the nation as ARPA-E continues to evolve. The committee believes that these recommendations will aid Congress as it considers ARPA-E's future.

For More Information... This Report Highlights was prepared by the Board on Science, Technology, and Economic Policy; Board on Energy and Environmental Systems based on the Consensus Study *An Assessment of ARPA-E* (2017). The study was sponsored by the U.S. Department of Energy and the Alfred P. Sloan Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; <http://www.nap.edu>.

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