

CRS Report for Congress

Advanced Research Projects Agency - Energy (ARPA-E): Background, Status, and Selected Issues for Congress

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Summary

In August 2007, Congress authorized the establishment of the Advanced Research Projects Agency - Energy (ARPA-E) within the Department of Energy (DOE) as part of the America COMPETES Act (P.L. 110-69). Modeled on the Defense Advanced Research Projects Agency (DARPA), ARPA-E would support transformational energy technology research projects with the goal of enhancing the nation's economic and energy security.

Proponents of ARPA-E contend that additional science and technology would help respond to the nation's need for clean, affordable, and reliable energy. Opponents question whether ARPA-E is necessary to develop new technologies, when existing energy technologies are not fully utilized due to insufficient policies to encourage their implementation. ARPA-E proponents counter that ARPA-E is needed to catalyze the energy marketplace by accelerating research that will bridge the gap between basic research and industrial product development.

The Bush Administration questions whether the DARPA model can be used for the energy sector and is concerned that it might redirect funds away from current DOE research activities, particularly the DOE Office of Science. Instead, the President's FY2009 budget requests funding for six new technology transfer collaborations. ARPA-E proponents doubt that DOE can achieve ARPA-E's goals with its existing structure and personnel, as opposed to the ARPA-E's innovative R&D management design.

Congress authorized \$300 million for ARPA-E in FY2008 and "such sums as are necessary" for FY2009 and FY2010. Congress subsequently appropriated no funds for FY2008. The Administration requested no funds for ARPA-E in FY2009. Congress is currently debating whether to fund ARPA-E in FY2009, and if so, the amount that should be appropriated. Budget constraints may present Congress with a dilemma: which is more important, existing DOE energy R&D activities, such as the Office of Science, proposed DOE activities such as the technology transfer collaborations and Energy Frontier Research Centers, or ARPA-E? An alternative is to incorporate some ARPA-E or another research management model, such as the CIA's In-Q-Tel venture capital activity, into existing DOE programs.

Some have proposed funding ARPA-E through a mechanism that differs from the usual single-year appropriations process to enhance its ability to conduct risky research without being subject to the annual appropriations cycle, political and financial pressures, and resource fluctuations that might stifle innovation. One option is for Congress to provide a multi-year advance appropriation. Another is for Congress to identify a revenue source. For example, some have suggested that ARPA-E could be funded by a repeal of oil industry tax and other incentives (to offset ARPA-E's cost); gasoline tax; oil company profit tax; a trust fund set up from federal oil and gas royalties, or from a fund derived under a climate change cap and trade program. Based on past experience, however, each of these proposals would face challenges in Congress.

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Advanced Research Projects Agency - Energy: Background, Status, and Selected Issues for Congress

In August 2007, Congress authorized the establishment of the Advanced Research Projects Agency - Energy (ARPA-E).¹ Modeled on the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense (DOD), ARPA-E would be a new organization within the Department of Energy (DOE). It would support transformational energy technology research projects with the goal of enhancing the nation's economic and energy security. Congress authorized \$300 million for ARPA-E in FY2008 and "such sums as are necessary" for FY2009 and FY2010. Ultimately, Congress appropriated no funds for FY2008. The Administration requested no funds in FY2009. Congress is currently debating whether to fund ARPA-E in FY2009.

Overview of ARPA-E Design

As outlined in the America COMPETES Act (P.L. 110-69, §5012), the goal of ARPA-E would be to enhance the economic and energy security of the United States through the development of technologies that reduce energy imports, reduce energy-related greenhouse gas emissions, and improve energy efficiency in all economic sectors. In addition, ARPA-E would aim to ensure that the United States is a technical leader in developing and deploying advanced energy technologies.

According to the act, ARPA-E would achieve this goal by identifying and promoting revolutionary advances in fundamental sciences and translating scientific discoveries and cutting-edge inventions into technological innovations. ARPA-E would focus its efforts on accelerating transformational technological advances in areas that industry, by itself, is not likely to undertake due to technical and financial uncertainty. As stated in §5012, the agency's programs would accelerate novel early-stage energy research with possible technology applications; the development of techniques, processes, and technologies and related testing and evaluation; research and development (R&D) of manufacturing processes for novel energy technologies;

¹ America COMPETES Act (P.L. 110-69), §5012. For more information, see CRS Report RL34328, *America COMPETES Act: Programs, Funding, and Selected Issues*, and CRS Report RL34396, *The America COMPETES Act and the FY2009 Budget*, both by Deborah D. Stine.

and coordination with nongovernmental entities to demonstrate technologies and research applications to facilitate technology transfer.

