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A REVIEW OF THE ADVANCED RESEARCH PROJECTS AGENCY—ENERGY

HEARING

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

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A REVIEW OF THE ADVANCED RESEARCH PROJECTS AGENCY—ENERGY

TUESDAY, JANUARY 24, 2012

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:04 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Paul Broun [Chairman of the Subcommittee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

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Subcommittee on Investigations & Oversight Hearing

A Review of the Advanced Research Projects Agency-Energy

Tuesday, January 24, 2012
2:00 p.m. to 4:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Arun Majumdar, Director, Advanced Research Projects Agency – Energy, U.S. Department of Energy

The Honorable Gregory Friedman, Inspector General, U.S. Department of Energy

Mr. Frank Rusco, Director, Energy and Science Issues, U.S. Government Accountability Office

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Investigations and Oversight

HEARING CHARTER

A Review of the Advanced Research Projects Agency - Energy

Tuesday, January 24, 2012
2:00-4:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Tuesday, January 24, the Science, Space, and Technology Subcommittee on Investigations and Oversight will hold a hearing entitled "***A Review of the Advanced Research Projects Agency-Energy.***" The purpose of this hearing is to review the Advanced Research Projects Agency-Energy's (ARPA-E) performance and evaluate recent reports from the Department of Energy Inspector General (DOE IG) report OAS-RA-11-11, "*Advanced Research Projects Agency-Energy*" and the Government Accountability Office (GAO) report 12-112, "*Advanced Research Projects Agency Could Benefit from Information on Applicants' Prior Funding.*"

WITNESSES

- **Dr. Arun Majumdar**, Director, Advanced Research Projects Agency – Energy, U.S. Department of Energy
- **The Honorable Gregory Friedman**, Inspector General, U.S. Department of Energy
- **Mr. Frank Rusco,** Director, Energy and Science Issues, U.S. Government Accountability Office

BACKGROUND

Established in 2007 by the America COMPETES Act (P.L.110-69), ARPA-E is statutorily charged to "overcome the long-term and high-risk technological barriers in the development of energy technologies" that result in "(i) reductions of imports of energy from foreign sources; (ii) reductions of energy-related emissions, including greenhouse gases; and (iii) improvement in the energy efficiency of all economic sectors."[1]

The America COMPETES Act charged ARPA-E with achieving these goals by:

> "(1) identifying and promoting revolutionary advances in fundamental sciences;
> (2) translating scientific discoveries and cutting-edge inventions into technological innovations; and

[1] P.L. 110-69 Sec. 5012(c)(1)(A)

(3) accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of the technical and financial uncertainty."[2]

First funded at a level of $400 million in the 2009 American Recovery and Reinvestment Act (Table 1), ARPA-E's initial Funding Opportunity Announcement (FOA) awarded $151 million to 37 awardees in October 2009. The first FOA did not limit awards to a specific technology and made awards in a wide array of energy efficiency and renewable energy technology areas. In April 2010, ARPA-E announced the second FOA which provided $106 million to 37 awardees through programs relating to electrofuels, vehicle batteries, and carbon capture and storage technology areas. The third FOA, announced in July 2010, provided $92 million to 43 awardees through programs to research electrical power electronics, grid scale energy storage, and building efficiency. A supplemental funding round of $9.6 million was announced in September 2010 to six "transformational energy research projects."[3] Each project receives funding ranging from $500,000 to $10 million.

Table 1. Advanced Research Projects Agency – Energy Budget (dollars in millions)

Program	FY09 ARRA	FY10 Enacted	FY11 CR	FY12 Request	FY12 Enacted	FY12 Enacted versus FY11 Enacted	
						$	%
ARPA-E	*400.0*	*15.0*	*180.0*	*650.0*	*275.0*	*95.0*	*52.8*

ARPA-E's award selection process is competitive and peer-reviewed. To determine the merit of applications, ARPA-E develops technical requirements for each program area and includes four standard criteria in the selection process. The standard criteria are as follows: (1) impact of the proposed technology relative to the state of the art; (2) overall scientific and technical merit; (3) qualifications, experience, and capabilities; and (4) a sound management plan.[4] The America COMPETES Act provided ARPA-E with administrative authorities that allow project selection and funding to be completed significantly faster than in other DOE R&D programs.

Current ARPA-E Activities

In the Fiscal Year (FY) 2011 Continuing Resolution, ARPA-E received $180 million. Upon receiving the funding, ARPA-E announced a fourth FOA for the following categories:

- **Plants Engineered to Replace Oil (PETRO)** to develop low-cost production of advanced biofuels. ($36 million)
- **High Energy Advanced Thermal Storage (HEATS)** to research advancements in hot and cold thermal energy storage. The energy storage technologies would assist storage

[2] P.L. 110-69 Sec. 5012 (c)(2)
[3] For more information and full list of awardees visit: http://arpa-e.energy.gov/ProgramsProjects/Programs.aspx
[4] For a more detailed description of the selection process, see GAO Report, "*Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding,*" (GAO-12-112), January 2011.

necessary to deliver solar electricity, produce fuel from the sun's heat, and improve driving range of electric vehicles due to improvements in air conditioning efficiency. ($37.3 million)

- **Rare Earth Alternatives in Critical Technologies (REACT)** to study technology alternatives to mitigate demand for rare earth materials. ($31.6 million)
- **Green Electricity Network Integration (GENI)** to advance grid control technologies necessary to manage issues relating to intermittent sources of electricity generation. ($36.4 million)
- **Solar Agile Delivery of Electrical Power Technology (Solar ADEPT)** to build on the SunShot Initiative. Solar ADEPT seeks to reduce the total cost of utility-scale solar systems by 75 percent by 2017. ($14.7 million)

On September 29, 2011, ARPA-E announced $156 million in awards to 60 projects in the previously announced categories.[5] The President's FY 2012 budget requested $650 million for ARPA-E. In December 2011, the President signed the FY 2012 Consolidated Appropriations bill, that provided $275 million to ARPA-E (of which $20 million is for program direction and is available until September 30, 2013.)

ARPA-E was initially required to spend 2.5 percent of its funds on technology transfer and outreach activities. The America COMPETES Reauthorization Act of 2010 doubled this percentage to 5 percent. This requirement is met in part through an annual Energy Innovation Summit hosted by ARPA-E. The third Energy Innovation Summit will take place in February 2012. The Summit intends to "bring together key players from across the energy ecosystem – researchers, entrepreneurs, investors, corporate executives and government officials – to share ideas for developing and deploying the next generation of clean energy technologies."[6] Additionally, the Summit includes a "Transformational Energy Technology Showcase" to highlight award winners, finalists, and other innovative energy technologies that did not receive previous ARPA-E funding.

GAO REPORT

On July 28, 2010, then-Science and Technology Committee Ranking Member Hall and then-Investigations and Oversight Subcommittee Ranking Member Broun requested a GAO review of the manner in which ARPA-E was fulfilling its statutorily required objectives. The request letter (Appendix A) asked GAO to "review the program with a focus on addressing the following questions:

1. "To what extent has ARPA-E met its statutory objective to avoid funding projects in technology areas that previously received, or currently receive, private sector funding?
2. What process and controls does ARPA-E have in place to evaluate whether applicants' proposed technology project areas receive, or received, industry funding?

[5] ARPA-E, "Department of Energy Awards $156 Million for Groundbreaking Energy Research Projects," September 29, 2010. Accessible at: http://arpa-e.energy.gov/media/news/tabid/83/vw/1/itemid/39/department-of-energy-awards-%24156-million-for-groundbreaking-energy-research-projects.aspx

[6] "ARPA-E, "2012 ARPA-E Innovation Summit," Accessible at: http://arpa-e.energy.gov/eventsworkshops/events/tabid/170/vw/3/itemid/38/d/20120227/2012-ARPA-E-Energy-Innovation-Summit-.aspx

   a. What information does ARPA-E need to collect from applicants to adequately determine if applicants receive, or received industry funding?
3. Has ARPA-E developed funding criteria or established technical milestones in order to assess program success as required by statute?[7]
   a. What criteria and milestones are being used by ARPA-E project managers to evaluate proposals and projects?
   b. How do such criteria consider and prioritize current and prior industry funding?
   c. How is ARPA-E's overarching statutory purpose to overcome "long-term and high-risk technological barriers" factored into funding criteria and the evaluation process?
4. Is ARPA-E successfully ensuring its activities do not duplicate the efforts of other DoE programs, as required by statute?
   a. What processes are in place to prevent duplication of effort?"[8]

In response to the request, GAO produced a report titled "*Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding*" (GAO-12-112). GAO recommends ARPA-E take three steps to ensure funds are appropriately managed:

- "[P]rovide guidance with a sample response to assist applicants in providing information on sources of private funding for proposed ARPA-E projects;
- [R]equire that applicants provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E; and
- [U]se venture capital funding databases to help identify applicants with prior private investors and to help check information applicants provide on their applications."[9]

In ARPA-E's official response to the GAO report, it committed to implementing all of GAO's recommendations.[10]

DOE IG REPORT

In August 2011, the DOE IG released an audit report on ARPA-E. The purpose of the audit was to "determine whether ARPA-E implemented safeguards necessary to achieve its goals and objectives and to effectively deploy associated Recovery Act resources."[11] The DOE IG found ARPA-E:

1. "Had not established a systematic approach to ensure that it was meeting the technology transfer and outreach requirement of the COMPETES Act. In particular, ARPA-E had not required funding recipients to expend a percentage of their awards on technology transfer; and

[7] P.L. 110-69 Sec 5012 (e)(2)
[8] Letter from Representatives Ralph Hall and Paul Broun to Mr. Gene Dodaro, July 28, 2010.
[9] GAO Report, p. 22.
[10] GAO Report, Appendix IV: Comments from ARPA-E, p. 35.
[11] DOE IG, "*Audit Report – The Advanced Research Projects Agency-Energy,*" (OAS-RA-11-11) August 2011. Accessible at: http://energy.gov/sites/prod/files/OAS-RA-11-11.pdf

2. Had not drafted or, in some cases, approved draft policies and procedures in a number of key areas, including those in the areas of monitoring and oversight of awardees; termination of non-performing awards; technology transfer and outreach; and, invoice review."[12]

Of the three award recipients that the IG examined, the IG identified concerns with the costs claimed by two of the recipients, identifying $280,387 in questionable costs. Of the identified questionable costs, the IG noted $40,890 in direct costs with activities including

> "meeting with bankers to raise capital, securing other government funding…costs which do not appear to be allocable to the cooperative agreement because they are related to selling a piece of equipment, a fee to appear on a local television program, and meal costs."[13]

The remaining $239,497 was questioned because the indirect cost rate was not supported by the recipient. The IG found ARPA-E was not aware of the type of costs incurred by the recipients, because the agency did not require awardees to submit transaction details as a part of their invoice review process.

The IG reported that, "[a]ccording to an ARPA-E official, ARPA-E focused its attention on meeting the Recovery Act requirement of expeditiously awarding funds to projects by September 30, 2010; and, as a consequence did not have sufficient time and resources to devote to establishing its operational controls in the area of policies and procedures."[14]

In February 2011, ARPA-E finalized its policy outlining what was considered an allowable cost for technology transfer and outreach activities. The DOE IG noted concern that the policy

> "allows recipients to incur several types of costs that are typically unallowable as direct costs under Federal Acquisition Regulations [FAR], such as the costs of procuring additional Government funding and for meeting with investors, without providing a justification as to reasons for their allowability."[15]

The IG report further noted that ARPA-E tech transfer spending policy "does not reference the FAR or refer to the fact that the types of costs listed are typically unallowable and require prior justifications for the costs before they are incurred. [16]

The DOE IG made five recommendations concerning ARPA-E:

1. "Finalize the remaining policies and procedures related to the operation of ARPA-E, such as those related to monitoring and oversight of awardees; and termination of non-performing awards;

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[12] DOE IG Report, p. 2.
[13] DOE IG Report, p. 4.
[14] DOE IG Report, p. 5.
[15] Ibid.
[16] Ibid.

2. Consult with the Headquarters Office of Procurement and Assistance Policy on the allowability of costs contained in the newly developed policy on technology transfer and outreach;
3. Establish a process to accurately measure progress toward meeting the technology transfer and outreach spending requirement;
4. Obtain a Contracting Officer official determination regarding the allowability of costs questioned in this report and to recover costs determined to be unallowable; and,
5. Communicate to recipients the types of costs that are allowable and unallowable as technology transfer and outreach costs."[17]

In response to the IG report, ARPA-E deployed a new project management system to monitor awardees and clarified its policies on technology transfer and outreach to applicants. The report noted differences remain between ARPA-E and the IG as to the appropriateness of certain costs incurred by awardees.

ISSUES FOR COMMITTEE CONSIDERATION

In FY 2012, ARPA-E received funding for its fourth year of operation. ARPA-E supports projects for periods ranging from one to three years; therefore, the projects initially funded in the first FOA are nearing completion and the agency's performance necessitates review. Additionally, other items for Committee consideration include:

- What metrics of success and technical milestones has ARPA-E established to assess the agency's performance?
- Is ARPA-E meeting its statutory objective to fund "high-risk, high reward" research and avoid funding projects in technology areas that previously received, or currently receive, private sector funding?
- Has ARPA-E developed the policy regarding appropriate technology transfer and outreach activities as identified by the DOE IG report?
- Is ARPA-E successfully ensuring its activities do not duplicate the efforts of other DOE programs?
- To what extent has the "halo effect"[18] borne out in practice?

[17] DOE IG Report, p. 6.
[18] The "halo effect" is a term attached to the phenomenon when a "stamp of approval" from an authoritative source generates follow-on action, such as an ARPA-E awardee receiving private investment due ARPA-E's endorsement of a technological concept.

Appendix A

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
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July 28, 2010

Mr. Gene Dodaro
Acting Comptroller General
U.S. General Accountability Office
441 G St., NW
Washington, DC 20548

Dear Mr. Dodaro:

On August 9, 2007 President Bush signed *The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act of 2007* or *America COMPETES Act* (P.L. 110-69) with the purpose of investing in innovation through research and development, and improving the competitiveness of the United States. Section 5012 of the COMPETES Act established the Advanced Research Projects Agency – Energy (ARPA-E) in order to "overcome the long-term and high-risk technological barriers in the development of energy technologies."[1] In order to assist the Committee in its oversight of this new agency, we request that the Government Accountability Office (GAO) review the Department of Energy's implementation of ARPA-E.

ARPA-E was created to foster long-term, high-risk, high-reward research and development. In establishing ARPA-E, great lengths were taken to ensure that these investments would not simply supplant private sector research and development activities with public investment. Sec. 5012(c)(2)(c) of America Competes states that ARPA-E shall fund projects "in areas that industry by itself is not likely to undertake because of technical and financial uncertainty."[2] This language represents Congressional interest in ensuring (1) ARPA-E focus limited resources on technology too risky to attract private investment; (2) ARPA-E activities reflect an appropriate role of government that avoids potential interference in the competitive marketplace, resulting in the government "picking winners and losers" among competing technologies; and (3) ARPA-E funding does not crowd out private investment.

Concerns of "crowding out" private investment were echoed by Secretary Chu in recent testimony before Congress which stated,

> *We must harness America's entrepreneurial spirit and leverage private sector imagination and ingenuity to transform the way we produce and use energy. Part of those policies must promote*

[1] P.L. 110-69, Section 5012(b)
[2] *Ibid*

Mr. Dodaro
July 28, 2010
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> *the research and development of key technologies needed in the coming decades* ***without crowding out private investment.***"[3] *[Emphasis added].*

Similarly, The President's 2011 Budget proposal stated,

> We recognize that in some instances, government funding could possibly crowd-out private capital. We are aware of this and we are working cautiously to avoid the areas where this could happen.[4]

In order to assist the Committee in its review of ARPA-E, we request that GAO review the program with a focus on addressing the following questions:

1) To what extent has ARPA-E met its statutory objective to avoid funding projects in technology areas that previously received, or currently receive, private sector funding?

2) What process and controls does ARPA-E have in place to evaluate whether applicants' proposed technology project areas receive, or received, industry funding?
   a. What information does ARPA-E need to collect from applicants to adequately determine if applicants receive, or received industry funding?

3) Has ARPA-E developed funding criteria or established technical milestones in order to assess program success as required by statue?[5]
   a. What criteria and milestones are being used by ARPA-E project managers to evaluate proposals and projects?
   b. How do such criteria consider and prioritize current or prior industry funding?
   c. How is ARPA-E's overarching statutory purpose to overcome "long-term and high-risk technological barriers" factored into funding criteria and the evaluation process?

4) Is ARPA-E successfully ensuring its activities do not duplicate the efforts of other DoE programs, as required by statute?[6]
   a. What processes are in place to prevent duplication of effort?

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[3] Statement of Dr. Steven Chu, United States Secretary of Energy, United States Senate, Committee on Appropriations, Subcommittee on Energy and Water Development, *Hearing on National Energy Policies*, 111th Congress, April 28, 2010.
[4] United States Department of Energy, Energy Transformation Acceleration Fund, Advanced Research Projects Agency- Energy, Proposed Appropriation Language, FY2011 Funding Request.
[5] P.L. 110-69 Sec. 5012 (e)(2)
[6] P.L. 110-69 Sec. 5012(h)(1)

Mr. Dodaro
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If you have any questions relating to this request, please contact Mr. Tom Hammond, Investigations and Oversight Subcommittee Minority Professional Staff Member, or Mr. Dan Byers, Energy and Environment Subcommittee Professional Staff Member at (202) 225-6371.

Your assistance in this matter is greatly appreciated.

Sincerely,

Ralph M. Hall

REP. RALPH HALL
Ranking Member
Committee on Science
and Technology

Paul C. Broun

REP. PAUL BROUN, M.D.
Ranking Member
Subcommittee on Investigations
and Oversight

cc: The Honorable Bart Gordon, Chairman
Committee on Science and Technology

The Honorable Brad Miller, Chairman
Subcommittee on Investigations and Oversight
Committee on Science and Technology

The Honorable Brian Baird, Chairman
Subcommittee on energy and Environment
Committee on Science and Technology

Chairman BROUN. The Subcommittee on Investigations & Oversight will come to order. I will try not to break this desk like my predecessor Chairman did.

Good afternoon, everyone, to today's hearing titled, "A Review of the Advanced Research Projects Agency—Energy," ARPA–E. You will find in front of you packets containing our witness panel's written testimony, biographies and their truth in testimony disclosures. I want to welcome everyone here, and I particularly want to welcome our witnesses here today.

Now I will recognize myself for five minutes for an opening statement.

The Advanced Research Projects Agency—Energy, or ARPA–E, was created in 2007 by the *America COMPETES Act* but not funded until 2009 with the passage of the *American Recovery and Reinvestment Act*. ARPA–E was directed to foster high-risk, high-reward energy technologies too risky for the private investment. In general, the statute calls for these technologies to be focused on reducing energy imports and emissions while improving energy efficiency.

The Agency is directed to accomplish these goals by doing the following: identifying and promoting revolutionary advances in fundamental sciences; secondly, translating scientific discoveries and cutting edge inventions into technological innovations; and thirdly, accelerating transformational advances in areas that industry by itself is not likely to undertake because of the technical and financial uncertainty.

These principles and goals are generally well-supported on both sides of the aisle here in Congress, and for good reason. If the Federal Government is going to fund energy research, it should not duplicate or crowd out private-sector investment. It should focus on revolutionary breakthroughs that will transform our energy infrastructure.

Despite this support, this Committee did raise a number of concerns when ARPA–E was proposed. Specifically, the Committee was concerned with how the creation of a new agency would affect the world-class research supported by DOE's Office of Science. Historically, DOE's Office of Science has been the home of basic energy research, and their efforts have focused on high-risk, high-reward basic research for decades. The Committee was concerned that ARPA–E would compete with the Office of Science for scarce resources, thereby undermining basic research.

Similarly, the Committee was also concerned that ARPA–E could unnecessarily duplicate DOE's significant related work in other programs and areas scattered throughout the department.

Finally, the Committee was concerned ARPA–E would focus on late-stage technology development and commercialization efforts that are better left for the private sector to undertake, thereby accepting both the risk and the potentially great reward. Such interventions could eventually crowd out private investment and get the government into the business of picking winners and losers among competing companies and technologies rather than letting the marketplace make these decisions.

Today's hearing allows the Committee to evaluate whether those concerns have been addressed. With respect to the impact ARPA–

E is having on the Office of Science, we saw a 53 percent increase in ARPA–E's budget in the 2012 fiscal year, while the Office of Science received only a 0.6 percent increase. In the prior fiscal year, ARPA–E's budget increased by 260 percent, while the Office of Science budget decreased six percent. Apparently our concern was well-founded.

We also have some initial data regarding duplication with private- and public-sector funding, and based on work undertaken by GAO and Committee staff, the record appears mixed. Of the 44 small- and medium-sized companies that received an ARPA–E award, GAO found that 18 had previously received private-sector investment for a similar technology. Committee staff were able to identify five additional companies that received private sector funding prior to their ARPA–E award.

Similarly, a review of GAO work papers and publicly available information indicates numerous instances of overlap and duplication between ARPA–E and both public- and private-sector funding. For example, GAO found that 12 of the 18 companies it identified as having received private sector-funding prior to their ARPA–E award planned to use ARPA–E funding to either advance or accelerate prior funded work. One eventual ARPA–E awardee stated in its application that their "original projections planned on prototype demonstration and subsequent first-market adopter sales in late 2012 or early 2013. The ARPA–E award coupled with another $1 million in venture financing as part of our cost share allows us to accelerate our development schedule to 2011 instead." Just brought it a year or possibly two sooner.

These and numerous other examples that are detailed in a majority staff report that I have attached to my opening statement raise a fundamental question regarding the role and future of ARPA–E. Should it direct taxpayer money to simply speed up or accelerate companies and what they are already doing, or should it fund research in truly high-risk white spaces, so-called white spaces, that no one else is willing to undertake? I hope today's hearing provides an opportunity to identify common ground on this question.

Another thing that taxpayer money should not be used for is meetings with bankers to raise capital and a fee to appear on a local television shows. The DOE IG noted in its report that these two tasks were cited as an allowable cost by ARPA–E under its Technology Transfer and Outreach policy. ARPA–E originally argued that such spending should be allowed despite the DOE IG's concerns, Just yesterday, however, ARPA–E provided an updated technology transfer policy that is now silent on the appropriateness of this type of spending. Personally, I think it is inappropriate. The Subcommittee is reviewing this policy, and I look forward to getting clarification from ARPA–E on this question. These concerns are not meant to imply that all of the work being conducted by ARPA–E is duplicative or unworthy of federal funding. Many of the projects it supports are clearly in line with its statutory direction, and if taxpayers are going to be involved in funding energy technologies at all, it should be in a manner similar to ARPA–E's focus on high-risk, high-reward research that is not being pursued by the private sector.

Despite ARPA–E's stated commitment to "carefully structure its projects to avoid any overlap with public and private sources of funding," we have seen numerous instances that deviate from that pledge. Going forward, we will continue to monitor whether the agency is actually following the statutory direction and look forward to ARPA–E's cooperation.

[The prepared statement of Mr. Broun follows:]

OPENING STATEMENT
The Honorable Paul Broun (R-GA), Chairman
Subcommittee on Investigations & Oversight
Committee on Science, Space, and Technology
A Review of the Advanced Research Projects Agency – Energy

January 24, 2012

The Advanced Research Projects Agency – Energy, or ARPA-E, was created in 2007 by the America COMPETES Act, but not funded until 2009 with the passage of the American Recovery and Reinvestment Act. ARPA-E was directed to foster high-risk, high-reward energy technologies too risky for private investment. In general, the statute calls for these technologies to be focused on reducing energy imports and emissions while improving energy efficiency.

The Agency is directed to accomplish these goals by:

- identifying and promoting revolutionary advances in fundamental sciences;
- translating scientific discoveries and cutting edge inventions into technological innovations; and
- accelerating transformational advances in areas that industry by itself is not likely to undertake because of the technical and financial uncertainty.

These principles and goals are generally well supported on both sides of the aisle here in Congress, and for good reason – if the federal government is going to fund energy research it should not duplicate or crowd-out private sector investment. It should focus on revolutionary breakthroughs that will transform our energy infrastructure.

Despite this support, this Committee did raise a number of concerns when ARPA-E was proposed. Specifically, the Committee was concerned with how the creation of a new agency would affect the world-class research supported by DOE's Office of Science. Historically, DOE's Office of Science has been the home of basic energy research, and their efforts have focused on high-risk high-reward basic research for decades. The Committee was concerned that ARPA-E would compete with the Office of Science for scarce resources, thereby undermining basic research. Similarly, the Committee was also concerned that ARPA-E could unnecessarily duplicate DOE's significant related work in other programs and areas scattered throughout the department. Finally, the Committee was concerned ARPA-E would focus on late-stage technology development and commercialization efforts that are better left for the private sector to undertake, thereby accepting both the risk and the potentially great reward. Such interventions could eventually crowd-out private investment and get the government into the business of picking "winners and losers" among competing companies and technologies rather than let the market make these decisions.

Today's hearing allows the Committee to evaluate whether those concerns have been addressed. With respect to the impact ARPA-E is having on the Office of Science, we saw a 53 percent increase in ARPA-E's budget in the 2012 Fiscal Year, while the Office of Science received only a 0.6 percent

increase. In the prior fiscal year, ARPA-E's budget increased by 260 percent, while the Office of Science budget decreased 6 percent. Apparently our concern was well founded.

We also have some initial data regarding duplication with private and public sector funding, and based on work undertaken by GAO and committee Staff, the record appears mixed. Of the 44 small- and medium- sized companies that received an ARPA-E award, GAO found that 18 had previously received private sector investment for a similar technology. Committee Staff were able to identify five additional companies that received private sector funding prior to their ARPA-E award.

Similarly, a review of GAO work papers and publicly available information indicates numerous instances of overlap and duplication between ARPA-E and both public and private sector funding. For example, GAO found that 12 of the 18 companies it identified as having received private sector funding prior to their ARPA-E award planned to use ARPA-E funding to either advance or accelerate prior-funded work. One eventual ARPA-E awardee stated in its application that their:

> "original projections planned on prototype demonstration and subsequent first market adopter sales in late 2012 or early 2013. The ARPA-E award coupled with another $1M in venture financing as part of our cost share allows us to accelerate our development schedule to 2011 instead."

These and numerous other examples are detailed in a majority staff report that I have attached to my opening statement raise a fundamental question regarding the role and future of ARPA-E: should it direct taxpayer money to simply speed up or accelerate what companies are already doing, or should it fund research in truly high-risk "white spaces" that no one else is willing to undertake? I hope today's hearing provides an opportunity to identify common ground on this question.

Another thing that taxpayer money should not be used for is "meetings with bankers to raise capital" and a "fee to appear on a local television show." The DOE IG noted in its report that these two tasks were cited as an allowable cost by ARPA-E under its Technology Transfer and Outreach policy. ARPA-E originally argued that such spending should be allowed despite the DOE IG's concerns, Just yesterday, however, ARPA-E provided an updated technology transfer policy that is now silent on the appropriateness of this type of spending. The Subcommittee is reviewing this policy, and I look forward to getting clarification from ARPA-E on this question. These concerns are not meant to imply that all of the work being conducted by ARPA-E is duplicative or unworthy of federal funding. Many of the projects it supports are clearly in-line with its statutory direction, and if taxpayers are going to be involved in funding energy technologies at all, it should be in a manner similar to ARPA-E's focus on high-risk, high reward research that is not being pursued by the private sector. Despite ARPA-E's stated commitment to "carefully structure its projects to avoid any overlap with public and private sources of funding," we have seen numerous instances that deviate from that pledge. Going forward we will continue to monitor whether the agency is actually following the statutory direction and look forward to ARPA-E's cooperation.

Chairman BROUN. Now I recognize the Ranking Member from New York, my good friend, Mr. Tonko, for five minutes or whatever time beyond that that he needs. Mr. Tonko.

Mr. TONKO. Thank you, Mr. Chairman. Thank you for holding this hearing today, and thank you to our witnesses for participating.

The Advanced Research Projects Agency—Energy, or ARPA–E, was designed to be nimble, creative and aggressive in funding promising ideas that could transform the way we obtain and use energy. Nothing in the law said that ARPA–E could only fund companies that did not have private-sector funding or that it could not fund companies that had funding from other agencies. Our expectation was that ARPA–E could apply the successful DARPA model to the energy sector and enable promising ideas to move expediently toward proof of concept or demonstration.

ARPA–E was to take on a scope of work that the private sector could not take on by itself and to accelerate the timeline of innovation in a way other agencies or venture capital could not do alone. Nothing in the GAO report that tackled this question suggests ARPA–E is doing anything but what the Congress and the president envisioned when ARPA–E was established in 2007. Time to market with an invention matters. Everyone knows who Alexander Graham Bell was and that he was awarded the first patent for a telephone. Very few people know who Elijah Gray was. He was second to file at the Patent Office for a very similar device. ARPA–E is supposed to make sure that the Alexander Graham Bells in our new and more competitive globalized world are American inventors and American companies.

The response to this new organization has been enormous. DOE has received over 4,000 concept papers in the three years of its existence. Companies and academic institutions that I interact with are very excited about this new model for funding our energy research. ARPA–E is funding innovative companies in my district, like SuperPower in partnership with the University of Houston and others to research materials and superconductivity applications with the potential to provide essential improvements in our energy infrastructure.

Given the importance of energy to every sector of our economy and our comeback and to all of our citizens, I believe we not only can afford this program, we cannot afford to lose it.

Other national governments are investing, investing in the energy technologies of the future, clean energy technologies, especially renewable energy technologies. The Chinese government invested $34.6 billion in clean energy in 2009 while our United States Government invested $18.6, or rather, the United States invested $18.6 billion. Perhaps others are willing to accept second place in the race to develop new energy technologies. I simply am not.

Finally, Mr. Chair, I have to comment on the Staff Report that the majority will enter into the record today. You and Chairman Hall have a well-documented opposition to ARPA–E. You asked GAO to examine how ARPA–E might be skirting the law requiring that DOE ensure they are not duplicating funding of the private sector. We will hear from the GAO about their findings today, but

their bottom line was that DOE has been working to ensure that they fund projects on a scale and time line that the private sector alone would not fund.

Mr. Chair, it appears that when GAO's report did not give the majority the findings you had hoped for, the majority staff wrote the report it wished to receive. The majority staff went through GAO's work papers and cherry-picked some examples to portray the law as something that it is not. These are hallmarks of a partisan hit piece, not a thoughtful, thorough report. Just as one example, the staff report points to several examples of companies that received private-sector funding or funding from other federal programs. However, the report does not validate whether the funding is duplicative with ARPA–E funding or not. The report settles for assertion and hand waving where only facts should matter. I will not oppose a motion to put the majority's report into the record, despite my misgivings about the process so long as it is understood that members on this side may decide to insert into the record our own evaluation of that work product and this program. I am pleased to note that we will receive testimony on two reports today, one from GAO, and one from the DOE Inspector General. I am going to put far more faith in their work products and findings, which are largely positive and productive than the partisan claims of the majority's report.

I thank the witnesses for appearing before us this afternoon, and I do look forward to your testimony. Thank you. I yield back.

[The prepared statement of Mr. Tonko follows:]

Statement of Ranking Member Paul D. Tonko
Committee on Science and Technology
Subcommittee on Investigations and Oversight
Hearing
A Review of the Advanced Research Projects Agency – Energy

January 24, 2012

Thank you, Mr. Chairman for holding this hearing today.

The Advanced Research Projects Agency-Energy, ARPA-E, was designed to be nimble, creative and aggressive in funding promising ideas that could transform the way we obtain and use energy. Nothing in the law said that ARPA-E could only fund companies that did not have private sector funding or that it could not fund companies that had funding from other agencies. Our expectation was that ARPA-E could apply the successful DARPA model to the energy sector and enable promising ideas to move expediently towards proof-of-concept or demonstration.

ARPA-E was to take on a scope of work that the private sector could not take on by itself and to accelerate the timeline of innovation in a way other agencies or venture capital could not do alone. Nothing in the GAO report that tackled this question suggests ARPA-E is doing anything but what the Congress and the President envisioned when ARPA-E was established in 2007.

Time-to-market with an invention matters. Everyone knows who Alexander Graham Bell was, and that he was awarded the first patent for a telephone. Very few know who Elisha Gray was—he was second to file at the patent office for a very similar device. ARPA-E is supposed to make sure that the Alexander Graham Bell's in our new and more competitive globalized world are American inventors and American companies.

The response to this new organization has been enormous. DOE has received over 5000 concept papers in the three years of its existence. Companies and academic institutions that I interact with are very excited about this new model for funding energy research. ARPA-E is funding innovative companies in my district, like SuperPower, in partnership with the University of Houston and others, to research materials and superconductivity applications with the potential to provide essential improvements in our energy infrastructure.

Given the importance of energy to every sector of our economy and to all our citizens, I believe we not only can afford this program – we cannot afford to lose it. Other national governments are investing in the energy technologies of the future – clean energy technologies, especially renewable energy technologies. The Chinese government invested $34.6 billion in clean energy in 2009, while the United States invested $18.6 billion. Perhaps, others are willing to accept second place in the race to develop new energy technologies. I am not.

Finally, Mr. Chairman, I have to comment on the staff report the majority will enter into the record today. You and Chairman Hall have a well-documented opposition to ARPA-E. You asked GAO to examine how ARPA-E might be skirting the law requiring that DOE insure they are not duplicating funding of the private sector. We will hear from the GAO about their findings today, but their bottom line was that DOE has been working to insure that they fund projects on a scale and timeline that the private sector alone would not fund.

Mr. Chairman, it appears that when GAO's report did not give the majority the findings you hoped for, the majority staff wrote the report it wished to receive. The majority staff went through GAO's work papers and cherry-picked some examples to portray the law as something that it is not. These are hallmarks of a partisan hit piece, not a thoughtful, thorough report. Just as one example, the staff report points to several examples of companies that received private sector funding or funding from other Federal programs. However, the report does not validate whether the funding is duplicative with ARPA-E funding or not. The report settles for assertion and hand-waving where only facts should matter.

I will not oppose a motion to put the majority's report in the record, despite my misgivings about the process, so long as it is understood that Members on this side may decide to insert into the record our own evaluation of that work product and this program.

I am pleased to note that we will receive testimony on two reports today, one from GAO and one from the DOE Inspector General. I am going to put far more faith in their work products and findings—which are largely positive and productive—than the partisan claims in the majority's report.

I thank the witnesses for appearing before us this afternoon. I look forward to your testimony.

Chairman BROUN. Thank you, Mr. Tonko. I want to read into the record the following. Review of GAO's work papers was necessary to provide context and quantification to key findings and best inform the Committee's oversight work going forward. ARPA–E is a fledgling agency that is still adjusting as it grows, and it just received a 50 percent budget increase over the prior year.

I think the minority will agree with me, it is important that we identify and correct potential problems now while the agency is still getting its feet under it.

To this end, the more extensive review adds great value to the community's efforts to be good stewards of the taxpayers' dollars.

I appreciate your opening statement. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point. I ask unanimous consent that Mr. Bartlett and Mr. Rohrabacher be able to participate. Hearing no objections, so ordered.

[The information may be found in Appendix 2.]

Chairman BROUN. At this time, I would like to introduce our panel of witnesses. Doctor—help me.

Mr. MAJUMDAR. Majumdar.

Chairman BROUN. Majumdar. Close. I am trying, sir. I apologize. My family can't spell, can't pronounce, I am not sure which, with my spelling, B-r-o-u-n. But anyway, Dr. Majumdar is Director of Advanced Research Projects Agency—Energy for the U.S. Department of Energy. The Honorable Gregory Friedman, Inspector General of the U.S. Department of Energy, and Mr. Frank Rusco, the Director of the Energy and Science team at the U.S. Government Accountability Office.

As our witnesses should know, spoken testimony is limited to five minutes each. I am not going to be real hard on that, as I mentioned to you all before, if you need a few extra moments, I will give you a little leeway. But if you could keep it to five minutes if possible, but I don't want to short-change you, either.

After those five minutes, of course, the Members of the Committee will have five minutes each to ask questions. Your written testimony will be included in the record of the hearing.

It is the practice of the Subcommittee on Investigations and Oversight to receive testimony under oath. Do any of you have objections to taking an oath? Let the record reflect that all witnesses were willing to take an oath by shaking their heads side to side in a negative manner.

If all of you would please stand and raise your right hand. Do you solemnly swear or affirm to tell the whole truth and nothing but the truth, so help you God? Let the record reflect that all witnesses participating have taken the oath and said, "I do."

Now, I recognize our first witness, Dr. Majumdar.

STATEMENT OF DR. ARUN MAJUMDAR, DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY—ENERGY, U.S. DEPARTMENT OF ENERGY

Dr. MAJUMDAR. Mr. Chairman, Ranking Member Tonko, Chairman Hall and the esteemed Members of this Subcommittee, I want to thank you for inviting me to testify on behalf of the Advanced

Research Projects Agency for Energy, or ARPA–E, about recent R&D activities, a recent report by the U.S. Government Accountability Office, GAO, and a report released in August 2011 by the U.S. Department of Energy's Office of Inspector General, IG.