To achieve these goals, ARPA-E would make awards to academic institutions, companies, research foundations, and trade and industry research collaborations as well as consortia of these organizations that could additionally include federally funded research and development centers (FFRDCs). According to the act, the criteria for selecting projects would include novelty, scientific and technical merit, the demonstrated capability of the applicant to successfully carry out the proposed project, future commercial applications of the project, and the feasibility of partnering with one or more commercial entities, as well as additional criteria established by the director of ARPA-E.

Management

The management of ARPA-E, as described in the act, is modeled on that of DARPA (see **Box 1**). DARPA has a well-known history of catalyzing innovative technologies such as the Saturn rocket engine used for moon flights, the pilotless Predator planes used in Iraq and Afghanistan, computer-aided design, global positioning satellites, the computer mouse, and the Internet. DARPA seeks to sponsor revolutionary, high-payoff research that “bridges the gap between fundamental discoveries and their military use.”² According to its director, “DARPA will take a chance on an idea with no data. We’ll put up the money to go get the data and see if the idea holds. That is the highest-risk type of research you can have.”³

The act states that ARPA-E would be managed by a presidentially appointed director, who would report to the Secretary of Energy. The director would approve all new programs, develop funding criteria, establish technical milestones to assess program success, and terminate programs not achieving their goals. The director would have the authority to appoint 70 to 120 scientific, engineering, and professional personnel without regard to civil service laws and to determine their compensation. The director would be responsible for ensuring that ARPA-E activities are coordinated with, and do not duplicate, DOE and other federal programs and laboratory activities; the program managers would establish R&D goals and select projects based on merit.

Both the director and the program managers would be permitted to seek advice on the overall direction of ARPA-E and specific program tasks from a new ARPA-E advisory committee or existing DOE federal advisory committees. Additional sources of advice provided for in the act include the President’s Council of Advisors

² Testimony of Dr. Anthony Tether, Director, Defense Advanced Research Projects Agency, in U.S. Congress, House Committee on Science, *The Future of Computer Science Research in the United States*, hearing, 109th Cong., 1st sess., May 12, 2005, H.Hrg. 109-14 (Washington, GPO, 2005) at [<http://science.house.gov/commdocs/hearings/full05/may12/tether.pdf>].

³ Anthony Tether as quoted in Stephen Barr, “The Idea Factory That Spawnded the Internet Turns 50,” *Washington Post*, April 7, 2008.

on Science and Technology (PCAST), professional organizations, and disciplinary societies.⁴

Box 1. DARPA Management Design Keys

How does DARPA differ from the typical business-as-usual federal R&D management model? According to DARPA, it has maintained the following management principles over its 50-year history:

Management: DARPA is a small, flexible, and flat organization with substantial autonomy and freedom from bureaucratic impediments. At DARPA, there is a complete acceptance of failure if the payoff of success was high enough. Management does focus on good stewardship of its taxpayer funds, but imposes little else in terms of rules. Management views their job as enabling DARPA’s program managers.

Staff: Program managers are selected to be technically outstanding and entrepreneurial. The best DARPA Program Managers have always been freewheeling zealots in pursuit of their goals. The technical staff is drawn from world-class scientists and engineers with representation from industry, universities, government laboratories and Federally Funded Research and Development Centers. Technical staff are assigned for 3-5 years and rotated to assure fresh thinking and perspectives. Necessary supporting personnel (technical, contracting, administrative) are “hired” on a temporary basis to provide complete flexibility to get into and out of an area without the problems of sustaining the staff.

Projects: DARPA’s activities are project-based. All efforts are typically 3-5 years long with strong focus on end-goals. Major technological challenges may be addressed over much longer times, but only as a series of focused steps. The end of each project is the end. It may be that another project is started in the same technical area, perhaps with the same program manager and, to the outside world, this may be seen as a simple extension. For DARPA, though, it is a conscious weighing of the current opportunity and a completely fresh decision. The fact of prior investment is irrelevant.

Source: DARPA, “DARPA Over the Years,” webpage at [<http://www.darpa.mil/body/overtheyears.html>].

Funding and Outcome Evaluation

The act authorizes an Energy Transformation Acceleration Fund in the Department of the Treasury, with \$300 million of funding authorized for FY2008 and “such sums as are necessary” for FY2009 and FY2010. ARPA-E’s budget request and appropriations are to be separate and distinct from the rest of DOE’s budget. After ARPA-E has operated for four years, the National Academy of Sciences (NAS) is to evaluate how well ARPA-E is achieving its goals and mission.

Should funds be appropriated for ARPA-E, no more than 50% may be used for coordination with nongovernmental entities for technology demonstration and

⁴ For a description of these organizations, see CRS Report RL34454, *Science and Technology Policymaking: A Primer*, by Deborah D. Stine.

research applications to facilitate technology transfer. At least 2.5% must be used for technology transfer and outreach activities. No funds may be used for construction of new buildings or facilities until August 2012.

The ARPA-E director would submit an annual report, describing projects supported in the previous year, as part of the annual budget request to Congress. The director would also submit strategic vision roadmaps to Congress no later than October 1, 2008, and October 1, 2011. The roadmaps are to describe the strategic vision ARPA-E would use to determine its future technology investments for the subsequent three fiscal years.

Legislative Origins and Policy Debates Prior to ARPA-E Authorization

The DARPA model has frequently been proposed as a structure for improving the management of federal R&D. For example, an “advanced civilian technology agency” was proposed in the 100th and 101st Congresses.⁵ In 1992, an NAS report recommended that the government consider a civilian technology corporation or a civilian technology agency in limited areas including energy research.⁶ In 1993, the Progressive Policy Institute made a similar proposal.⁷ In 1992, presidential candidate Bill Clinton and Senator Al Gore proposed the creation of a civilian advanced research agency to support research on renewable technologies and renewable fuels.⁸

From 1977-2000, DOE had an Advanced Energy Projects (AEP) division to “explore the feasibility of novel, energy-related concepts that evolve from advances in basic research,” and “high-risk, exploratory concepts which do not readily fit into an existing DOE program area but which could lead to applications that span scientific or technical disciplines.”⁹ In 1995, DOE placed AEP’s activities were under a new Computational and Technology Research program. This reorganization was

⁵ Proposals during the 101st Congress, 2nd session, included S. 1978, H.R. 3833, H.R. 4715, and S. 2765. These are discussed in U.S. Congress, Office of Technology Assessment, *Making Things Better: Competing in Manufacturing*, OTA-ITE-443 (Washington, DC: U.S. Government Printing Office), February 1990.

⁶ National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, *The Government Role in Civilian Technology: Building a New Alliance* (Washington, DC: National Academy Press, 1992).

⁷ Will Marshall and Martin Schram, *Mandate for Change* (New York: Berkeley Books, 1993).

⁸ Bill Clinton and Al Gore, *Putting People First: How We Can All Change America* (New York: Random House, 1992).

⁹ Department of Energy, “Advanced Energy Projects:FY 1995 Research Summaries,” DOE/ER-0660T, September 1995 at [http://www.sc.doe.gov/bes/archives/summaries/Advanced_Energy_Projects_Summary_Book_FY1995.pdf]. Sarah Adee, “Power Up,” *IEEE Spectrum*, September 2007 at [<http://spectrum.ieee.org/sep07/5484>].

formally stated in DOE's 1997 budget request. Funding for the program was reduced in FY1998 and FY1999, and the AEP program was terminated in FY2000.¹⁰

The Homeland Security Act of 2002 (P.L. 107-296) established a Homeland Security Advanced Research Projects Agency (HSARPA) in the Department of Homeland Security.¹¹ According to the act, HSARPA is to “(A) support basic and applied homeland security research to promote revolutionary changes in technologies that would promote homeland security; (B) advance the development, testing and evaluation, and deployment of critical homeland security technologies; and (C) accelerate the prototyping and deployment of technologies that would address homeland security vulnerabilities.”

Legislative Origins in the 109th and 110th Congress

Against this historical backdrop, in October 2005, a committee of the NAS recommended the establishment of ARPA-E in its report *Rising Above the Gathering Storm*.¹² In November 2005, during the 109th Congress, the House Minority Leader released an innovation agenda that proposed to create a new DARPA-like initiative within DOE.¹³ In 2007, this same concept was part of an updated “Innovation Agenda” proposed by the Speaker of the House at the beginning of the 110th Congress.¹⁴

In the January 2006 State of the Union address, President Bush announced the American Competitiveness Initiative (ACI), the Administration's response to the concerns about U.S. competitiveness that were similar to those expressed in the America COMPETES Act. Instead of endorsing the ARPA-E concept, however, the Administration proposed an Advanced Energy Initiative (AEI). The Administration has continued its support for the ACI and the AEI into the 110th Congress.¹⁵

¹⁰ A history of this organization is available at [http://www.sc.doe.gov/bes/BES_history.html].