I am here to report to you on ARPA–E's activities and challenges. ARPA–E, which this Committee was integral in creating, is modeled after DARPA, which helped catalyze innovations such as the Internet, GPS, stealth technology, and many others. These innovations not only strengthened our national security but also economic prosperity by creating entirely new industries. ARPA–E's goal is to catalyze similar quantum leaps in energy technologies, ones that are too risky for the private sector, and those that have the potential to create entirely new industries.

Today, we import roughly 50 percent of the oil we use from other nations, many who don't share our values, and we pay approximately $1 billion a day. This is a national security problem as well as an economic prosperity one. If we keep importing oil and pay like business as usual, we will put our children's and grandchildren's future at risk. A secure future is like a stool with three legs—national security, economic security, and environmental security—and at the foundation of all three securities are innovations in energy technologies.

ARPA–E funds high-risk research projects focused on early-stage breakthrough energy technologies by a competitive process. Some examples, batteries that will make electric cars have a longer range and be cheaper than gasoline-based cars so that they can be sold without subsidies; entirely new ways of making biofuels using microbes that do not use sunlight but rather use electricity from nuclear, wind and other sources.

With durations of two to three years, these inherently high-risk projects have the potential to be transformative and create a large economic growth 15 to 20 years from now. ARPA–E does not fund incremental improvements in existing technology but rather funds research that could create new technologies that do not exist today. But if it did, it would make today's technologies obsolete.

As you may know, ARPA–E issued its fourth round of Funding Opportunity Announcements on April 20, 2011, and subsequently announced 60 cutting-edge research projects aimed at dramatically improving how the U.S. produces and uses energy. With over $150 million from our fiscal year 2011 budget, the new ARPA–E projects focus on research for innovative energy technologies, while increasing U.S. competitiveness in rare earth alternatives and breakthroughs in biofuels, thermal storage, grid controls, and power electronics. These projects are located across 25 states, with 50 percent of the projects led by universities, 23 percent by small businesses, 12 percent by large businesses, and 13 percent by national labs, and two percent by non-profits.

We are currently looking at new technologies and innovations in various areas. For example, we are holding a technical workshop in the area of natural gas and its undeveloped, innovative and potentially transformational uses in the transportation sector. We are also gearing up for our third annual ARPA–E Energy Innovation Summit on February 27th to 29th, which will feature many of the country's energy thought leaders such as Bill Gates, Fred Smith,

Lee Scott, Ursula Burns and Susan Hockfield. I invite you to join us at the summit and witness for yourself our Nation's energy innovation ecosystem.

To be globally competitive, speed is of the essence. ARPA–E has developed a streamlined process so it can execute with a fierce sense of urgency and unprecedented speed and efficiency. Being vigilant stewards of taxpayer dollars is a critical component of ARPA–E's DNA. All projects will be selected purely based on merit, based on a panel of experts. Once selected, ARPA–E Program Directors are personally invested in every project they manage to help them overcome technical barriers. But if a technology does not work and a project cannot reach its go/no-go milestones, ARPA–E discontinues the projects before the end of the day rather than waste taxpayer dollars.

I would like to express my thanks to the DOE Inspector General and the GAO for their total reviews and final recommendation, all of which have been accepted and implemented by ARPA–E. ARPA–E is committed to continuously improving its operations so as to better fulfill its statutory mission of enhancing our Nation's economic and energy security and maintaining the U.S.'s technological lead in the development and deployment of advanced energy technologies.

I would also like to thank the IG and the GAO for safeguarding the sensitive proprietary information of ARPA–E applicants and awardees. Maintaining the confidentiality of this information was promised in the competitive selection process. It is critical to attracting the best ideas and talent in future funding competitions and maintains the competitiveness of a performance in domestic and foreign markets.

Thank you again for your time, and I look forward to answering your questions.

[Statement of Dr. Majumdar follows:]

STATEMENT OF

DR. ARUN MAJUMDAR

DIRECTOR
ADVANCED RESEARCH PROJECTS AGENCY-ENERGY
U.S. DEPARTMENT OF ENERGY

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

JANUARY 24, 2012

Mr. Chairman, Ranking Member Tonko, and the esteemed Members of this Subcommittee, I want to thank you for inviting me to testify on behalf of the Advanced Research Projects Agency-Energy (ARPA-E) about our recent R&D activities, a recent report by the U.S. Government Accountability Office (GAO), and a report released in August 2011 by the U.S. Department of Energy Office of Inspector General (IG).

I am here to report to you on ARPA-E's activities and challenges. ARPA-E, which this Committee was integral in creating, is modeled after DARPA, which helped catalyze innovations for the Defense Department, such as the Internet, GPS, stealth-type technology, and many others. These innovations not only strengthened our national security but also our economic prosperity.

Today, we import a significant amount of the oil we use. Our children's and grandchildren's security is at stake, and that secure future is like a stool with three legs: national security, economic security, and environmental security. At the foundation of all three securities are innovations in energy technologies.

As you know, ARPA-E focuses exclusively on breakthrough energy technologies that promise genuine transformation in the ways we generate, store, distribute and utilize energy. ARPA-E looks to high impact research projects that the private sector is unlikely to invest in, but, if successful, could create the foundation for entirely new industries. As you may know, ARPA-E issued its fourth round of Funding Opportunity Announcements (FOAs) on April 20, 2011 and subsequently announced 60 cutting-edge research projects aimed at dramatically improving how the U.S. produces and uses energy. With over $150 million from the Fiscal Year 2011 budget, the new ARPA-E projects focus on research on innovative energy technologies while increasing America's competitiveness in rare earth alternatives and breakthroughs in biofuels, thermal storage, grid controls, and solar power electronics. The projects selected are located across 25 states, with 50% of projects led by universities, 23% by small businesses, 12% by large businesses, 13% by national labs, and 2% by non-profits.

We are currently looking at new technologies and innovations in various areas. For example, we are holding technical workshops in the area of natural gas and its undeveloped, innovative, and

potentially transformational uses in the transportation sector. We are also gearing up for our third annual ARPA-E Energy Innovation Summit on February 27th-29th that will feature many of the country's energy thought leaders.

In implementing this program, which as you know had to be built from the ground up in the last three years, we have been grateful to have the assistance of overseers such as the Inspector General of DOE and the GAO. As we have ramped up our organization it is critical to have an outside perspective to be sure that our systems are being set up correctly and to identify areas where we can improve them to further minimize the occurrence of waste, fraud, and abuse. I am pleased to be joined by representatives from the DOE IG office and the GAO, and I would like to let you know how ARPA-E has responded to their oversight.

GAO

With regard to the GAO report, ARPA-E agrees with the GAO's finding that "most ARPA-E projects could not have been funded solely by private investors" and "venture capitalist[s] generally do not fund projects that ARPA-E looks to fund." GAO's review suggests that most ARPA-E projects could not and would not have been funded solely by private investors. Private venture capital firms told GAO that, among other considerations, they generally do not fund projects that rely on unproven technologies and tend to invest in projects that can be commercialized in less than 3 years. Importantly, GAO did not identify a single instance in which private investors would have funded an ARPA-E project within the same, accelerated timeframe (i.e. 3 years or less). This demonstrates that selected projects were appropriate and fulfilled a critical criterion and objective of the agency.

GAO notes on the cover page of the report that it identified "18 out of 121 award winners through ARPA-E's first three funding rounds that had received some prior private sector investment." This is not inconsistent with ARPA-E's mission to fund innovative ideas, and I would like to highlight GAO's findings with respect to those 18 award winners, which are found in Appendix IV to the Report:

- ARPA-E enabled about two-thirds of the 18 award winners "to develop prototypes or to prove basic technology concepts on more advanced ideas than their prior work."

- 7 of the 18 award winners received funding for "completely new research."
- 6 of the 18 award winners received funding for "major advancements to prior research."

➢ ARPA-E enabled some of the awardees "to work on projects with outstanding scientific research questions which private investors would not have allowed."

➢ ARPA-E significantly accelerated the research and development timeframe for 5 of the 18 award winners.

ARPA-E also agrees with the GAO's finding that "ARPA-E officials have taken steps to coordinate with other Department of Energy offices in advance of awarding funds." ARPA-E actively engages with other DOE office and programs, federal agencies, national laboratories, industry, and academia to identify "white space" where a strategic infusion of funding would catalyze the development and deployment of transformational and disruptive energy technologies. ARPA-E uses world-class experts from government, industry, and academia to evaluate applications and assess the technical progress of its projects. In addition, ARPA-E participates in intra- and inter-departmental initiatives focused upon specific technology areas.

With regard to the three recommendations in the GAO report, ARPA-E has these comments:

- First, the report recommended that ARPA-E provide guidance with a sample to assist applicants in providing information on sources of private funding for proposed ARPA-E projects. ARPA-E will include a sample response in future funding opportunity announcements (FOAs) in order to assist applicants in providing information on sources of private funding for proposed ARPA-E projects.
- Second, the report recommended requiring that applicants provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E. In future FOAs, ARPA-E will require applicants to explain why investors would not be willing to fund the projects proposed to ARPA-E and to include documentation of previous attempts to secure private funding if available.
- Third, the GAO report recommended using venture capital funding databases to help identify applicants with prior private investors and to help check information applicants provide on their applications. In the future, ARPA-E will make use of publicly available

information such as venture capital funding databases to help verify information provided by applicants in their applications.

IG

Concerning the IG report, ARPA-E is pleased to report that it has finalized the three policies referenced in the IG report. Specifically, ARPA-E has finalized its policies for the monitoring and oversight of awardees, allowable technology transfer and outreach activities expenses, and the process for project termination. ARPA-E also worked directly with the Department's Offices of Headquarters, Procurement, and General Counsel on various aspects of these policies, as recommended by the IG.

The DOE IG report questioned approximately $40,000 in direct costs under two ARPA-E awards. Subsequently, DOE's Contracting Officer performed a thorough analysis of the questioned costs and found that 98% of the costs were allowable as "technology transfer and outreach" costs, consistent with ARPA-E's statutory requirement to spend 5% of appropriated funds on "technology transfer and outreach" activities.

Of the remainder (approximately $1,700), ARPA-E had already denied some of the costs, and it has recovered the balance from the recipients on the rest.

I should note that when working with performers, ARPA-E reimburses only expenditures that are allowable under the Federal Acquisition Regulation (FAR). ARPA-E communicates directly with individual performers regarding any unallowable costs in an invoice and reviews invoices in accordance with its statutory mandate and the FAR.

Thank you again for your time, and I look forward to your questions.

Chairman BROUN. Thank you, Doctor. Our next witness is Mr. Friedman. Mr. Friedman, you are recognized for five minutes.

STATEMENT OF HON. GREGORY FRIEDMAN, INSPECTOR GENERAL, U.S. DEPARTMENT OF ENERGY

Mr. FRIEDMAN. Thank you, Mr. Chairman. Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to testify at your request on the work of the Office of Inspector General concerning the Department of Energy's Advanced Research Projects Agency, commonly referred to as ARPA–E. Specifically, as requested by the Subcommittee, my testimony today will focus on our August 2011 audit report.

ARPA–E, as has been noted previously, was created to enhance domestic economic and energy security by funding high-risk, high-payoff energy technology research and development. As of January 17, 2012, according to department data, it had approved 153 projects valued at about $448 million. Of this amount, approximately $220 million has been expended.

The purpose of our audit was to evaluate ARPA–E's program implementation and its stewardship of taxpayer-provided resources. Our review revealed that ARPA–E generally had effective systems in place to make research awards and to deploy Recovery Act resources. Of particular note, we found that ARPA–E, despite being a relatively new program, had developed and implemented research proposal selection criteria designed to make certain that awards were consistent with its mission objectives.

We did, however, identify several opportunities to enhance safeguards over program execution activities and funding. At the time of our review, ARPA–E had not fully implemented policies and procedures to ensure that first, technology transfer and outreach activity expenditure goals were met and that such costs were effectively tracked and verified; second, that awardee activities were effectively monitored and that recipient requests for reimbursement were properly reviewed; and finally, ARPA–E had not established formal procedures for determining whether to continue or terminate projects that were not meeting program objectives.

Based on the interim results of our audit, ARPA–E surveyed award recipients about their technology transfer and outreach activities and expenditures. Recipients reported that they have spent an estimated $15.3 million on such activities which allowed program officials to conclude that ARPA–E had exceeded the 2.5 percent spending requirement established in law.

To address this matter on an ongoing basis, ARPA–E established a requirement that recipient expenditures reflect at least the minimum required amount and that such expenditures be tracked and reported.

We also identified potentially unallowable costs that had been incurred by a small business recipient. At this small business, which was awarded approximately $5.8 million in ARPA–E funding, $1.2 million of which had been incurred at the time of our audit, we identified almost $40,000 in questionable direct costs. Responding to our finding, the responsible contracting officer, as had been mentioned earlier, concluded that virtually all of the direct costs were

allowable because, in his judgment, they fell under the broad category of technology transfer activities.

Further, this same recipient did not have support for its indirect cost rate. As such, we questioned the total indirect costs of $239,000 claimed by the recipient as of June 30, 2010. In response to our finding, program officials requested a review of the recipient's indirect cost rate.

APRA–E's response to our report was favorable. ARPA–E took specific steps to address several of the issues we raised during the course of the audit. For example, policies governing monitoring and oversight, invoice review, and those related to terminating non-performing awards had been finalized. Further, ARPA–E officials told us that it had taken action to better define allowable technology transfer costs, and it implemented a process to measure progress in meeting spending goals in this area.

We will continue to monitor ARPA–E's activities as part of our normal risk assessment process. I would like to point out that the Office of Inspector General recently issued a Lessons Learned Report based on our body of work covering the department's efforts under the Recovery Act, a major source of ARPA–E support. Our report, based on over 70 audits and inspections, along with a number of investigations, identifies several best practices, which if fully implemented, in our judgment, should help ARPA–E and the Department enhance overall program execution.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions that you or the Members of the Subcommittee may have.

[Statement of Mr. Friedman follows:]

Statement of Gregory H. Friedman

Inspector General

U.S. Department of Energy

Before the

Subcommittee on Investigations and Oversight,

Committee on Science, Space, and Technology

U.S. House of Representatives

FOR RELEASE ON DELIVERY
2:00 PM
January 24, 2012

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to testify at your request on the work of the Office of Inspector General concerning the Department of Energy's Advanced Research Projects Agency – Energy (ARPA-E). Specifically, as requested by the Subcommittee, my testimony today will focus on our August 2011 audit report on the Program (OAS-RA-11-11, August 25, 2011). ARPA-E was created to enhance domestic economic and energy security by funding high-risk, high-payoff energy technology research and development projects. A key element of this concept involves transferring developed technologies to the marketplace.

While ARPA-E was authorized in 2007 as part of the America COMPETES Act, it did not begin operations until 2009, when the Omnibus Appropriations Act provided an initial $15 million in funding. The American Recovery and Reinvestment Act of 2009 provided an additional $400 million to ARPA-E. In addition to the Recovery Act funding, the program received $180 million in Fiscal Year 2011 and $275 million in Fiscal Year 2012.

ARPA-E has issued a number of funding opportunity announcements that targeted specific technology research areas, such as obtaining fuel from plants, providing more efficient cooling for buildings, and carbon capture technologies. As of January 17, 2012, according to Department data, it had approved 153 projects valued at about $448 million. Of this amount, approximately $220 million has been expended.

Office of Inspector General Oversight

The purpose of our audit was to evaluate ARPA-E's program implementation and its stewardship of taxpayer-provided resources. Our review revealed that ARPA-E generally had effective systems in place to make research awards and to deploy Recovery Act resources. Of particular note, we found that ARPA-E, despite being a relatively new program, had developed and implemented research proposal selection criteria designed to make certain that awards were consistent with its mission objectives.

We did, however, identify several opportunities to enhance safeguards over program execution activities and funding. Specifically, we found that policies and procedures had not been implemented in certain areas nor were necessary controls in place to ensure that technology transfer spending objectives were met. ARPA-E took action to address several of the issues we raised when brought to their attention during the audit. Further, subsequent to the issuance of our report, action plans have been developed in response to a number of our recommendations.

Policies and Procedures

At the time of our review, ARPA-E had not fully implemented policies and procedures to ensure that:

- Technology transfer and outreach activity expenditure goals were met and that such costs were effectively tracked and verified. In this regard, ARPA-E had not provided recipients with guidance regarding budgeting for and tracking of expenditures, and the allowability of such costs;
- Awardee activities were effectively monitored and that recipient requests for reimbursement were properly reviewed. ARPA-E appropriately focused on technical performance during

periodic site visits of awardees. However, we noted that business aspects of the award, including recipient control over costs, were not emphasized as part of regular oversight activities.

Further, ARPA-E had not established formal procedures for determining whether to continue or terminate projects that were not meeting objectives nor was it clear who had the authority and responsibility to make such determinations.

Technology Transfer and Outreach

ARPA-E was required by statute to spend 2.5 percent of its funding on technology transfer and outreach activities.[1] These activities are a means through which ARPA-E was to achieve its goal of ensuring that the United States, working with the commercial sector, maintains a lead in deploying advanced energy technologies.

In implementing these requirements, the program considered technology transfer and outreach to be an integral part of each recipient's activities. In addition to an in-house commercialization effort, ARPA-E expected that recipients would engage in technology transfer activities and, as a result, would incur related costs. In this regard, ARPA-E decided to include such recipient expenditures when measuring overall program progress in meeting the 2.5 percent threshold. However, in implementing this approach, the Department had not adopted a system to ensure or verify that awardees were meeting technology transfer and outreach requirements. ARPA-E, in its formal agreements, had not required recipients to meet specific spending levels nor had it required that they track and report such expenditures to the Department.

[1] This requirement was subsequently increased to 5 percent with the enactment of the America COMPETES Reauthorization Act of 2010.

In response to our concerns, ARPA-E surveyed award recipients about their technology transfer and outreach activities and expenditures. According to the responses, recipients reported that they had spent an estimated $15.3 million on such activities. As a result, program officials concluded that ARPA-E had exceeded the 2.5 percent spending requirement. In response to our audit, ARPA-E established a requirement that recipient expenditures on technology transfer reflect at least the minimum amount required by the America COMPETES Reauthorization Act and that their expenditures be tracked and reported.

Allowable Costs

During our review, we also identified potentially unallowable costs that had been incurred by a small business recipient. At this small business, which was awarded approximately $5.8 million in ARPA-E funding, $1.2 million of which had been incurred at the time of our audit, we identified $39,992 in questionable direct costs. Responding to our finding, the responsible contracting officer concluded that virtually all of the direct costs were allowable because, in his judgment, they fell under the broad category of technology and outreach activities.