¹¹ For more information on HSARPA, see CRS Report RL34356, *The DHS Directorate of Science and Technology: Key Issues for Congress*, by Dana A. Shea and Daniel Morgan.

¹² The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007), p. 154. This report was initially released in pre-publication form in October 2005.

¹³ U.S. Congress, Office of Congresswoman Nancy Pelosi, “Pelosi: Unveils Innovation Agenda, Part of Vision for a Stronger America,” press release, November 15, 2005 at [<http://www.house.gov/pelosi/press/releases/Nov05/innovation.html>].

¹⁴ U.S. Congress, Speaker Nancy Pelosi, *The Innovation Agenda: 110th Congress* at [<http://www.speaker.gov/issues?id=0016>], April 27, 2007.

¹⁵ U.S. President (G.W. Bush), *American Competitiveness Initiative*, Domestic Policy Council/Office of Science and Technology Policy, February 2006, at [<http://www.ostp.gov/pdf/acibooklet.pdf>]; *Advanced Energy Initiative*, National Economic Council, February 2006 at [http://www.whitehouse.gov/stateoftheunion/2006/energy/energy_booklet.pdf]; and “Advanced Energy Initiative 2008” at [http://www.ostp.gov/pdf/fy08_aei_one_pager.pdf]. and “Energy Security for the 21st

Although some analysts questioned whether ARPA-E was the best policy option to respond to the nation's energy challenges,¹⁶ the proposal recommended in the NAS report became the basis for congressional hearings and debates in the 109th and 110th Congresses and eventually served as the outline for ARPA-E as authorized in the America COMPETES Act. (See **Box 2**.)

Box 2. ARPA-E Management Design Keys

How does ARPA-E differ from the typical business-as-usual federal R&D management model? In congressional testimony, members of the committee that wrote the National Academies report recommended ARPA-E should have four objectives that would distinguish it from current DOE activities:

1. Bring a freshness, excitement, and sense of mission to energy research that will attract many of our best and brightest minds — those of experienced scientists and engineers, and, especially, those of students and young researchers, including those in the entrepreneurial world.
2. Focus on creative, out-of-the-box, potentially transformational research that industry cannot or will not support.
3. Utilize an ARPA-like organization that is flat, nimble, and sparse, yet capable of setting goals and making decisions that will allow it to sustain for long periods of time those projects whose promise is real, and to phase out programs that do not prove to be productive or as promising as anticipated.
4. Create a new tool to bridge the troubling gaps between basic energy research, development, and industrial innovation. It can serve as a model for how to improve science and technology transfer in other areas that are essential to our future prosperity.

Source: Testimony of Dr. Charles M. Vest, in U.S. Congress, Senate Committee on Energy and Natural Resources, *Protecting America's Competitive Edge — Energy*, hearings, 109th Congress, 2nd sess., February 14, 2006, S.Hrg. 109-358 (Washington: GPO, 2006) at [http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=1526&Witness_ID=4320]. Testimony of Dr. Steven Chu, in U.S. Congress, House Committee on Science, *Should Congress Establish "ARPA-E", The Advanced Research Projects Agency - Energy?*, hearings, 109th Congress, 2nd sess., March 9, 2006, H.Hrg. 109-39 (Washington: GPO, 2006).

¹⁵ (...continued)

Century” at [<http://www.whitehouse.gov/infocus/energy/>].

¹⁶ See for example, David Goldston, “Misspent Energy,” *Nature*, 447:130, May 10, 2007 at [<http://www.nature.com/nature/journal/v447/n7141/pdf/447130a.pdf>].

Policy Debates

In the 109th Congress, the Senate Committee on Energy and Natural Resources and the House Committee on Science held hearings on ARPA-E.¹⁷ The chairman of the House Committee on Science stated that he was an “open-minded skeptic” regarding ARPA-E, and pointed out that the recommendation for its establishment was based on four assumptions that he considered questionable:

- The problem with the energy market is that the supply of new technologies is insufficient;
- The supply of new technologies is constrained because of a lack of fundamental research;
- A sensible way to promote more fundamental research is to apply the DARPA model to a civilian energy sector; and
- Implementing the DARPA model is the best way to improve energy research, given tight federal budgets.¹⁸

In the 110th Congress, the House Committee on Science and Technology held a similar hearing. In his opening statement, the committee chairman stated that, among several policy goals and objectives, DARPA has succeeded largely because it continued to foster a culture of innovation. The key for ARPA-E success, he said, is that it be a similarly nimble organization with minimal administrative layers and the ability to quickly start and stop research programs. According to the chair, “Investment in ARPA-E must be seen as the first step in boosting energy research and development to a level that addresses the scale of our challenge, and the true cost of doing transformational research.”¹⁹

The Administration formally opposed the authorization of ARPA-E during the 110th Congress:

The Administration supports the conceptual goal of ARPA-E “to overcome the long-term and high-risk technological barriers in the development of energy technologies.” However, the Administration continues to strongly object to this provision due to serious doubts about the applicability of the national defense model to the energy sector and because a new bureaucracy at the DOE would drain resources from priority basic research efforts. The Administration believes

¹⁷ U.S. Congress, Senate Committee on Energy and Natural Resources, “PACE Energy Act,” hearing, 109th Cong., 2nd sess., February 15, 2006 (Washington, DC: GPO, 2006) at [<http://www.gpoaccess.gov/chearings/index.html>]; U.S. Congress, House Committee on Science, “Should Congress Establish ‘ARPA-E,’ The Advanced Research Projects Agency - Energy?,” hearing, 109th Congress, 2nd sess., March 9, 2006 (Washington: GPO, 2006) at [<http://www.gpoaccess.gov/chearings/index.html>]

¹⁸ U.S. Congress, House Committee on Science, “Should Congress Establish ‘ARPA-E,’ The Advanced Research Projects Agency - Energy?,” hearings, 109th Congress, 2nd sess., March 9, 2006, (Washington, D.C.: GPO, 2006) at [<http://www.gpoaccess.gov/chearings/index.html>].

¹⁹ U.S. Congress, House Committee on Science and Technology Committee, “Establishing the Advanced Research Projects Agency-Energy (ARPA-E),” hearing, 110th Cong., 1st session, April 26, 2007, at [<http://www.gpoaccess.gov/chearings/index.html>].

that the goal of developing novel advanced energy technologies should be addressed by giving the Secretary of Energy the flexibility to empower and reward programs within existing DOE offices to fund unique, crosscutting, and high-risk research.²⁰

The following sections discuss several key questions debated during the House Science and Technology and Senate Committee on Energy and Natural Resources hearings held regarding ARPA-E in the 109th and 110th Congress.²¹ This analysis incorporates issues discussed in hearing charters, Members' statements and questions, and the statements and responses of those providing expert testimony.

Is ARPA-E Needed? Is ARPA-E needed when the federal government and industry already invest a great deal in energy R&D? A related question is whether In-Q-Tel,²² the Central Intelligence Agency (CIA) venture capital firm that provides funding to identify, develop, and deliver technologies of interest to the intelligence community, is a better model for the energy marketplace than DARPA. (See **Box 3**.)

Proponents state that ARPA-E will address organizational problems at DOE by being small and flexible, unlike existing DOE organizations, which they believe are risk-averse and do not sufficiently interact with each other to reach the nation's energy goals. In addition, proponents argue that ARPA-E should focus on breakthrough research, using emerging basic research in areas such as nanotechnology to develop totally new technologies, as opposed to existing programs that have already identified paths forward and tend to focus on incremental advances. Further, unlike current programs, ARPA-E is designed to bridge the gap between basic research and industrial development — not to get products to the marketplace, but to transform the marketplace by accelerating research.

In response to the claim that ARPA-E will be more flexible and less risk-adverse, critics point out that the new organization will still be within DOE, so there is no guarantee that DOE management will let it take more risks than existing programs. In response to the claims that ARPA-E would bridge the gap between basic research and industrial development and that existing applied programs tend to focus on incremental advances, some critics argue that reforming DOE's existing programs would be better than creating a new organization.

²⁰ U.S. President (George W. Bush), "S. 761 — America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act," Statement of Administration Policy, April 23, 2007 at [<http://www.whitehouse.gov/omb/legislative/sap/110-1/s761sap-s.pdf>].