Separately, we noted that this recipient also did not have support for its indirect cost rate. Rather, it was using the rate of an affiliated firm, a rate that had not been reviewed by an independent party as required. As such, we questioned the total indirect costs of $239,497 claimed by the recipient as of June 30, 2010. In response to our finding, program officials requested a review of the recipient's indirect cost rate.

ARPA-E Response and Actions

APRA-E's response to our report was favorable and management indicated that it was committed to improving its operations. In fact, as noted, corrective actions had been taken to address several

concerns during the course of our audit. For example, policies governing monitoring and oversight, invoice review, and those related to terminating non-performing awards had been finalized. Additionally, management implemented a number of other improvements, including the deployment of a web-based project management system to facilitate the monitoring and oversight of awardees. Further, ARPA-E officials told us that it had taken action to better define allowable technology transfer and outreach costs and implemented a process to measure progress in meeting spending goals in this area.

Path Forward

ARPA-E is a relatively new, yet very important Department of Energy initiative. As such, we will continue to monitor its activities as part of our normal risk assessment process. In addition, the Office of Inspector General recently issued a Special Report on "Lessons Learned/Best Practices during the Department of Energy's Implementation of the American Recovery and Reinvestment Act of 2009" (OAS-RA-12-03, January 18, 2012), which is based on our extensive body of work covering the Department's efforts under the Recovery Act, a major source of ARPA-E support. Our report, based on over 70 audits and inspections, along with a number of investigations, identifies several best practices, which if fully implemented, should help ARPA-E and the Department at-large enhance overall program execution.[2]

Mr. Chairman, this concludes my statement and I would be pleased to answer any questions that the Subcommittee may have.

[2] A full listing of our Recovery Act-related reviews is available at: http://energy.gov/ig/calendar-year-reports/recovery-act/recovery-act-reports.

Chairman BROUN. Thank you, Mr. Friedman. I next recognize our next witness, Mr. Rusco. You are recognized for five minutes, sir.

STATEMENT OF MR. FRANK RUSCO, DIRECTOR, ENERGY AND SCIENCE ISSUES, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. RUSCO. Thank you. Mr. Chairman, Ranking Member Tonko and Members of the Subcommittee. I am happy to speak today about GAO's work on ARPA–E. At the request of this Committee, GAO undertook an evaluation of ARPA–E to examine, one, the Agency's use of criteria and other considerations for making awards, including applicants' identification of past private-sector funding; two, the extent to which ARPA–E projects could have been funded by the private sector; and three, the extent to which ARPA–E coordinates with other DOE offices to avoid duplication of efforts. At this hearing, the resulting GAO report is being released, and I will speak briefly about our key findings. In reviewing applications and selecting awardees, ARPA–E uses four key criteria. These include an assessment of the potential impact of the proposed technology; the project's overall scientific merit; the applicant's qualifications, experience and capabilities; and the quality of the applicant's management plan.

In addition, ARPA–E program directors take other things into consideration, including the transformative nature of projects and the likelihood that the project could be funded by the private sector.

ARPA–E program directors also assist successful applicants in shaping projects and management plans to focus on transformational energy technologies and to increase the chances of success. With regard to the extent to which ARPA–E type projects could have been funded privately, it is impossible to know with certainty whether or not any individual project could be solely funded by private sources. However, based upon a wide range of evidence, we concluded that it is unlikely that most ARPA–E projects could have been solely financed by the private sector.

We did find that 18 of 121, or 15 percent of applicants given awards in ARPA–E's first three rounds of funding, had previously received some venture capital funding. It is important to note that some of the applicants also would have had other forms of funding that were not visible to us in the course of our audit. So any successful company engaged in this will have some source of private funding likely or other university funding. But we found 18 that had venture capital funding, and that was available for us to review.

Of these projects funded by ARPA–E that had received previous venture capital funding, the projects differed from what had been previously funded by the venture capital. In most cases, the differences were technological. Either the ARPA–E projects were fundamentally different than projects that had received prior funding or were related but more challenging or transformational in nature. And for five of the projects, they were quite similar to what had been previously funded, but the ARPA–E funding allowed them to

speed up their research significantly over what was possible with private funding alone.

Our overall conclusion was based on the result of interviews with ARPA–E program directors, six venture capitalists and ARPA–E applicants and awardees including the 18 that had previously received private funding. All of these sources provided evidence consistent with the conclusion that the specific projects funded by ARPA–E would not have been funded solely by the private sector.

Finally, we found that ARPA–E program directors and other staff take steps to coordinate with other DOE program offices before making funding announcements to try to identify funding gaps. ARPA–E program directors also use officials from other DOE offices and from the Department of Defense to assist in reviewing ARPA–E applications. These efforts to communicate with and coordinate with other members of federal research and development programs may reduce the potential for overlap in funding.

While we found it unlikely that most ARPA–E projects could have been solely funded by the private sector, we also found that ARPA–E could improve its approach to collecting and evaluating information about applicants' past private funding. Specifically, while ARPA–E directors were generally aware of prior funding and applicants were required to provide such information, we found that most applicants did not initially adequately identify prior funding or explain why their projects could not be solely funded by the private sector. As a result, in order for program directors to evaluate private-sector funding, the directors had to ask for supplemental information from those applicants.

To improve the efficiency of the application review process and the quality of information about private funding, we recommended that ARPA–E provide guidance to applicants, including a sample response. We also recommended that ARPA–E require applicants that had previously received private-sector funding to provide letters from investors or other documentation with their applications that explained why investors are not willing to fund applicants' projects.

Finally, we recommended that ARPA–E use venture capital funding databases to help identify applicants that had received private-sector funding and to verify information provided by applicants. ARPA–E concurred with our findings and recommendations.

Thank you. This concludes my prepared statement. I will be happy to answer any questions you may have.

[The prepared statement of Mr. Rusco follows:]

United States Government Accountability Office

GAO

Testimony

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DEPARTMENT OF ENERGY

Advanced Research Projects Agency-Energy Could Improve Its Collection of Information from Applicants

Statement of Frank Rusco, Director
Natural Resources and Environment

U.S. Government Accountability Office
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ACCOUNTABILITY * INTEGRITY * RELIABILITY

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Chairman Broun, Ranking Member Tonko, and Members of the Subcommittee:

I am pleased to be here today to discuss our work on the Department of Energy's (DOE) Advanced Research Projects Agency-Energy (ARPA-E). As you know, in 2007, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (America COMPETES) Act established ARPA-E within DOE to overcome the long-term and high-risk technological barriers in the development of energy technologies.[1] ARPA-E borrows from the model of the Defense Advanced Research Projects Agency (DARPA), an agency created within the Department of Defense (DOD) in 1958 to direct and perform advanced research and development projects.

Since first receiving an appropriation in 2009 in the American Recovery and Reinvestment Act of 2009, ARPA-E has awarded $521.7 million to universities, public and private companies, and national laboratories to fund 181 projects that attempt to make transformational—rather than incremental—advances to a variety of energy technologies, including high-energy batteries and renewable fuels.[2] Award winners must meet cost share requirements, through either in-kind contributions or outside funding sources.[3]

ARPA-E is required by statute to achieve its goals through energy technology projects that, among other things, accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty. At the same time, the Director of ARPA-E is required to ensure, to the maximum extent practicable, that ARPA-E's activities are coordinated with, and do not

[1]Pub. L. No. 110-69, § 5012 (2007).

[2]ARPA-E has released a total of four funding announcements—meaning the agency was accepting project proposals for a set period of time—in April 2009, December 2009, March 2010, and April 2011. ARPA-E generally uses cooperative agreements to make funding awards, which involve the transfer of a thing of value to the recipient to carry out a public purpose authorized by law. Cooperative agreements differ from grants because substantial involvement is expected between ARPA-E and the recipient.

[3]The cost share requirement for award winners is generally at least 20 percent of total allowable costs, although under section 988(b)(3) of the Energy Policy Act of 2005, ARPA-E has reduced the cost share requirement for certain applicants, such as universities, to 5 percent or 10 percent for all of the funding rounds except the first. Award winners' cost share must be provided by a nonfederal source.

duplicate the efforts of, programs and laboratories within DOE and other relevant research agencies.

My testimony today focuses on the key findings and recommendations from a GAO report on ARPA-E being released today by the subcommittee.[4] For that work, you asked us to examine (1) ARPA-E's use of criteria and other considerations for making awards and the extent to which applicants identify and explain other private funding information, (2) the extent to which ARPA-E-type projects could have been funded through the private sector, and (3) the extent to which ARPA-E coordinates with other DOE program offices to avoid duplicating efforts.

We conducted this work in accordance with generally accepted government auditing standards. More detailed information on the scope and methodology from this work on which this testimony is based can be found in appendix I of the report.

In summary, the agency uses several selection criteria in making awards though its requirements for information on private sector funding could be improved. Also, our review suggests that most ARPA-E projects could not have been funded solely by the private sector. Finally, ARPA-E officials have taken steps to coordinate with other DOE offices to avoid duplication.

- ARPA-E uses four selection criteria—the impact of the proposed technology relative to the state of the art; the overall scientific and technical merit of the proposal; the qualifications, experience, and capabilities of the applicant; and the quality of the proposed management plan—in awarding funds. ARPA-E's eight program directors, who are generally scientists and engineers, create and manage funding programs for the agency and apply these selection criteria when reviewing applications. Of the 20 applications we reviewed for award selection criteria, all contained supporting information addressing the agency's four criteria. In addition to applying its four criteria, ARPA-E gives program directors discretion to use additional considerations to award funds to projects, including whether ARPA-E applicants received private funding. Identification in applications of sources of private funding and the extent to

[4]GAO, *Department of Energy: Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding*, GAO-12-112 (Washington, D.C.; Jan. 13, 2012).

which that funding might support the proposed projects can help provide program directors with assurance that ARPA-E funds do not overlap with private investment. We identified 18 out of 121 award winners through ARPA-E's first three funding rounds that had received some prior private sector investment, and ARPA-E took steps to identify and understand how this funding was related to proposed projects. During the first two funding rounds, ARPA-E required that applicants identify relevant private investors if the applicant believed these funds were related to the proposed project. When applicants provided little prior funding information, ARPA-E's program directors spent time and resources to determine the extent of such funding for proposed ARPA-E projects. According to our review of ARPA-E data from the first three rounds of funding, the agency reduced requested award amounts by 5 percent or more on 31 out of 121 projects, for a total of $59 million below total requested award amounts for these rounds.[5] Beginning with the third funding round, ARPA-E began requiring that applicants explain why private investors were not willing to fund proposed projects. However, ARPA-E did not provide applicants with guidance, such as a sample response, to assist them in completing this requirement, and responses were generally limited. Some applicants provided general information about prior research but did not specifically explain why private investors would not support their projects. One applicant included a letter from its venture capital investor to explain why the investor was not willing to fund the work proposed to ARPA-E, an approach the National Institute of Standards and Technology uses as a check in its funding applications for advanced research but that ARPA-E currently does not use. Also, ARPA-E officials said that they have considered but have not used venture capital data to identify applicants with prior private investors. Examining such data allowed us to quickly cross-check applicants' prior private funding.

- Our review suggests that most ARPA-E-type projects could not be funded solely by private investors. This finding is based on our interviews with representatives of venture capital firms and our analysis of subsequent funding received by contingently selected APRA-E applicants—those applicants that met ARPA-E's

[5]ARPA-E can reduce the proposed project scope to fund only what the program directors consider to be the transformational part of the project to avoid funding applied research or development work that would be outside ARPA-E's program goals.

selection criteria but were not selected for an award.[6] The representatives we spoke with from six venture capital firms indicated that they generally do not fund the types of projects that ARPA-E looks to fund for three reasons.

- First, venture capital firms generally do not fund projects that rely on unproven technological concepts or lack working prototypes demonstrating the technology. Data from ARPA-E on award winners show that 91 out of 121 ARPA-E projects from the first three funding rounds had technological concepts that had not yet been demonstrated in a laboratory setting.[7]
- Second, venture capital firm officials told us that they focused closely on the timeliness of investment returns, with one firm noting that the industry tended to invest in technologies that could be commercialized in less than 3 years and that would potentially exhibit exponential market growth in approximately 5 to 7 years. However, we found that nearly all of the 13 ARPA-E award winners and most of the 22 contingently selected applicants we spoke with estimated that their projects were 3 or more years away from potential commercialization.[8]
- Third, venture capital firms may not be comfortable investing in new energy technologies, noting the historical lack of successful venture capital investments in these types of projects. Venture representatives said that venture firms were more comfortable investing in software companies or other businesses with higher potential profit margins and less costly product development than new energy technologies.

The 18 award winners we identified as having received prior private venture capital told us that with the ARPA-E funding, they were generally able to pursue the development of energy technologies with greater scientific or technical uncertainty

[6]According to ARPA-E officials with whom we spoke, these applicants would have been selected for an award had additional funds been available.

[7]These data showed that most ARPA-E award winners were at or below technology readiness level (TRL) 3. TRL 3 represents a level where potential technologies are still unproven.

[8]On the basis of the initial testing of our questions, we determined that these estimates may be optimistic, given that respondents are invested in attempting to bring a technology to market as soon as possible.

than they had when they were working with their private funding. About two-thirds of these award winners told us that the ARPA-E funding has allowed them to develop prototypes or to prove basic technology concepts on more advanced ideas than their prior work—6 of these award winners said this was for completely new research and 7 said it was for major advancements to prior research. A few of these award winners also told us they were able to work on projects with outstanding scientific research questions that private investors would not have funded. Five of these award winners reported that they would likely have been able to pursue some research similar to their ARPA-E projects, but it would have taken years longer without ARPA-E funding. In addition, officials from two public companies we spoke with that were awarded ARPA-E money told us that although their companies had internal resources devoted to research and development, they were not able to internally fund the projects they proposed to ARPA-E for two following reasons. First, existing product lines placed heavy demands on their internal research and development budgets, and there is continuous pressure from existing customers and competitors to improve existing products. Second, these companies told us that internal investments had to meet minimum investment return thresholds, and that ARPA-E-type projects were not able to meet these thresholds.[9] In addition, we found that few contingently selected applicants found funding from private investors or public sources. Eighteen of the 22 ARPA-E contingently selected applicants we interviewed sought funding after being turned down for ARPA-E funds. Of the 18 that sought funding elsewhere, 13 submitted project proposals to government sources, such as other DOE offices, the National Science Foundation, or nonprofit academic research institutes, and the remaining 5 submitted proposals to private investors such as venture capital firms.[10] As of September 2011, we found that 2 out of the 22 contingently selected applicants secured funding from venture capital firms for work

[9]Officials from one company told us that the rate of return on investment required by its management was at least 20 percent per year.

[10]One of the 5 contingently selected applicants that sought funding from a private investor also sought public funding.

that was very similar to their ARPA-E project proposals.[11] We also found that 4 contingently selected applicants secured funding from a government or nonprofit source for their projects.[12] The 4 contingently selected applicants that secured funding from a government or nonprofit source modified their ARPA-E proposals to be more focused on basic science research, rather than on developing a commercial technology.

- According to ARPA-E officials and documents, agency officials have taken steps to coordinate with other DOE offices in advance of awarding ARPA-E funds to help avoid duplication of efforts. These coordination efforts can be categorized into three areas: (1) prefunding coordination, (2) coordination of application reviews, and (3) participation in official DOE coordination groups. For prefunding coordination, ARPA-E officials told us that program directors engage with officials from related DOE offices in advance of announcing the availability of ARPA-E funds. For example, ARPA-E officials told us that directors use the workshops and other meetings to identify research areas that other DOE offices are not working on, and the other DOE officials provide insights on funding areas where they are not active. For coordination of application reviews, some ARPA-E program directors told us that they have recruited officials from other DOE offices to review applications submitted to ARPA-E and that these officials made up as many as one-third of the reviewers for one director. ARPA-E has also used application reviewers from other federal agencies, such as the Department of Defense. One program director told us that these reviewers have also helped avoid funding projects similar to those potentially funded elsewhere. Finally, ARPA-E is also a participant in official DOE coordination groups. For example, ARPA-E is a participant in DOE's SunShot Initiative within the Solar Energy Technologies Program. The SunShot Initiative is an effort to coordinate solar energy research across DOE's Office of Science, four national laboratories, the

[11]In addition, our review of venture capital funding data for the other 11 contingently selected applicants with whom we did not speak did not show that any had received venture capital funding since not being awarded ARPA-E funds.

[12]Three contingently selected applicants that submitted proposals to government or nonprofit sources were still awaiting responses at the time of our review.

National Science Foundation, and ARPA-E, with the goal of achieving costs of $1 per watt for solar-generated electricity. Additionally, the ARPA-E Director created the Panel of Senior Technical Advisors (PASTA), which is a group of high-level DOE managers that meet periodically to discuss current and future DOE research efforts. ARPA-E officials told us that PASTA is an attempt to avoid duplicating efforts within DOE. PASTA meeting attendees have included officials from DOE's applied and basic science offices. We were not able to directly evaluate the effectiveness of ARPA-E's efforts to coordinate with other DOE offices. Nevertheless, on the basis of our interviews with ARPA-E award winners and contingently selected applicants, we found that 4 award winners and 2 contingently selected applicants had received prior funding from other DOE offices.[13] According to these award winners and contingently selected applicants, the prior funding was either for more proven technologies or was focused on more basic or foundational research than was the ARPA-E funded project.

On the basis of these findings we recommended that ARPA-E:

- provide guidance with a sample response to assist applicants in providing information on sources of private funding for proposed ARPA-E projects,
- require that applicants provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E, and
- use venture capital funding databases to help identify applicants with prior private investors and to help check information applicants provide on their applications.

ARPA-E commented on a draft of the report being released today and concurred with these recommendations.

Chairman Broun, Ranking Member Tonko, and Members of the Subcommittee, this concludes my prepared statement. I would be pleased to respond to any questions that you may have.

[13]These award winners included those in our nonprobability sample of 13, as well as the 18 we identified with VentureDeal data.

GAO Contact and Staff Acknowledgments

For questions about this statement, please contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this statement include Tim Minelli, Assistant Director; Karen Keegan; Rob Marek; and Jeanette Soares. Key contributors for the work that this testimony is based on are listed in appendix V of the report being released today.

Chairman BROUN. Thank you, Mr. Rusco, and I want to thank the whole panel for your all's testimony.

Reminding Members that the Committee rules limit Member questioning to five minutes per round of questions, the Chair at this point will open the round of questions. The Chair recognizes himself for five minutes of questions.