²¹ U.S. Congress, Senate Committee on Energy and Natural Resources, "PACE Energy Act," hearing, 109th Cong., 2nd sess., February 15, 2006 (Washington, DC: GPO, 2006) at [<http://www.gpoaccess.gov/chearings/index.html>]; U.S. Congress, House Committee on Science, "Should Congress Establish 'ARPA-E,' The Advanced Research Projects Agency - Energy?," hearings, 109th Congress, 2nd sess., March 9, 2006 (Washington: GPO, 2006) at [<http://www.gpoaccess.gov/chearings/index.html>]; U.S. Congress, House Committee on Science and Technology Committee, "Establishing the Advanced Research Projects Agency-Energy (ARPA-E)," hearing, 110th Cong., 1st sess., April 26, 2007 (Washington, D.C.: GPO, 2007) at [<http://www.gpoaccess.gov/chearings/index.html>].

²² For more information on In-Q-Tel, see [<http://www.inqtel.org/>].

Advocates for ARPA-E indicated that candidate energy technologies are not yet at a stage where venture capital investment, such as occurs with In-Q-Tel, would provide the best return. At some point, however, ARPA-E research may lead to technologies appropriate for venture capital. At that stage, it might be appropriate to incorporate a venture capital component into ARPA-E's design. Just as DARPA has evolved over 50 years, ARPA-E may need to evolve as well, some witnesses said.

Box 3. In-Q-Tel Management Design Keys

In 2001, a panel of the Business Executives for National Security (BENS) conducted an analysis of the In-Q-Tel model. It found that In-Q-Tel has the following characteristics that differentiate it from the typical business-as-usual federal R&D model.

In-Q-Tel

- Can make equity investments;
- Has fewer bureaucratic constraints;
- Is not required to comply with the Federal Acquisition Regulations (FAR) requirements;
- Can obligate funds in multi-year increments, i.e., “no year” money;
- Is not restricted by civil service personnel policies;
- Engages only in unclassified projects;
- Has the cachet of being associated with the CIA; and
- Has a flexible deal structure modeled after commercial contractual/investment vehicles.

The BENS panel also described the differences between the In-Q-Tel model and a private venture capital firm. In-Q-Tel, BENS states, is better described as a “technology accelerator” than a venture capital firm, as In-Q-Tel

- Places its value proposition on obtaining IT [information technology] solutions, not foremost on return on equity or asset;
- Deals always result in a product or service (e.g. feasibility assessment, test product or prototype);
- Investments are more likely to provide value to the portfolio companies beyond cash: Investment is “smart money” in its portfolio companies; that is, In-Q-Tel provides portfolio companies with intellectual capital, technology-related experience and the Agency as a potential test-bed; and
- Due diligence process is more strict: In-depth investigation into the company's structure and financial status as well as the ability of the proposed technology to meet the Agency problem domain is completely evaluated before forming a contract.

The BENS panel found that “In-Q-Tel's potential advantage to the CIA outweighs the risk. In-Q-Tel should continue as the CIA's entrepreneurial and innovative venture facilitating the delivery of new technology to the CIA.”

Source: Business Executives for National Security, *Accelerating the Acquisition and Implementation of New Technologies for Intelligence: The Report of the Independent Panel on the Central Intelligence Agency In-Q-Tel Venture*, June 2001 at [http://www.bens.org/mis_support/nqtel-panel-rpt.pdf].

How Much Funding Should ARPA-E Receive? The NAS report proposed that funding for ARPA-E start at \$300 million the first year and increase gradually over five or six years to \$1 billion per year. At that point, the program's effectiveness would be evaluated and appropriate actions taken, according to the report.

One issue discussed in hearings was whether the level of authorized funding for ARPA-E is sufficient to support the research necessary for ARPA-E to reach its goals. Some noted with concern that the proposed \$300 million in FY2008 was less than 0.02% of the transportation and energy industries' annual revenues, a level they believed was insufficient relative to the potential return. Some suggested that if it is to be successful, ARPA-E needs to be funded at a level comparable to DARPA — about \$3 billion per year.²³

Some of those testifying did not believe ARPA-E should be funded due to budget constraints. ARPA-E, they argued, would be funded by shifting resources from DOE's Office of Science. Increasing funding for the DOE Office of Science is also a goal of the America COMPETES Act. Some hearing witnesses expressed concern that dilution of DOE Office of Science resources might influence DOE's acceptance of ARPA-E, and hinder its success. Supporters of ARPA-E agreed that funding for the DOE Office of Science is the highest priority and testified that funding for ARPA-E should not be redirected from that office.

Some witnesses expressed concerns that a risk-tolerant agency like ARPA-E could not survive if it was subject to the annual appropriations cycle, political and financial pressures, and resource fluctuations that might stifle innovation. To overcome this potential challenge, some testifying proposed dedicated funding (see below).

Will ARPA-E Work? Some critics believe that what is preventing the United States from reaching its energy goals is not federal funding for innovative, high-risk research, but rather a lack of private-sector investment in basic research, failure to effectively transfer new energy technologies to the marketplace, or some combination of these. They point out the lack of a captive customer: energy has a broad and diverse public and private market, while DARPA has DOD as its single primary customer, guaranteeing a solid base of demand. ARPA-E proponents indicated that ARPA-E is needed for "translational research." This type of research identifies the most pressing market needs, selects and funds the most promising scientific approaches to enable breakthrough products, and brings the best candidates of those products to the brink of production.

²³ DARPA's FY2008 budget is \$3.0 billion. Its FY2009 request is \$3.3 billion. For more information, see [<http://www.darpa.mil/body/budg.html>].

Bush Administration Response to ARPA-E Authorization

Although President Bush signed the America COMPETES Act into law because it shares the goals of the ACI, he did not support ARPA-E. A White House fact sheet stated that “The bill creates over 30 new programs that are mostly duplicative or counterproductive — including a new Department of Energy agency to fund late-stage technology development more appropriately left to the private sector.”²⁴ After final passage of the act, Raymond Orbach, DOE Under Secretary for Science, stated that although the goal of the newly authorized agency is “laudable,” its structure needs to be developed.²⁵ Dr. John H. Marburger, director of the White House Office of Science and Technology Policy, testified that the FY2009 budget does not request funding for ARPA-E because “the Administration believes very strongly that the basic research programs at the DOE Office of Science are a higher leverage investment and in greater need of funding than new DOE programs.”²⁶

Rather than create ARPA-E, the Secretary of Energy has issued a new policy on technology transfer that espouses goals similar to that of ARPA-E.²⁷ As a result of this policy, DOE will now pool funds from the Office of Science and other programs to fund six new collaborations that integrate basic and applied research. According to DOE, funding for these collaborations will be based on congressional language that requires DOE to set aside 0.9% of its applied energy research and development budget for technology transfer.²⁸ For FY2009, DOE has also proposed \$100 million for a new Office of Science program, Energy Frontier Research Centers (EFRCs) “to

²⁴ U.S. President (G.W. Bush), “America COMPETES Act of 2007,” Fact Sheet, August 9, 2007, at [<http://www.whitehouse.gov/news/releases/2007/08/20070809-6.html>].

²⁵ American Institute of Physics, “Ray Orbach on FY2008 Funding Bill: ‘The Clock is Ticking,’” newsletter, FYI Number 97, September 21, 2007, at [<http://www.aip.org/fyi/2007/097.html>].

²⁶ Testimony of Dr. John Marburger, III, Director, White House Office of Science and Technology Policy, House Committee on Science and Technology, *Funding for the America COMPETES Act in the FY2009 Administration Budget Request*, hearing, 110th Congress, 2nd session, February 14, 2008 at [http://democrats.science.house.gov/Media/File/Commdocs/hearings/2008/Full/14feb/Marburger_Testimony.pdf].

²⁷ See the press release at [<http://www.doe.gov/print/5977.htm>] and the policy statement at [http://www.doe.gov/media/Policy_Statement_on_Technology_Transfer.pdf]. The technology transfer policy states “This Policy Statement builds upon the stimulus provided by the technology transfer provisions contained in the Energy Policy Act of 2005 and other recent legislative actions such as the ‘America COMPETES Act’ that seek to improve the transfer of energy technologies from the Department’s Facilities to products and applications that address public and private needs.”