Dr. Majumdar, I want to see if you can help us by clarifying for the Subcommittee what appears to be a point of confusion regarding ARPA–E's philosophy with respect to industry awardees. You have emphasized many times that ARPA–E limits its support to how risk technology, so-called white spaces, that are not being supported by industry or elsewhere in the government. GAO found that this was true with respect to most awards, most as they described it. However, GAO's review as well as other public information indicates many instances where ARPA–E's philosophy appears to instead support acceleration of activities already being undertaken by the private sector.

Let me give you two quick examples. One venture capital-backed company, Phononic, testified before this Committee that it was using ARPA–E funds to accelerate what it was already doing. The Phononic CEO stated that his company's "original projections planned on prototype demonstration and subsequent first market adoptive sales in late 2012 or early 2014, the ARPA–E award coupled with another $1 million in venture financing as part of our cost share allows us to accelerate our development schedule to 2011 instead." GAO paperwork states that another company "said that once the technical development of its first traunch of private financing were met, the second traunch was automatically funded and would have occurred irregardless of whether the company received ARPA–E funding or not."

Those don't sound like high-risk projects in which the private sector is unwilling to invest. Please help reconcile award examples like this with ARPA–E's stated philosophy to limit funding to technology areas too risky for private investment.

Dr. MAJUMDAR. Congressman, thank you for your question. Let me just explain the philosophy of what do I mean by ARPA–E funds projects that are too risky for the private sector. And I have stated this before in many of my hearings, that ARPA–E will fund ideas that have never been funded before by the private sector, not to say that if there are companies that have been funding by the Venture Capital industry or by other private sector, that we will not fund. They may have funded for low-risk ideas for things that will generate revenue in three or four years, which is what the GAO report——

Chairman BROUN. Let me interrupt you just for the sake of time. I have about two minutes left.

GAO has this example where they said all they did is accelerate their funding. Now, that is one example, granted. But it is one example that is out there. And they said that ARPA–E funding just accelerated the production of work that they would have done anyway. Is this an anomaly or is this something that is ongoing or is this something that is pervasive within ARPA–E or what?

Dr. MAJUMDAR. We have never funded any idea that had been funded by the private sector. Since you raised the issue of, you

know, specifically of Phononic Devices, that happens to be my area of research myself. So I can get into gory details on that. But essentially, they are trying to come up with a material which conducts electricity very well but blocks heat. Now, as you know, you take material like copper, it will conduct electricity and heat, and if you take a material like in a diamond, it won't conduct electricity, but will conduct heat. To find a material which conducts electricity but blocks heat is a non-trivial problem, and there is—you know, they are, in a sense, trying to get into a scientific breakthrough that they will translate into a device. But if they could do that, here is—let me just give you a number.

Chairman BROUN. Again, I have 1/4 of a minute, 3/4 of a minute left. I misspoke. That was not GAO. That was the company's CEO that made those statements, and he said the Charles grant just accelerated what they were going to do anyway with private funding all from private sourcing, not something new, something that would be just that they were going to do anyway. You all's grant just helped them to do it in 2011 instead of 2012 or 2013 as they stated.

The point is, and my time has run out, and I will just let this go and you and I can talk later, ARPA–E is supposed to fund projects that the private sector will not and cannot fund. This CEO said that all you did was just accelerate their development, and I think we need to be very cognizant that taxpayer dollars are very scarce. We are in a financial crisis as a Nation, and we need to make sure that projects that are funded through ARPA–E will not get private funding, cannot get private funding because they are too risky. That is one of the charges of ARPA–E. So we will talk about that later. My time is up. Now I yield to Mr. Tonko for five minutes.

Mr. TONKO. Mr. Rusco, you are releasing your report today?

Mr. RUSCO. Yes, that is correct.

Mr. TONKO. And a report that you spent perhaps the better part of a year in developing. And that I believe was done at the request of Chairman Hall and Chairman Broun?

Mr. RUSCO. Yes.

Mr. TONKO. Can you briefly describe the review steps at GAO for the report to be developed, the interviews, the documents that you collect, and can you do that within the frame of a minute, please?

Mr. RUSCO. Yes. Just briefly, to look at the private-sector funding, we looked at a venture capital funding database to try to identify prior capital that had gone to the companies that had the ARPA–E projects. And then we followed up with both the program directors and with the companies that had gotten the funding to try to determine what the nature of the funding was and how it differed from the projects. And then we also talked to venture capitalists, some of whom were the funders of the ARPA–E projects we looked at.

Mr. TONKO. Well, thank you. And curiously, the staff to the majority did their own report, largely based on your working papers. When did they see your working papers?

Mr. RUSCO. We have had a long back-and-forth with our client's staff throughout this, and I think it has been productive. At the very beginning of the job, they gave us information they would be

working on. And then at the end of the report when we released the report to them but it had not been publically issued, then as per our protocols, they were able to come over and look at our work——

Mr. TONKO. At what point?

Mr. RUSCO. That took place last week.

Mr. TONKO. So last week? So they took about a week to develop their own report? That staff product reaches radically different conclusions, does it not, from those in your report?

Mr. RUSCO. I think that the facts in the Committee report are in our work papers, the ones that——

Mr. TONKO. Right, but the conclusions——

Mr. RUSCO. And I haven't had a chance to look at it very carefully so I can't really speak too much to it. But I think that the difference is that our conclusion is based on a body of evidence that goes beyond those work papers and that——

Mr. TONKO. But are the conclusions——

Mr. RUSCO [continuing]. May be why we interpret things differently.

Mr. TONKO. Would you analyze or characterize those conclusions as being drastically, radically different than yours?

Mr. RUSCO. I wouldn't characterize it as radically different. I think it is a matter of degree. It is sort of like what should the program be doing? We certainly found cases where——

Mr. TONKO. Well, does it live within, is it a conclusion that they live within the context of the statute? Are we misinterpreting statute here to draw a conclusion?

Mr. RUSCO. Well, certainly we would have reported on that had we found that. That was not one of our objectives to interpret the statute, but we always have our general counsel working on reports. We did not find anything that to us looked like the agency was in violation of statute or we would have reported that.

Mr. TONKO. Okay. And did the Republican staff ask you to check on their facts and conclusions?

Mr. RUSCO. Yes.

Mr. TONKO. And when did that come about?

Mr. RUSCO. They sent us a memo on Thursday, last week, and we looked through the facts through our work papers and commented on those.

Mr. TONKO. Well, the report, using your work papers again, finds cases where they allege or imply that a company was getting funding for work from the private sector, even as they took ARPA–E money. They point to ample cases from your work papers to suggest that ARPA–E is simply duplicating work already funded or soon to be funded by private capital or other agencies. I assume you know what is in your work papers. Did you find the kind of overlapping funding in duplication?

Mr. RUSCO. I think our interpretation is different. We did find cases in which companies had received prior private funding, but the projects differed to a large extent or a significant extent from what was funded in the past, and in several instances, five instances, we found that the company said that the ARPA–E funding had enabled them to significantly speed up their research and it was a——

Mr. TONKO. So as we heard already from Dr. Majumdar, there are cases of innovation, of technology transfer and of expediting, moving along, developing the market, transforming the market. So these 18 cases were getting funded for something other than previously being funded?

Mr. RUSCO. Most of them were technologically distinct from what had been previously funded.

Mr. TONKO. Okay. Thank you very much.

Chairman BROUN. Thank you, Mr. Tonko. I want to ask you to put your hatchet down because the report was actually meant to supplement and not to refute the working papers, and in fact, staff have done some extra research on top of that and found other instances where—we just call into question—we just want the same thing that the minority staff and minority members want, this ARPA–E to be successful and utilize taxpayers' dollars in the proper way.

Mr. TONKO. Well, Mr. Chair, if you will——

Chairman BROUN. Certainly.

Mr. TONKO. I think the statute is quite clear about transformational and about speeding up, expediting a process that can transform the market. And I think that it is very clear, the spirit and the letter of the law is very clear that this is to move along in a way that—time is innovation here. Time will determine who comes to the market first. If you can transform the market, I am assuming that is what we all wanted ARPA–E to do, and the statute is very clear. And to misrepresent it or misinterpret it, is just not helping, I think, the effort.

Chairman BROUN. Mr. Tonko, there has never been an allegation that there has been a statutory breach.

Now I recognize the Full Committee Chair, Mr. Hall, for five minutes.

Chairman HALL. Thank you, Mr. Chairman. I have a feeling that maybe ARPA–E is saying that they couldn't spend the money wisely because they had to spend it so quickly. I am not sure I am on solid ground there, but during debate on the *America COMPETES Act* which created ARPA–E, a lot of us were very concerned that the new agency might ultimately reshuffle the budget prioritization for existing DOE offices and de-emphasize the basic science research conducted within the Office of Science.

So given the current budget constraints, where does ARPA–E fit into DOE's priority list? Whoever wants to answer that could.

Dr. MAJUMDAR. I will be happy to answer, as Secretary Chu has said many times in the past that ARPA–E is one of his top priorities. In terms of DOE priorities, Secretary Chu has said ARPA–E is one of his top priorities.

Chairman HALL. Which offices will be reduced funding to provide additional ARPA–E funds if they are special and they set them up on such a high plane?

Dr. MAJUMDAR. Well, I think that, you know—frankly, the budget is decided by Congress. And so——

Chairman HALL. Well, that doesn't help us a hell of a lot. Go ahead.

Dr. MAJUMDAR. So I mean, it is really the budget that is decided by Congress that we execute on. And so with regards to where the

funds go, I think Congress will decide, and we will just execute according to the law.

Chairman HALL. Well, EPA seems to have a way around what Congress says to do. That is not the subject here, though.

Mr. Friedman, the IG report states that in response to the questionable spending by ARPA–E recipients that you identified, an ARPA–E official said that the agency, and I am quoting here, "focused its attention on meeting the Recovery Act requirement of expeditiously awarding funds to projects by September 30, 2010, and as a consequence didn't have sufficient time and resources to devote to establishing its operational controls in the area of policies and procedures." That is the reason I said initially that basically ARPA–E is saying that they couldn't spend the money wisely because they had to spend it so quickly. Is that a fair statement?

Mr. FRIEDMAN. Well, Mr. Hall, I think you are going beyond where I would go. What we clearly have said in the report and what we found was that there were certain mid-point and end-point policies and procedures that had not been formalized. Some of them were in draft, some of them were not. And we were told by people in the program office that their priority going in that because of the rush, because of the pressure they faced with some of the front-end decisions as to how to selection criteria and the rest, so that they were putting the other policies and procedures—sort of they were the second priority.

Chairman HALL. Well, the lack of institutional financial controls seems to indicate the potential that misuse of funds could be much more widespread than that identified in the three awards that the IG reviewed. Do you agree to that?

Mr. FRIEDMAN. Well, not to be too clever, Mr. Hall, I don't know what I don't know. We felt that the three that we selected gave us a fair representation. We looked at the control structure fairly thoroughly. Is it possible in the 100-plus awards that were made that we didn't look at there were problems? Absolutely.

Chairman HALL. Well, I guess it is not too much to ask, if your office will review this spending in more detail as part of your ongoing stimulus oversight. And if we have some questions later to follow up on this, that we are going to ask the Chairman to ask you to answer them within a reasonable amount of time.

Mr. FRIEDMAN. I will do my best.

Chairman HALL. I have some other questions I would like to ask about, Solyndra and many others. But I may get back to that. I may try to handle that by direct letter where you will have plenty of time to sit down and give us your answer to that or that you don't have an answer to it.

I thank you, and I yield back my time.

Chairman BROUN. Thank you, Mr. Chairman. And I now recognize Mr. Miller for five minutes.

Mr. MILLER. Thank you, Mr. Chairman. In the four years that I chaired this Subcommittee, in addition to knocking a hole in the Chairman's podium with the gavel, we also did look at the performance of a lot of agencies within this Committee's jurisdiction. And in a perfect world, agency leadership, the Inspector General would have welcomed the work of the GAO. It was an important oversight tool for Congress. The IG statute contemplates that. It intends for

it to be a management tool for the executive branch as well as an oversight tool for Congress. And GAO and the IGs can make constructive criticism, can actually be helpful in their suggestions.

But it was rarely seen as that by the executives, by the top leadership of the agencies. They always saw it as unwelcomed criticism, not as helpful criticism. And frequently any cooperation was very grudging at best.

Mr. Friedman, Mr. Rusco, what cooperation was there from ARPA–E in your work? Were they cooperative or did they hinder in any way your work?

Mr. FRIEDMAN. Mr. Miller, was that directed to me?

Mr. MILLER. To both of you, yes.

Mr. FRIEDMAN. I must say that in his testimony, when Dr. Majumdar, praised the work of the IG and GAO, I got very nervous. But having said that, we had a very good relationship. It was a productive relationship. As we point out in our report, management took responsive action during the course of our audit when we brought issues to their attention. So I would say it was a productive relationship.

Mr. RUSCO. I would echo that.

Mr. MILLER. Same thing. And in looking at your report, the reports never come back and say they are doing everything perfectly. There are always suggestions for how things might be done differently. But my sense from your report, Mr. Friedman and Mr. Rusco, is that you regard—well, how did you regard ARPA–E's management overall? I know the GAO has kind of a watch list of the most troubled agencies. ARPA–E is not on that. How do you regard the management of ARPA–E overall, having spent some time looking at the program?

Mr. FRIEDMAN. Well, we would point out some shortcomings, and obviously ARPA–E has come back and told us they have made a lot of changes, improvements, corrections, instituted policies that we found lacking at the time. We have not confirmed what they have said. But fundamentally, as I said, Mr. Miller, the relationship was good, and I think it was a productive situation. I must say that I think so far we view it as a fairly positive situation in the Department of Energy family.

Mr. RUSCO. The ARPA–E management has been very responsive to our requests for information. They have also been very responsive to our findings and recommendations. But again, we always evaluate what has happened after the passage of time. So I am hoping they will follow up on these.

Mr. MILLER. Okay. Mr. Majumdar, sorry. Dr. Majumdar, there has been some criticism on this Committee on ARPA–E as crowding out research that the private sector would have done otherwise. But leaders in industry seem to disagree with that, including Bill Gates of Microsoft, Jeff Immelt of GE, Norm Augustine who was the former head, the former CEO of Lockheed-Martin and of course the chair of the Augustine Commission that issued the Rise Above the Gathering Storm report on competitiveness. And they concluded that ARPA–E was in fact funding high-tech, high-risk, long-term investments in clean energy. That would not have happened otherwise. And this is a quote from a letter they wrote. "By nearly

all accounts it appears that ARPA–E is being managed as a highly efficient, risk-taking, results-oriented organization."

Dr. Majumdar, could you compare for us ARPA–E to other government programs that are considering energy issues, and what value does ARPA–E bring to our commitment to invest in clean energy innovation research?

Dr. MAJUMDAR. Well, thank you, Mr. Congressman. I think if you go to the Gathering Storm report that Dr. Augustine and his committee wrote, they felt there was a gap in our energy landscape in the R&D, in the research section of the landscape, where we were doing basic science where, you know, looking for how energy interactions matter, the origins of superconductivity and basically scientific discoveries.

And then we were doing quite applied work, and there was a gap out there of translating basic science understanding into something useful that did not exist before and that was—and they created or they proposed that an agency like ARPA–E be created so that to translate the science into technologies that did not exist before, the first prototype of something that did not exist before, and thereby provide U.S. technological lead and economic and national security, which is what you have enacted under the law, and we are following exactly what was proposed in the law including the accelerating of transformation technology which is in the law. That is exactly what we are doing.

Chairman BROUN. The gentleman's time is expired. I now recognize Mr. Bartlett for five minutes.

Mr. BARTLETT. Thank you, sir, but is there still a Subcommittee Member that hasn't had a chance, time, on the Democrats' side?

Chairman BROUN. Mr. McNerney.

Mr. BARTLETT. I would yield to him. I should come at the end of all your——

Chairman BROUN. Okay. Mr. McNerney, I apologize.

Mr. MCNERNEY. Well, Mr. McNerney thanks the esteemed Member for his time.

I have in front of me what I believe are the Republican objections to the ARPA–E program, first of all, that it funds projects that receive private funding; secondly that it picks winners and losers; and third, that it crowds out private investment. So the first objection, that it funds projects that receive private funding, I think has already been discredited. But just to drive the point home a little bit, I am going to read a section of the statute that I believe is a fitting section and that is Section C.2.2.C, "Accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty." So that, in my mind, doesn't say that private funding is to be excluded from ARPA, and I think that drives that point home.

The objection that ARPA–E crowds out private investment I think was dealt with pretty effectively by my colleague. And the third objection is it picks winners and losers. So Dr. Majumdar, I would like you to address that.

Dr. MAJUMDAR. Well, thank you, Congressman, for the question. Here is what we do in ARPA–E. The process involves identifying a white space as was mentioned before. Let me give you an example. We are looking for those batteries for electric vehicles that will

make the electric cars have a longer range and be cheaper than gasoline cars so that these electric vehicles, so these plug-in hybrid electric vehicles will be cheaper so that you can sell without subsidies. Now, that battery does not exist anywhere in the world, and today's lithium ion battery is not going satisfy that metric. So we said we will go to that white space where no one exists and no one in the world has this battery, and if we develop that battery, the U.S. will get the technological lead then. And that battery has to be double the energy density of today's lithium ion battery and 1/3 the cost.

And so that was a technology agnostic metric that if anyone could meet. And what that created is really the competition. We are not picking winners. We are creating the competition between 15 different types of approaches that we have funded in that portfolio. They are all competing to get to that metric because if they do, and some of them might, we will have the technological lead. And if you manufacture those batteries in the United States, we will have really the economic growth as well. And that is what we are trying to do.

Mr. MCNERNEY. So that is typical of a portfolio is that you fund different organizations to come up with technologies competing with each other and then let the winner decide by the technology?

Dr. MAJUMDAR. We create the competition. We don't pick winners.

Mr. MCNERNEY. Okay. Just to answer what the Chairman of the Full Committee asked, is there any connection whatsoever between ARPA–E and Solyndra?

Dr. MAJUMDAR. Absolutely not.

Mr. MCNERNEY. Can you confirm that, Mr. Friedman?

Mr. FRIEDMAN. Well, I have no indication there is any connection whatsoever. There may be something that I am not aware of. But let me address the Solyndra matter now if I can. As has been publically stated both by the Department of Justice and by my office, there is a criminal investigation ongoing with regard to Solyndra. So it is impossible for me to answer. It could possibly disrupt an ongoing investigation. I know that would not be in the interest of anybody, and therefore, I really can't talk beyond that.

Mr. MCNERNEY. Thank you. Mr. Friedman, also, I would like to ask you what are the similarities and difference between ARPA–E and another program called the SBIR program? Are they both trying to accomplish the same thing? What is the difference in philosophy? Is that something you could answer?

Mr. FRIEDMAN. You know, I really couldn't give you the best answer. Certainly we have done work in the SBIR program, a fair amount of work. We have done work now in ARPA–E. The Department of Energy is a $13 billion a year science department on many different levels using many different programs. So you know, I can't define specifically the differences between them right here and now.

Mr. MCNERNEY. Dr. Majumdar, do you have any idea what the differences are between the two programs?

Dr. MAJUMDAR. Well, I can give you a long answer but I have only 22 seconds. I was, at one point, a former recipient of an SBIR grant for a small company that started in the Bay Area, and basi-

cally, lots of differences. SBIR do not have active program management. We hire some of the smartest people in the technical community to come to ARPA–E and actively manage and help make the decision if something is not working to terminate it to not waste taxpayer dollars.

That does not happen in SBIR. In SBIR, there is Phase One, and there is a gap of six months before you get to Phase Two. In the start-up company there is no cash flow. It will go out of business. And so that doesn't happen in ARPA–E. There are go/no-go milestones, annual milestones, and quarterly reports that people have to submit.

So there are many, many differences. I could go on and on, but I will just limit my answer to that.

Chairman BROUN. The gentleman's time has expired. Sorry. I would like to add, back to—part of the statute it says areas that industry by itself is not likely to undertake. So you can't overlook the not, either, Mr. McNerney and Mr. Tonko, and that is the whole thing. We are not here to be a hatchet job on ARPA–E or anybody else.

Mr. MCNERNEY. Mr. Chairman, it is not likely to undertake by itself.

Chairman BROUN. It says is not likely to undertake, period. It doesn't say by itself.

I now recognize Mr. Bartlett for five minutes.

Mr. BARTLETT. Thank you very much. I believe the—I am told the staff has loaded a couple of slides for me that will I hope kind of put—okay. There they are. We can see them now—kind of put the need for ARPA–E in context.

[Slide]

Mr. BARTLETT. The upper figure here is from '08 from the International Energy Association which is a creature of OECD. I think you would see it on the side screen so you don't have to turn around. And what they are showing there is oil from our wells that we are now pumping. The dark blue at the bottom, you see that we have now reached a peak there.

By the way, we were told that that was going to happen 56 years ago by M. King Hubbard, and 32 years ago in 1980, looking back at 1970 when he predicted the U.S. would peak, we knew with absolute certainty that he was right about the U.S., and therefore he would probably be right about the world.

I want to note a couple things in that slide. Note that the total liquid fuels is about 84 million barrels a day for five years now. Note that they projected by 2030 that the world would be producing 106 barrels of oil per day. Now, just two years later in the slide at the bottom, reality is setting in. They go up to 35 now, not to just 30. And note there the precipitous decline in production in the wells from which we are now pumping oil. And the two curves on top, by the way, are the same thing. They are different colors, and they are flipped around. One is natural gas liquids, and the other is unconventional oil. They are the same things. They are just one on top of the other in different colors.

The dark red wedge on top, which is enhanced oil recovery, in the lower slide is incorporated where it should be in the oil we are

now pumping because that just squeezes a little more out with live steam or CO_2 or something like that down there.

Notice the two huge wedges that they put in there to keep the world from having a reduced production of liquid fuels. They put huge wedges in there of oil that they hope will be produced from fields that we have found, but too tough to develop, like under 7,000 feet of water and 30,000 feet of rock in the Gulf of Mexico.

And then there is a pretty big wedge there that is of fields yet to be discovered. Now, I will tell you with some confidence, that those two wedges will not occur to that degree. They did not occur in our country. We are the most creative, innovative society in the world. We drill more oil wells than all the rest of the world put together. And today we produce half the oil that we did in 1970. Now, if you think that the world is more creative and innovative than the United States, then maybe you think those two wedges are going to happen. They are not going to happen. Your government paid for four studies that said that we were going to be here, two of them issued in '05, two of them issued in '07. Your government didn't like what those studies said, so they just ignored them. The first was the big Hirsch report. In '05, the second was the Corps of Engineers, in '07 two reports. The Government Accountability Office, sir, your office did a report, and the National Petroleum Council. All four reports said essentially the same thing, the peaking of oil is either present or imminent with potentially devastating consequences. The world has never faced a problem like this to quote the Hirsch report, the SAIC report. And the social and economic consequences will be unprecedented is what they said.

You know, the tragedy is that ARPA–E was not here 20 years ago because that is when we needed it. It is now too late because I think that there essentially no chance that the world is going to avoid some enormous geopolitical consequences as a result of the peaking of oil. It is not that we are running out of oil. Don't let anybody tell you that. We are not running out of oil. There is a lot of oil left out there. Half of all the oil that we will ever pump, probably more than half that we will ever pump, is still left out there. What we have run out of is our ability to produce the oil as fast as we would like to use it.

The next slide shows that.

[Slide].

Mr. BARTLETT. There is the next slide. A bit of wishful thinking in this. The bar at the left shows increased production. There is not going to be any increased production. This is wishful thinking. But the bar on the right is not wishful thinking. That is going to be demand. Demand is going up. It is kind of the perfect storm, Mr. Chairman. At just the time we are trying to come out of a recession and just the time that they are developing oil with China and India leading, that is when oil is $100 a barrel, that is just the time that we need more oil and it is not going to be there.

So there is a dire need for ARPA–E. If you could use more money, sir, I would gladly vote to provide it for you. You know, I tell audiences that the innocence and ignorance on matters of energy in the general population is astounding, and we have truly a representative government. Thank you.

Chairman BROUN. I assume you yield back?

Mr. BARTLETT. Mr. Rohrabacher.

Chairman BROUN. Mr. Rohrabacher, you are recognized for five minutes.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman, and I am not as pessimistic as my colleague, but I am certainly in agreement with him that we need——

Dr. BARTLETT. It is realistic, sir.

Mr. ROHRABACHER [continuing]. And that we—realistic. Or maybe I am too optimistic, let us put it that way. But I do believe that no matter how you come down on it, we need to be focusing on developing energy resources and using our brains and our creativity in finding new ways of creating energy, rather than just more traditional ways. And that is what ARPA–E is supposed to be about.

Let me ask about—you know, people mention Solyndra, and everybody, you know, sort of is shaking around and trying to duck. But let me just ask—and again, I am sorry. I always mispronounce your name as well.

Dr. MAJUMDAR. Maybe because it has fallen down.

Mr. ROHRABACHER. Okay, Majumdar. Has the White House, anyone in the White House, ever contacted you regarding a grant that someone had applied for an ARPA–E grant?

Dr. MAJUMDAR. No, never.

Mr. ROHRABACHER. This White House has never contacted you for any of these awards that you are giving? So you don't have any pressure from them at all?

Dr. MAJUMDAR. No.

Mr. ROHRABACHER. Okay. That is good to hear. Obviously—well, I can't say obviously was the case with Solyndra. We will find out. There is a case, for example, where Beacon Power received a $2.8 grant from you, and they also received a $24 million grant from the Office of Electricity from DOE and a $43 million loan guarantee from the DOE, all within a seven-month period. Now, how is it that your organization that is supposed to be aimed at helping people who can't get funding is now helping an organization duplicating the support from two different other entities or two other approaches they are doing for money? How is that?

Dr. MAJUMDAR. Sure. I will be happy to clarify that, Congressman. What they did in the ARPA–E project is they went through a competitive process. They actually went through that process and won this grant, which is not a loan, it is a grant, and this is on energy storage as opposed to power storage. So the one that they got from the Office of Electricity is for power storage which is for frequency regulation. It is short-time power storage with fly wheels.

Mr. ROHRABACHER. Now, I know——

Dr. MAJUMDAR. Our program was designed to look for storing gigawatts of power for an hour. When a wind gust comes in from the west or from anywhere else, you got to store about a gigawatt of electricity for an hour. That is energy. That is not power. And ARPA–E's program was designed to look at the energy storage which is quite different from the power storage. And I can go into——

Mr. ROHRABACHER. I will have to admit to you that not being an expert when a Ph.D. tells me that there is a difference between energy and power, and those of us who are less educated——

Dr. MAJUMDAR. Let me explain.

Mr. ROHRABACHER. It seems rather similar to be—no, it is government money. And by the way, this company happened to go bankrupt after receiving this $70 million of money from the Government.

Dr. MAJUMDAR. The difference between power and energy is like if you have a car, the power comes from your engine, and the energy storage comes from your gas tank, the size of a gas tank. They are different, and so that is what—so what we were funding them for is the energy storage part.

Mr. ROHRABACHER. Well, there are a couple other in this GAO report. There are several other companies that have suggested their names were redacted. But it does look like—it says, "Potentially duplicative funding for essentially the same work. Are these—maybe I should ask our GAO guy. Are we talking about here—and here is another one—name redacted, submitted similar grant proposals to ARPA–E and other agencies, and both proposals were successfully awarded.

Are these just because they are similar, people don't know the difference between energy and power or what have we got here?

Mr. RUSCO. I am sorry. I am not sure exactly what you are referring to. Is that in the committee report or is that in our——

Mr. ROHRABACHER. This is from a GAO work paper notes that one company named redacted. And here is a quote, "Submitted similar grant proposals to ARPA–E and other agencies, and both proposals were successfully awarded." And so you found them to be apparently similar grant proposals.

And then another company by your report, name redacted, explicitly stated that its application, that the proposal was "potentially duplicative funding for essentially the same work statement." Do you know—I can't tell you the company because you eliminated the name there. Oh, excuse me. We redacted the name. I thought this was coming from——

VOICE. It is a summary of their work.

Mr. ROHRABACHER. It is a summary of their work, but I have been recommended — I guess or recommended when they gave me this paper not to read the names of the companies. Perhaps we should let them know what the name of the company is.

Chairman BROUN. The gentleman's time is expired. If one of you want to make a quick answer, I will be glad to accept that or you can present the question, if that is all right with you, Mr. Rohrabacher. If you have a quick answer, please say it.

Mr. RUSCO. Maybe the best way to proceed would be for us to talk to your staff about those things off line since some of the information in our—much of the information in our work papers is business sensitive.

Mr. ROHRABACHER. Well, there are two companies then that you did name and were eliminated from my copy here but——

Chairman BROUN. The gentleman's time is expired.

Mr. ROHRABACHER. Sorry about that. We are going to go to a second round of questions. The minority has acquiesced to my sugges-

tions that we go to three minutes per member, and I ask unanimous consent that that be approved, so ordered.

The Chair will recognize himself for three minutes. The IG report notes that in February of 2011, ARPA–E updated its technology transfer and outreach policy that included guidance to awareness on appropriate tech transfer expenditures. But this policy "allows recipients to incur costs that are typically unallowable under the FAR." That is Federal Acquisition Regulations.

At 3:00 p.m. yesterday, ARPA–E provided an updated TTO policy to the Committee. There were several notable differences between the February 2011 policy and the one provided yesterday. Dr. Majumdar, I would like to ask you a few questions about these differences, please, sir. The formal policy explicitly says that the expenditures on the following activities are acceptable uses of awardees' funds: number one, meetings with investors to raise capital; number two, business plan, development and market research; three, expenditures relating to seeking additional funding from the private sector and government agencies; four, marketing and other expenditures relating to promoting an ARPA–E funded technology; and five, commercialization expenditures. The new policy we just received lists examples of both appropriate and inappropriate spending but is silent on all of these activities.

So I would like to ask you to clarify, does ARPA–E allow awardees to spend taxpayer funding on each of these items?

Dr. MAJUMDAR. Well, Congressman, just to give you some general terms, we have basically created this policy in consultation with the Federal Acquisition Regulation. Our contracting officer has decided, has determined, that these are allowable costs under the FAR rules, and if there is something that is unallowable and if the IG—we worked with the IG in the past, some things are unallowable, we go and recover the cost. And so we work together to do that.

And so we are basically following the regulations, Federal Acquisition Regulation, with our contracting office making the determination.

Chairman BROUN. Sir Inspector General, would you agree with that?

Mr. FRIEDMAN. Well, I have not seen the new policy formulation that you apparently received. We haven't had a chance to study it, so I really wouldn't be in a position, Mr. Chairman, to comment on the new policy.

What we found—I should point out that when it comes to cost-incurred audits that we do, we develop questionable costs and make recommendations to the contracting officer. The ultimate decision is that of the contracting officer. We provide advisory reports which we have done, and the contracting officer ultimately decides. That doesn't mean we agree with the contracting officer in every instance, but I would have to see the new policy in this regard.

Chairman BROUN. Very good. My time is just about expired. I will yield it back and yield to Mr. Tonko for three minutes.

Mr. TONKO. Thank you, Mr. Chair. To me, you know, listening to the testimony here today, I come to the conclusion that the IG and the GAO, the two places we turn to for honest evaluations of how programs are doing, both came back from the reviews of

ARPA–E with largely positive reports. They have recommended modifications. It seems as though they have been complied with by ARPA–E folks. It would seem to me that simple fairness would dictate that the Committee acknowledge and congratulate Dr. Majumdar on his accomplishments. I am disappointed that partisanship has sunk to the level where we cannot even come together for such a simple thing as acknowledging when we find a program that seems to be on the right track, encouraging jobs and allowing acceleration and transformation to take hold. I look at the guidelines within the statute which indicates accelerating transformational technological advances in areas that industry by itself is not likely to undertake.

So with that, Dr. Majumdar, I would ask with small companies and start-ups often looking for any support they can get to carry forth with their ideas, I know they look to venture capital and other agencies anywhere they can. How does ARPA–E differ in what it does as compared to other agencies or the private capital market?

Dr. MAJUMDAR. Well, as I explained in the past, what we are looking for are white spaces, and let me just describe what that white space is because it has been referred to several places, are those areas where (a), within, first of all within the Department of Energy, no one else is funding. Secondly, are areas where there are potential for transformative solutions that meet the ARPA–E goals as written in the statute, the U.S. technological lead, reducing our imports, et cetera. Where there is an opportunity for science, new scientific discoveries can be translated into quantum leaps in technologies that will provide the U.S. with a technological lead and potential technological growth down the line. That is the area. And to identify that, we recruit some of the best people from the technical community to bring them in and then work with the technical community and within the DOE and other federal agencies, including the Department of Defense, to identify those white spaces. And that is how we create these areas, and the battery one that I gave earlier was an example of that. I gave the example of creating oil based on microbes that have never been used to make oil before. And these live on electrodes, and they grab electricity and make oil which has never been done ever by anyone in the world before. And that is a completely new pathway of creating oil. And if in the future it becomes successful and scales down in cost and volume, it will create the foundation of an entirely new industry that does not even exist today. That is the kind of research that we are funding right now.

Mr. TONKO. That might be something that the country needs right now. We need that reinforcement if we are going to compete effectively in an innovation economy race around the world. Thank you.

Chairman BROUN. Mr. Tonko, I agree with you. In fact, in my opening statement I congratulated or said that ARPA–E is supporting a lot of projects that are clearly aligned. This is a Committee of Investigation and Oversight. We are not trying to beat up on them. We just have a responsibility to our constituents and taxpayers in this country to make sure that we continue with this very much-needed research. In fact, Dr. Majumdar and I had some

private discussions about some of the things they are doing, and I am very excited about some of the projects that he has undertaken.

I now recognize Mr. Hall for three minutes.

Chairman HALL. Mr. Chairman, I maybe made a few people nervous when I mentioned Solyndra. I didn't really mean any harm to anybody. I just know that it is a good example that we can learn from, and we are going to follow up. And I think it is reason for the nervous situation.

In the wake of Solyndra, I would hope DOE is taking great care to insure such influential political actors are not receiving favored treatment from the Administration, but it is very difficult to follow the money in some of these cases and not be concerned. Dr. Majumdar, wouldn't one of the best ways to avoid such potential cronyism and favored treatment be to avoid funding companies with such extensive private-sector backing in the first place?

Dr. MAJUMDAR. Well, Chairman Hall, I can only speak for ARPA–E, and I think I would say that everything that we do in ARPA–E is based purely on merit. It is based on external panel reviews that we have, of two stages of reviews, and as I said, it is purely based on merit and that is how every single project has been decided and executed on.

Chairman HALL. Well, let me ask you this. How often were officials from the White House were in touch with you? They weren't in touch with you or your team or people under you regarding specific ARPA–E awards. Would you answer that for me?

Dr. MAJUMDAR. They have never been in touch with me in terms of actual ARPA–E awards before the selection.

Chairman HALL. You have said that before. Anyone with your team under you?

Dr. MAJUMDAR. No one has been in touch—no one from the White House has been touch with anyone in ARPA–E with regards to selection.

Chairman HALL. Okay. Did anyone connected to the White House or entities concerned with the presidential elections contact you or your staff regarding any ARPA–E applicants prior to the award to them?

Dr. MAJUMDAR. No.

Chairman HALL. All right. I thank you.

Chairman BROUN. Thank you, Mr. Chairman. Now I recognize Mr. Miller for three minutes.

Mr. MILLER. Thank you, Mr. Chairman. There have been a lot of questions about some research getting funding from more than one source within the Federal Government. It is almost an implication that that research is getting more than is needed and they are pocketing the rest, like Mel Brooks' movie, "The Producers." My impression is that all that money is actually being spent on the research in those cases, but how do you account for some research getting funding from more than one source and what steps are you taking to make sure there is not, in fact, duplicative funding of the same kind of research by different parts of the Federal Government?

Dr. MAJUMDAR. Well, Mr. Congressman, let me just give you my own background. I have been a scientist and an engineer for the last 22 years in the research community. I have received funding

from many of the federal agencies out here. In fact, my group was, I would say, fairly successful where I had funding from the NIH, funding from NSF, from the Office of Naval Research, et cetera. So my group had funding from multiple sources. But we had to make clear, absolutely crystal clear, that they were for different projects. And so that is exactly what we are following right now, that if ARPA–E is providing funding for anything and if that particular group has received funding from somewhere else, our job is to make sure that the ARPA–E funding is distinct and it is unique for that particular project only. And that is what we have followed, and you know, the records would show that.

Mr. MILLER. Do you have any procedures to make sure that there is not overlapping funding for the same kind of research, that it is in fact distinct funding?

Dr. MAJUMDAR. Yes, we do, and I think I would like to acknowledge the help of the IG in helping us with that. I am sorry, the GAO in helping us with that and the IG. And they have made recommendations in making sure that we follow some of the procedures. And those have now been enacted and there are policies in ARPA–E to make sure that we do this in the right way, and we appreciate the help that we have received from them.

Mr. MILLER. Either of you in the little time I have left have any comment on this? You don't have to have a comment on this, you just can have a comment on this.

Mr. FRIEDMAN. Well, Mr. Miller, the uneasiness that—Chairman Hall appears to be bipartisan. We are working on several cases that involve precisely the subjects that you are talking about, but they are at a very early stage, and it would be inappropriate for me to discuss them.