²⁸ This may be a reference to Section 1001 of the Energy Policy Act (P.L. 109-58): “TECHNOLOGY COMMERCIALIZATION FUND. — The Secretary shall establish an Energy Technology Commercialization Fund, using 0.9 percent of the amount made available to the Department for applied energy research, development, demonstration, and commercial application for each fiscal year, to be used to provide matching funds with private partners to promote promising energy technologies for commercial purposes.”

accelerate the rate of scientific breakthroughs needed to create advanced energy technologies for the 21st century. . .[and to] pursue the fundamental understanding necessary to meet the global need for abundant, clean, and economical energy.”²⁹

Ongoing Congressional Debate Over ARPA-E Funding

An issue for Congress is whether to fund ARPA-E in FY2009, and if so, how much and how long. The America COMPETES Act authorized \$300 million for FY2008, and “such sums as necessary” for FY2009 and FY2010. Some have proposed providing an advance appropriation supporting ARPA-E for several years, rather than the usual one-year appropriation. Another option is to identify a dedicated revenue source for ARPA-E. Some of the sources that have been proposed are a repeal of oil industry tax and other incentives (to offset ARPA-E’s cost);³⁰ gasoline tax;³¹ oil company profit tax;³² a trust fund set up from federal oil and gas royalties, or from a fund derived under a climate change cap and trade³³ program.³⁴ An analogous situation might be research supported through the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Program,³⁵ authorized by the Energy Policy Act of 2005 (P.L. 109-58), which receives funding of \$50 million per year derived from royalties, rents, and bonuses from federal onshore and offshore oil and gas leases.³⁶ Based on past experience, however, all of these proposals would face challenges in Congress.

²⁹ For more information, see Department of Energy, Energy Frontier Research Centers, webpage at [<http://www.sc.doe.gov/bes/EFRC.html>].

³⁰ House Committee on Science and Technology, “Chairman Gordon Presses Establishment of ARPA-E as a Key to Clean Energy Independence, press release May 9, 2008, at [<http://science.house.gov/press/PRArticle.aspx?NewsID=2189>].

³¹ For more information on the federal excise tax on gasoline, see CRS Report RL30304 , *The Federal Excise Tax on Gasoline and the Highway Trust Fund: A Short History*, by Pamela J. Jackson.

³² For more information on use of oil company profits, see CRS Report RL34044, *The Use of Profit by the Five Major Oil Companies*, by Robert Pirog.

³³ For more information on cap and trade programs see CRS Report RL33846, *Greenhouse Gas Reduction: Cap-and-Trade Bills in the 110th Congress*, by Larry Parker and Brent D. Yacobucci.

³⁴ Testimony of Melanie Kenderdine, Vice President, Gas Technology Institute in U.S. Congress, House Committee on Science, *Should Congress Establish “ARPA-E”, The Advanced Research Projects Agency - Energy?*, hearings, 109th Congress, 2nd sess., March 9, 2006, H.Hrg. 109-39 (Washington: GPO, 2006) at [<http://science.house.gov/commdocs/hearings/full06/March%209/Kenderdine.pdf>].

³⁵ For more information, see [http://www.fossil.energy.gov/programs/oilgas/ultra_and_unconventional/index.html].

³⁶ For more information, see CRS Report RL33493, *Outer Continental Shelf: Debate Over Oil and Gas Leasing and Revenue Sharing*, by Marc Humphries.

The Boxer-Lieberman-Warner Substitute to the Lieberman-Warner Climate Security Act (S. 2191) includes a provision in Title IX, Subtitle B for funding ARPA-E through the Energy Transformation Acceleration Fund,³⁷ a sponsor-estimated \$17 billion from 2012 to 2050.³⁸

Appropriations for ARPA-E would be in the Energy and Water Development appropriations bill.³⁹ At this stage in the process, it is unclear whether ARPA-E will be part of those budget discussions. Due to budget constraints, Congress may need to decide whether funding for existing DOE energy R&D activities, the proposed technology transfer collaborations and Energy Research Frontier Centers, or ARPA-E is more important. An alternative is to reform existing DOE programs by incorporating some ARPA-E or In-Q-Tel type aspects.

³⁷ As discussed earlier, this fund was created in the America COMPETES Act as a mechanism within the U.S. Treasury to fund ARPA-E.

³⁸ The Boxer-Lieberman-Warner Substitute to the Lieberman-Warner Climate Security Act, S. 2191 and the summary of the bill is at [http://epw.senate.gov/public/index.cfm?FuseAction=Majority.PressReleases&ContentRecord_id=0cf9da8d-802a-23ad-48e9-25af99b226f4&Designation=Majority]. For more information on this bill, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191*, by Larry Parker and Brent D. Yacobucci.

³⁹ See CRS Report RL34417, *Energy and Water Development: FY2009 Appropriations*, coordinated by Carl E. Behrens.