Mr. MILLER. But not involving ARPA–E?

Mr. FRIEDMAN. In one or more cases, ARPA–E's funds are involved, but it does not reflect negatively upon the management of ARPA–E or the Department of Energy.

Mr. MILLER. Okay.

Mr. FRIEDMAN. In other words, people in the science community are not immune from seeking funding from multiple organizations for essentially the same work. That happens, research misconduct cases that we do work, we do have in our inventory.

Mr. MILLER. Okay. My time has expired.

Chairman BROUN. Thank you, Mr. Miller. Dr. Bartlett, we enjoyed your five-minute sermon. I recognize you for another three-minute sermon if you have it geared——

Mr. BARTLETT. Okay. Thank you very much.

Chairman BROUN [continuing]. Up or questions, sir.

Mr. BARTLETT. I would just like to note that in a former life, I worked for the IBM Corporation, Federal Systems Division, and at one time I was performing 14 different grants and contracts. So one entity can solicit money from a number of different sources because there are different projects that you work on.

I would like to ask the members of the family if they know that there is a better prognosticator of energy futures than the IEA? Are you sufficiently familiar with the International Energy Association?

Dr. MAJUMDAR. Yes, sir.

Mr. BARTLETT. Do you know if there is a better energy prognosticator in the world than this group?

Dr. MAJUMDAR. I think they are considered one of the top, you know, agencies to look at energy futures, et cetera.

Dr. BARTLETT. Of the slides that I showed were called the World Energy Outlook. The first one was in '08 where they thought that by 2030 we would be producing 106 million barrels of oil a day. Just two years later, just last year in 2010, they now believe that by 2035, five years late, we would be producing only 96 million barrels of oil a day. And if you look at the crude oil projections, even with those two huge wedges which I do not think have a prayer of being realized, they are flat. The only increase in growth that they have is from natural gas liquids, and those won't be in your gas tank probably because they are propane and butane and things like that, and then unconventional oil that is growing. That is like the tar sands of Alberta, Canada, and we will get a bit more from that.

We really need to—energy is somewhat fungible but not totally. The energy future for electricity is very good. I don't have any problem with their energy future there, more nuclear and wind and solar and microhydro and true geothermal, tapping into the molten core of the earth, we can get about all the electricity that we need.

Our real crisis for the future is going to be liquid fuels, and there is—every 12 days we use a billion barrels of oil. That is about sixth-grade arithmetic. That is not tough, is it? 84 million barrels a day, 12 days, that is about a billion, right? So you see a new find of 10 billion barrels and that is a huge discovery of oil. That will last 120 days. Big deal. We face a huge challenge here, and you know, I am exhilarated by challenges, and this is a huge challenge. It is going to call the best from us to meet this challenge. It is not trivial. And why do you think your government ignored four different studies that essentially the same thing, four organizations I mentioned? They didn't want to hear it so they didn't pay any attention to it. You know, it is sad. Thank you, Mr. Chairman.

Chairman BROUN. The Chairman's time has expired. You don't have anybody on your side. Mr. Rohrabacher, you are recognized for three minutes.

Mr. ROHRABACHER. Thank you very much. Just to go back to the line of questioning they had before, especially about Beacon Power, which, as I mentioned at the end of the last time, it went bankrupt after receiving these $70 million from three different sources, from ARPA–E as well as from the DOE. Our records seem to show that all of this was done to develop a flywheel energy storage technology. Again, I am not educated enough to know the difference between the terms that we were talking about, energy and power, but doesn't the fact that it was all going for flywheel technology seem to indicate that there was duplication? And by the way, just so my colleagues on the other side of the aisle, when we say we are against duplication, it doesn't mean that we are suggesting that someone has pocketed the money. That is absurd. We are suggesting that maybe the money could have been used better somewhere else that wasn't duplicating the money being spent on the research. But you may answer the question.

Dr. MAJUMDAR. Congressman, I am also very concerned—that I share a concern about duplication as well, which is why we coordinate very, very closely with the rest of the DOE and other federal agencies and also look at where the private sector is funding. In this particular case, they went through a competition, they won the award competitively. Right now they are meeting the go/no go milestones that we have put together. They are also meeting——

Mr. ROHRABACHER. They are now meeting it?

Dr. MAJUMDAR. Yeah, and they are also meeting the obligations of the cost share.

Mr. ROHRABACHER. But even after they filed for bankruptcy they are meeting these things?

Dr. MAJUMDAR. Well, it is going through some restructuring, and we are in consultation with the Department of Justice, you know, when we work with them.

Mr. ROHRABACHER. And what factor, how does that play into if someone is asked for a grant, do you check to see if they are not going to go bankrupt before you provide the grant?

Dr. MAJUMDAR. Well, at that time, you know, when we actually gave the grant, we did check at that time. At that time they had not filed for bankruptcy, and you know, then they subsequently did because——

Mr. ROHRABACHER. Well, wouldn't the money be coming back? If a company gets money from ARPA–E and then goes bankrupt, do we get any of the money back as part of the settlement for a company that is going out of business?

Dr. MAJUMDAR. Well, they have not been liquidated, they are being restructured right now.

Mr. ROHRABACHER. Okay.

Dr. MAJUMDAR. So it is not that they are completely gone. They have been restructured, and that is part of the Department of Justice thing. We are not involved in that except to the point that we consult with them in making sure that we are not violating any laws.

Mr. ROHRABACHER. Okay.

Dr. MAJUMDAR. But at the same time, they are meeting the milestones and their cost-share obligations.

Mr. ROHRABACHER. Okay. Well, let me just note for the record that we do have two companies that we do have their names here, but we didn't want to put them forth in this hearing for fear of saying something bad about the company. But we do have two names that were included in the GAO report that said there was duplication. It appeared to be duplication, and if we could get the answer back in writing of why that was not duplicative and the GAO report was inaccurate.

Chairman BROUN. The gentleman's time is expired. I remind Members that we can all submit questions in writing, and I appreciate the witnesses to answer in a timely manner. I think you have two weeks to do so, and we appreciate it. We are going to——

Mr. ROHRABACHER. Mr. Chairman.

Chairman BROUN. Mr. Rohrabacher.

Mr. ROHRABACHER. Whereas our friends on the other side of the aisle have suggested that we have not congratulated them for the good things that they have done, could I please note for the record

that because we ask questions like this does not mean that we do not deeply appreciate the job that you are doing and that of course all of you have done for your country and for the benefit of all of mankind, and so we congratulate you for that, and thank you, and please don't think the tone that we have here does not mean that we don't appreciate the good things.

Dr. MAJUMDAR. Thank you very much to all of you.

Chairman BROUN. I want to associate myself with those remarks, and I am sure all our Democrat friends would also associate. I hope that you all will associate yourself with those remarks.

I thank you all for your valuable testimony and Members for your questions. The Members of the Subcommittee may have additional questions as I have already mentioned, and we do ask you to respond to those in writing. The record will remain open for two weeks for additional comments from Members. The witnesses are excused, and the hearing is now adjourned.

[Whereupon, at 3:40 p.m., the Subcommittee was adjourned.]

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Department of Energy
Washington, DC 20585

July 20, 2012

The Honorable Paul Broun
Chairman
Subcommittee on Investigations and Oversight
Committee on Science, Space, and Technology
U. S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

On January 24, 2012, Dr. Arun Majumdar, Director, Advanced Research Projects Agency-Energy, testified regarding: "A Review of the Advanced Research Projects Agency-Energy (ARPA-E)."

Enclosed are the answers to six questions that you submitted to complete the hearing record.

If we can be of further assistance, please have your staff contact our Congressional Hearing Coordinator, Lillian Owen, at (202) 586-2031.

Sincerely,

Christopher Davis
Deputy Assistant Secretary
for Congressional Affairs
Congressional and Intergovernmental
Affairs

Enclosures

cc: The Honorable Paul D. Tonko, Ranking Member

Printed with soy ink on recycled paper

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

1. *The Inspector General report on ARPA-E notes that, in February 2011, ARPA-E updated its technology transfer and outreach (TTO) policy that included guidance to awardees on appropriate tech transfer expenditures, but that this policy "allows recipients to incur costs that are typically unallowable per the FAR" [Federal Acquisition Regulations]. On January 23, ARPA-E provided an updated TTO policy to the Committee. There are several notable differences between the February 2011 policy and the updated one:*

   The former policy explicitly says that expenditures on the following activities are acceptable uses of awardees funds:

   i. *Meetings with investors to raise capital;*
   ii. *Business plan development and market research*
   iii. *Expenditures relating to seeking additional funding from the private sector and government agencies;*
   iv. *Marketing and other expenditures relating to promoting an ARPA-E funded technology;*
   v. *Commercialization expenditures.*

   The new policy is silent on all of these activities.

   a. *Is funding for any of the above-mentioned activities considered allowable spending under the new TTO policy? If so, how does ARPA-E's conclusion differ from that of the IG, which stated the February 2011 policy "allows recipients to incur costs that are typically unallowable per the FAR."? If not, how has ARPA-E communicated the revision to awardees to ensure clear guidance on allowable TTO spending?*

Every ARPA-E funding opportunity announcement (FOA) and financial assistance award has required all costs to be allowable under applicable Federal cost principles. Although ARPA-E's technology transfer and outreach (TT&O) policy has evolved over time, it has never purported to alter the terms and conditions of ARPA-E's FOAs or financial assistance awards. Instead, the TT&O policy has merely defined the types of costs that might qualify as TT&O expenditures.

Consistent with the DOE IG's recommendation, ARPA-E's current TT&O policy correlates each TT&O expenditure category with specific FAR provision(s) defining particular types of allowable costs.

In April 2011, ARPA-E published guidance on allowable and unallowable TT&O costs in its Funding Opportunity Announcements. All TT&O costs are subject to review and approval by the Contracting Officer, who, as a representative of the Department's Office of Procurement and Acquisition Management, is the final authority on interpreting and implementing the FAR. Applicants are required to propose TT&O costs in the budgets submitted with their funding applications. These costs must relate to achieving specific objectives and technical milestones outlined in the Statement of Project Objectives. The DOE Contracting Officer may allow or disallow TT&O costs, as appropriate.

ARPA-E recipients are required to report on their TT&O expenditures in every reimbursement request and quarterly report. ARPA-E reviews these reimbursement requests and quarterly reports to ensure that recipient expenditures are in accordance with authorized budgets and Federal regulations.

b. *Please define and provide a representative range of examples of "commercialization expenditures" incurred by awardees and list specific ARPA-E approved instances of "commercialization expenditures."*

The following types of TT&O expenditures comport with Federal cost principles and are reimbursable:

- Documented travel and registration for energy-related conferences and events;
- Documented travel to meet with potential suppliers, partners, or customers;
- Documented work by salaried or contract personnel to develop commercialization models or plans;
- Documented costs of acquiring industry-accepted market research reports; and
- Approved patent costs.

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

2. *Of the ARPA-E projects considered by GAO, about 20 or so went to large, well-capitalized businesses such as GM, Boeing, DuPont, and GE. What specific steps does the ARPA-E review process undertake to determine the extent to which these corporations may have been already supporting—or were able to support—the work proposed to ARPA-E?*

Congress instructed ARPA-E to accelerate "transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty." In accordance with its statutory mandate, ARPA-E makes investments in transformational and disruptive energy technologies that private investors are not likely to fund at their present stage of development.

ARPA-E hires Program Directors who, by virtue of their scientific expertise and business backgrounds, are able to make sophisticated judgments about the types of research projects that are appropriate for ARPA-E to fund. ARPA-E Program Directors meet regularly with companies to get a sense of their appetite for risk and the types of projects they are funding and not funding. ARPA-E follows a practice of "constructive confrontation" throughout its program design and project selection process. Constructive confrontation involves vigorous internal debate and review of programmatic decision by the ARPA-E Director, Deputy Directors, and Program Directors.

Before announcing a new program, ARPA-E undertakes a comprehensive process to identify a technology "white space" that is not likely to be addressed by the private sector or other Federal Agencies. ARPA-E technical staff begin by reviewing the scientific literature to identify potential program areas. Next, ARPA-E technical staff examine the current state of the art, the main players in this space, and the major technology challenges. If ARPA-E concludes that a technology white space exists, ARPA-E technical staff organize a workshop, bringing in relevant players from industry, academia, and government to further refine the concept for a potential program. If the workshop is successful, ARPA-E may issue a funding solicitation containing market-based cost and performance metrics that, if achieved, would displace the prevailing technology.

Applicants are required to disclose in their applications whether they submitted the same or similar concepts to ARPA-E, other Federal agencies, or private investors. In addition, applicants are required to disclose prior and current sources of funding for the proposed research project and related work. Finally, applicants are required to provide an explanation for why investors are not willing to fund the projects proposed to ARPA-E and to include documentation of previous attempts to secure private funding if available. For example, large businesses are required to explain why the proposed project is not being sponsored internally.

During the merit review process, ARPA-E uses expert reviewers from industry, academia, and government to rate and provide comments on applications. These reviewers help ARPA-E to avoid projects funded by other Federal agencies and private investors.

Upon the execution of the funding agreement, ARPA-E invites industry representatives to participate in its meetings with recipients. These meetings enable a free exchange of ideas and encourage collaboration with potential commercialization partners.

ARPA-E recipients are required to disclose in their quarterly performance reports any new funding received from public or private sources. This ensures transparency and enables ARPA-E to make appropriate funding determinations.

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

3. *As you know, ARPA-E is charged by statute to advance technologies with a goal to reduce dependence on foreign energy. Projects awarded to date have overwhelmingly if not entirely focused on "clean technologies"—development of energy efficiency and alternative energy technologies. Has ARPA-E devoted any of its resources to potentially transformational R&D not currently being addressed that could enhance supply and production of traditional energy sources such as oil and natural gas? Now that ARPA-E just received a 50% increase in this year's budget to $275 million, do you plan to fund high-risk ideas that could lead to increased production of oil and natural gas?*

In accordance with its statutory goals, ARPA-E invests in technologies that enhance the economic and energy security of the United States through the development of energy technologies that result in reductions of imports of energy from foreign sources; reductions of energy related emissions, including greenhouse gases; and improvement in the energy efficiency of all economic sectors; as well as working to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies. ARPA-E is mandated to accomplish these goals by identifying and promoting revolutionary advances in fundamental sciences, translating scientific discoveries and cutting-edge inventions into technological innovations, and accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty. In accordance with both our statutory goal of reducing emissions, including greenhouse gases, and Administration policy, ARPA-E does not fund R&D of traditional energy production and extraction technologies that are lucrative to already mature industries and/or increases emissions.

The following ongoing programs exemplify ARPA-E's investments in technologies that will reduce imports of energy from foreign sources.

- Batteries for Electrical Energy Storage in Transportation (BEEST)
  The BEEST program aims to make a new generation of ultra-high energy density, low-cost battery technologies for long-range (300 to 500 miles) plug in hybrid electric vehicles (PHEVs) and electric vehicles (EVs). Successful development of these types of batteries will make PHEVs and EVs more useful to more people and will put more cars on the road that run on domestically.-generated electricity rather than oil. ARPA-E investments in this area run from moderately risky projects to take lithium ion batteries (the current industry standard) to their greatest potential performance, to pushing the boundaries of batteries by using lithium air systems that can hold as much energy as a tank of gasoline in the same volume. Other projects in the BEEST program are looking at new ways to safely store electric energy that can power cars for up to a 500 mile range and be able to fully charge in minutes. ARPA-E is funding research efforts that will promote U.S. leadership in the emerging EV battery market. There are currently ten projects within the BEEST program.

- Electrofuels
  The 13 projects that comprise the Electrofuels program intend to explore new paradigms for the production of renewable liquid fuels that are compatible with today's infrastructure— using microorganisms to harness chemical or electrical energy to convert carbon dioxide into liquid fuels, without using petroleum or biomass. Theoretically, this could be 10 times more efficient than current approaches.

- Plants Engineered to Replace Oil (PETRO)
  PETRO aims to create plants that capture more energy from sunlight and convert that energy directly into fuels. ARPA-E funds breakthrough technologies that optimize the biochemical processes of energy capture and conversion to develop robust, farm-ready crops that deliver more energy per acre with less processing prior to the pump. If successful, PETRO will create biofuels from domestic sources such as tobacco and pine trees for half their current cost, making them cost-competitive with fuels derived from oil.

In February 2012, ARPA-E issued a funding solicitation for novel and low-cost natural gas compression and storage technologies, which, if successful, would enable widespread adoption of natural gas fueled vehicles. This research is aimed at making natural gas a more viable alternative to oil-based fuels in the transportation sector.

In FY 2013, ARPA-E is prioritizing research on Transportation Systems. ARPA-E aims to create a diverse portfolio of technological options. This focus may include another round of funding in the Electrofuels program, taking a new look at transformational biofuels approaches, and investing in innovative approaches to natural gas compression and storage for transportation systems. ARPA-E plans to also further explore game-changing battery technologies for plug-in hybrid electric vehicles (PHEVs) and electric vehicles (EVs).

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

4. *GAO's review indicates that cases of rapid follow-on venture capital funding to ARPA-E recipients may have resulted from a "halo effect" or "certification effect" in which government validation of a technology or company "served as a signal of scientific and financial approval for potential investors." Does ARPA-E agree that such a certification effect unrelated to reduction of technical risks has occurred? If so, has ARPA-E considered potential non-financial methods to drive private sector technology investments? For example, could ARPA-E reduce award amounts, increase the number of award recipients, and increase the overall value of investment driven with less exposure to the taxpayers? Or perhaps consider an entirely non-financial certification of legitimacy and potential as a "stamp of approval" that could be used to attract private investment?*

ARPA-E is always interested in delivering the most value to taxpayers at the least cost. ARPA-E is also pleased when research projects it has funded succeed in securing follow-on funding with the goal of fostering eventual success in the commercial marketplace. ARPA-E believes this is a result of the technical progress made by the recipient, not ARPA-E's "certification" per se. If there is an effect, it is due to the increased likelihood of technical and commercial success associated with the aggressive market-based cost and performance targets, dependable project funding, active program management carried out by ARPA-E program directors to manage the risk, and technology-to-market assistance offered by ARPA-E.

ARPA-E fulfills a critical need for research of transformational energy technologies by identifying and promoting early-stage transformational research projects. ARPA-E, by statute, makes investments in transformational and disruptive energy technologies. ARPA-E investments have both high technical risk and high market risk. It is extremely rare for private capital to finance projects that have high technical risk and high market risk. ARPA-E funding is intended to carry technologies across the "valley of death" in order to reduce potential investor risk and motivate commercial investment. The goal is to then "hand off" successful ARPA-E projects to the private sector for further development and scaling.

ARPA-E undertakes technical merit reviews pursuant to specific authorities to provide limited funding for technology research and does not do so as a service to private investors. In considering whether doing so would be desirable, questions that might be considered include: Would the same criteria apply to ARPA-E merit reviews in each circumstance? Would private sector investors pay a fee for this service? Could ARPA-E reasonably be expected to "bat 1.000" with respect to its endorsements of innovative technologies – that is, be correct 100% of the time? If not, what consequences could be expected – by way of liability, public criticism, or otherwise – if ARPA-E encouraged others to invest in a technology which did not perform as well as anticipated?

In order to realize the full value of the DOE investment in the technical review of concept papers, ARPA-E has allowed applicants who were encouraged to submit a Full Application to have their technologies and contact information be listed on ARPA-E's website as well as to participate in the Technology Showcase at the annual ARPA-E Energy Innovation Summit. This is intended to facilitate communication between "Encouraged Applicants" and potential investors, partners, and customers. In such cases, DOE notes that the public acknowledgment of ARPA-E's expression of interest in receiving a full application does not constitute a certification of technical merit.

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

5. *In questions for the record from the Energy and Environment Subcommittee's June 2011 hearing on DOE clean technology programs, you noted that ARPA-E had obligated approximately $26 million using its "other transactions authority" (OTA) under the America COMPETES Act. Please describe the circumstances in which use of this authority is necessary instead of the more standard cooperative agreement, and provide a list of FY2011 and FY2012 OTA spending, including recipient, amount and description. Please explain ARPA-E's plans for continued use of OTA.*

To date, ARPA-E has executed three Technology Investment Agreements (TIA) under section 1007 of the Energy Policy Act of 2005 (EPACT 2005), which granted the Secretary of Energy the same authority to enter into transactions (other than standard contracts, grants, and cooperative agreements), subject to the same terms and conditions, as the Secretary of Defense under section 2371 of title 10 of the United States Code.

This "other transactions authority" provides a tool for DOE to provide for more flexible terms and conditions, and thereby enhance the Federal Government's ability to acquire or support cutting-edge science and technology by attracting nontraditional government contractors or by allowing the Federal Government to obtain the participation of an essential contractor who otherwise would not participate in a particular program. This authority, similar to that previously authorized for the Departments of Defense and Homeland Security, allows an agency to enter into agreements that are not subject to many Federal laws and regulations governing contracts, grants, or cooperative agreements.

As required by EPACT 2005, DOE developed and issued final regulations to implement its other transactions authority (OTA). The Government Accountability Office reviewed DOE's regulations and initial Technology Investment Agreement and concluded that "the controls DOE put into place over the use of its other transactions authority appear to be adequate, assuming that DOE continues to effectively implement the safeguards and to incorporate lessons learned as the department negotiates future agreements."

Among the TIA requirements, each TIA recipient was required to provide at least 50 percent of the total project cost. For example, FloDesign Wind Turbine Corp., a small business cost-sharing 50 percent, was selected for an ARPA-E award to conduct research on new ways to create a high-efficiency, shrouded wind turbine design. Foro Energy, another small business cost-sharing 50 percent, was selected to do research on laser-assisted drilling technology for geothermal energy, natural gas production and other applications. DuPont, a large business cost-sharing 50 percent, was selected for an ARPA-E award to explore the production of isobutanol, an alternate fuel for combustion engines, from macroalgae (seaweed).

ARPA-E OTA awards funded under the Recovery Act (amounts are before cost share):

FloDesign	$8,325,400
DuPont	$8,884,698
Foro	$9,141,030

ARPA-E has no specific quota for OTA awards, and the use of OTA is seen as an exception. The regulatory framework implementing DOE's use of OTA limits its use to only certain circumstances where standard contracts, grants, or cooperative agreements are unable to accommodate the needs of the award.

QUESTION FROM DR. PAUL BROUN, CHAIRMAN

6. *How does ARPA-E intend to modify its activities in light of a 50 percent increase in funding for Fiscal Year 2012? For example, will ARPA-E issue more Funding Opportunity Announcements, increase award sizes, or make more awards for each FOA? How will the additional funding impact program management?*

ARPA-E is well-equipped to handle an increase in funding. ARPA-E successfully responded to the challenge of awarding Recovery Act funds in just 17 months – with a very small start-up staff in place — through the creation of novel processes for evaluation and contracting, careful resource allocation, and the efforts of a committed team. The current, expanded ARPA-E team, with its crucial previous experience of creating and managing the existing programs, awarding and obligating funds, and establishing policies and practices, has the resources and expertise to obligate, award, and oversee the entire FY 2012 appropriated amount on schedule.

ARPA-E has issued an Open Funding Opportunity Announcement (FOA) in March 2012 for $150 Million. This will be ARPA-E's second Open FOA and, similar to ARPA-E's initial FOA from April 2009, the FY 2012 Open FOA will be open to any transformational energy technology. ARPA-E is open to considering any "out of the box" proposals that do not fit within the parameters of specific funding opportunities, align with ARPA-E's mandated goals, and have a potential for transformational impact.

In addition, ARPA-E issued two Requests for Information (RFIs). One is focused on research to create transformational technologies that enable advanced management strategies for Energy Storage Systems. This is being done in close collaboration with the Department of Defense, since our military has significant need for novel approaches to providing diagnostic, prognostic, and control capabilities in order to significantly increase performance and accelerate the adoption of energy storage technologies

The other RFI focuses on accelerating research into transformative market-ready non-photosynthetic biofuel technologies. ARPA-E's Electrofuels program has successfully supported several technologies on the lab-scale that allow microorganisms to combine chemical or electrical energy with carbon to create liquid transportation fuels. Now, ARPA-E is seeking input from industry, academia, and other interested stakeholders on the steps and challenges necessary to scale-up and apply these and related technologies in a commercial-scale facility.

In addition, ARPA-E issued a FOA named Methane Opportunities for Vehicular Energy (MOVE). Present natural gas vehicle technologies require tanks that are high pressure, cumbersome, and either too large or too expensive to be suitable for passenger vehicles. These technological and cost barriers make using natural gas for passenger vehicles with home refilling cost prohibitive. MOVE aims to overcome these barriers using two independent approaches that focus on developing innovative, low cost natural gas storage technologies that could enable mass adoption of natural gas vehicles. ARPA-E is seeking to fund absorbent materials allowing for lower pressure vehicle tanks that can hold and release natural gas. ARPA-E also seeks to fund lightweight and form-configurable tanks that fit into modern passenger vehicles. This approach

also includes developing affordable natural gas compressors that can efficiently fuel a natural gas vehicle at home.

Department of Energy
Washington, DC 20585

February 21, 2012

The Honorable Paul Broun
Chairman
Subcommittee on Investigations and Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Chairman Broun:

This is in response to your letter dated February 10, 2012, concerning the Subcommittee on Investigations and Oversight's January 24, 2012, hearing entitled "A Review of the Advanced Research Projects Agency - Energy." Enclosed are answers to the Questions for the Record posed in your letter. Additionally, as requested, our suggested edits to the hearing transcript have been provided electronically to Mr. John Serrano of the Subcommittee's staff.

Please do not hesitate to contact me if I may be of further assistance.

Sincerely,

Gregory H. Friedman
Inspector General

Enclosure

Printed with soy ink on recycled paper

Enclosure 1

Questions for the Record Submitted by Dr. Paul Broun, Chairman

1. *The IG report found that one ARPA-E recipient used award funds to pay for "meetings with bankers to raise capital" and a "fee to appear on a local television show." The report also states that ARPA-E revised its technology transfer policy in response to your concern, but that even the February 2011 revised policy "allows recipients to incur costs that are typically unallowable per the FAR [Federal Acquisition Regulations]."*

   a. *Please provide the IG's comments and opinion with respect to whether ARPA-E's most recently revised policy (updated January 23, 2012) may allow recipients to incur costs typically unallowable under the FAR.*

      We have not analyzed the implementation of ARPA-E's revised policy. We may do so in the future.

   b. *Please clarify whether the FAR allows Federal funds to be spent to "seek additional funding from the private sector and government agencies" and "marketing and other expenditures relating to promoting an ARPA-E funded technology."*

      The individual transactions must be reviewed to determine their allowability under the FAR cost principles. The cost principles that we identified as being related to seeking additional funding include:

      FAR 31.205-27 explicitly states that expenditures in connection with "raising capital" are unallowable. The specific example in the report was "meeting with bankers to raise capital."

      FAR 31.205-18 allows, as indirect costs, the bid and proposal costs connected with obtaining Federal awards.

      The cost principles that we identified as being related to marketing and promoting include:

      FAR 31.205-1 specifically states that advertising costs are unallowable. Advertising can include promotion of a specific product or service, or promotion of the business.

      FAR 31.205-38 states that selling costs are allowable. This provision makes "market planning" and "direct selling" allowable. Direct selling, unlike advertising, is catered to a specific customer.

Appendix 2

Additional Material for the Record

MAJORITY STAFF REPORT AS SUBMITTED BY CHAIRMAN PAUL C. BROUN

MAJORITY STAFF REPORT

TO:	Science, Space, and Technology (SST) Investigations and Oversight (I&O) Subcommittee Members
FROM:	SST Committee Staff
DATE:	January 24, 2012
RE:	I&O Subcommittee Hearing on *A Review of the Advanced Research Projects Agency – Energy (ARPA-E)*

Purpose and Summary

The purpose of this memo is to provide, in accordance with SST Committee legislative and oversight responsibilities, additional detail and context to key questions and concerns raised by the Committee regarding ARPA-E's projects and programs, particularly as they relate to the Government Accountability Office (GAO) and Inspector General (IG) reports that are the subject of the hearing. Key items addressed in this memo include:

1. White spaces. Of particular interest and importance are GAO's central findings that "most ARPA-E projects could not have been funded solely by private investors" and "venture capitalists generally do not fund projects that ARPA-E looks to fund."[1] These conclusions are not in dispute but the GAO descriptors "most" and "generally" warrant elaboration and quantification. While it is clear many ARPA-E projects are pursuing high-quality, potentially transformative research that is too risky for private investment, reviews of GAO work papers and publicly available information reveal many exceptions to this practice, and raise questions regarding ARPA-E's commitment to "carefully structure its projects to avoid any overlap with public and private sources of funding."
2. Follow-on Private Funding as an ARPA-E Success Metric. Vice-President Biden and DOE Secretary Chu have both given high-profile speeches touting ARPA-E awardees that received private sector funding after their ARPA-E award as proof that ARPA-E is working and successful. However, of the eleven companies touted by Vice-President Biden and Secretary Chu, ten had significant private sector funding *prior* to receiving their award as well, raising questions regarding the degree to which the ARPA-E award itself was the driver of the follow-on funding.
3. IG Concerns with Inappropriate Spending. Also of concern and addressed in this memo is the DOE IG finding that an ARPA-E recipient used award funds to pay for "meetings with bankers to raise capital" and a "fee to appear on a local television show." Most troubling with respect to this finding, however, is that ARPA-E disputed the IG's conclusion that such costs are not allowable, and in fact has a Technology Transfer and Outreach (TTO) policy that explicitly states the following expenditures are acceptable uses of taxpayer dollars:
   - "Travel and other expenditures relating to conferences and meetings with potential partners, investors, and customers;
   - Consulting and other expenditures relating to developing ARPA-E-funded technologies, building business, and identifying potential uses, markets, and customers (e.g., business plan development, market research);

[1] GAO-12-112, "Advanced Research Projects Agency – Energy Could Benefit from Information on Applicants' Prior Funding," Government Accountability Office, January 2012.

- Marketing and other expenditures relating to promoting an ARPA-E-funded technology;
- Presentation and other expenditures relating to seeking additional funding from the private sector and Government agencies; and
- Commercialization expenditures."

Background

As noted in the Committee's hearing charter, the Advanced Research Projects Agency – Energy (ARPA-E) was authorized in 2007 as part of the America COMPETES Act (P.L 110-69) to "overcome the long-term and high-risk technological barriers in the development of energy technologies" by:

> "(A) identifying and promoting revolutionary advances in fundamental and applied sciences;
> (B) translating scientific discoveries and cutting-edge inventions into technological innovations; and
> (C) accelerating transformational technological advances **in areas that industry by itself is not likely to undertake** because of technical and financial uncertainty." [emphasis added]

During the debate and consideration of the America COMPETES Act in 2007, Science Committee Republicans expressed three overarching concerns with the ARPA-E legislative proposal. Specifically, they noted that it could:

1. Compete with and potentially reduce overall funding available for high priority basic research funded by the Department of Energy Office of Science;
2. Emphasize late-stage technology development and commercialization activities more appropriately performed by the private sector; and
3. Be vulnerable to duplicating the efforts of the Department of Energy's numerous applied research and technology development programs, in particular the Office of Energy Efficiency and Renewable Energy (EERE).

The first concern may have materialized to some degree. Reflecting the Administration's support for green technology development as a centerpiece of its domestic policy agenda, President Obama requested $650 million for ARPA-E in his fiscal year 2012 (FY12) budget request, a single year increase of $470 million, or 260 percent. The final FY12 budget provided ARPA-E received a 53 percent ($95 million) funding increase over the prior year, bringing its budget to $275 million, while the Office of Science received a 0.6 percent increase ($31 million). Similarly, in FY 2011, ARPA-E funding increased from $15 million to $180 million while the Office of Science received a 6 percent ($317 million) decrease.

Regarding the second and third concerns—that ARPA-E could duplicate private sector efforts or those of other Federal programs—the agency emphasized that it limits its funding to technological "white spaces" unsupported by other entities. For example, ARPA-E Director Arun Majumdar recently stated that ARPA looks "for white spaces where technology would be completely breakthrough and would have large commercial impact, but is too risky for the private sector"[2] and that it "has implemented numerous safeguards to ensure we adhere to our

[2] http://www.forbes.com/sites/joshwolfe/2012/01/03/leading-the-charge-into-energys-future-with-dr-arun-majumdar/2/

original mission and only select appropriate projects that would otherwise not be undertaken."[3] With respect to potential overlap with other DOE programs, Majumdar told the Energy and Environment Subcommittee that "more generally, ARPA-E takes great care to ensure that its projects do not overlap with other DOE programs, but instead complement them in multiple ways. The program works in close coordination with program offices on its "borders" - DOE's basic science and applied research programs - to avoid duplicative research and ensure a balanced research portfolio across the DOE."[4]

In order to better understand how well ARPA-E was adhering to these principles in practice, and in response to concerns that several ARPA-E projects were funding activities already supported by the private sector, Chairman Hall and I&O Subcommittee Chairman Broun requested GAO undertake a review of the agency's practices and projects. The results of that review are described and elaborated upon below in more detail, as are the results of a recent DOE Inspector General report on the agency.

GAO Review Scope and Methodology

GAO's review encompassed ARPA-E's first three funding rounds, which supported 121 individual awards. Nearly all aspects of energy efficiency and renewable energy were funded—wind, solar, geothermal, batteries, biomass, etc.—as were nearly all stages of R&D, from early-stage applied research to late-stage technology development and commercialization. Recipients were similarly diverse, with 55 awards (45 percent) made to universities, national labs, or non-profit research entities; 44 (36 percent) to small- and medium-size businesses, and 22 (18 percent) to large businesses.

It is important to note that because the technology maturity (often characterized in terms of a "Technology Readiness Level" or TRL) and focus of these awards was very diverse, many projects—in particular, those with an academic, fundamental focus—are of less concern with respect to their potential to duplicate or follow private sector efforts (though overlap with other Federal funding could be more of an issue). Accordingly, GAO did not review these in detail.

Awards to large companies are an area of potential concern. ARPA-E awardees such as Boeing, DuPont, GE, and GM traditionally support large internal R&D programs. While this R&D tends to emphasize improvements to existing products and is often constrained by return-on-investment considerations, large, well-capitalized companies certainly have resources to also fund risky but potentially transformative (and profitable) projects. However, the internal nature of these efforts makes it extremely difficult to ascertain the degree to which such companies may have supported work on the same technologies being pursued with ARPA-E award funding. Accordingly, GAO also did not examine awards to large businesses in detail.

The GAO review thus focused on the 44 awards to small- and medium-sized businesses that comprised approximately one-third of ARPA-E awards. Specifically within this group, GAO used a proprietary database to identify 18 awardees that received private sector funding prior to

[3] Response to questions for the record from June 15, 2011 Energy and Environment Subcommittee hearing
[4] Ibid.

receiving an ARPA-E award. (GAO noted in its report that it could not verify the completeness of the online search service that it used, and follow-up searches by Committee staff identified an additional five companies that received private funding prior to receiving their ARPA-E award.) GAO then interviewed the 18 companies and reviewed their ARPA-E applications in detail to answer the aforementioned questions regarding the degree to which ARPA-E projects may overlap with other private or Federal efforts.

Results of GAO and Staff Review of ARPA-E Overlap with Private Sector and other Federal Efforts

In a key finding, GAO categorized the nature of the work of these 18 companies based on its research and interviews, and found that six of the companies used the ARPA-E funding to research a new technology, seven used funding to enable advancements to prior work, and five used funding to accelerate current work. The awards in the latter two categories suggest a concern with respect to ARPA-E's charge to fund technology areas not being pursued by the private sector.

Additional context and specific concerns identified through review of GAO work papers and public information regarding these awards are summarized in the bullets below.

[NOTE: because GAO interviews with awardees were generally conducted in confidence, company names, specific technologies and other identifying information are withheld.]

Overlap with Private Sector Efforts

- Company A received [amount withheld] in venture capital funding prior to receiving its ARPA-E award. GAO notes stated that "While [Company A] would have been able to continue [some][5] work on their research without ARPA-E, the ARPA-E award has allowed them to accelerate their work by a number of years."

- Company B received [specific amount withheld] in venture capital funding in [date withheld], about one year prior to receiving its ARPA-E award. GAO notes stated that "[Company B] believes that it would have likely been able to get a little more money from [its venture capital investor]to work on developing its [technology] had it not received the ARPA-E money. However, under this scenario, [the venture capital money] would have required them to basically sign over the whole company[...][6]"

- Company C received [amount withheld] in venture capital funding [date withheld], prior to receiving its ARPA-E award.

[5] Erratum: In the original transcription of GAO work notes, the word "some" was omitted. This was corrected on February 15, 2012.
[6] Erratum: In the original transcription of GAO work notes, a period was inserted instead of an ellipsis. This was corrected on February 15, 2012.

- GAO notes stated that the "funding that the company received allowed them to develop proof-of-concepts that showed the idea was feasible. ARPA-E funding allows for demonstration units and larger testing in [technology withheld]."
- Company C also received [amount withheld] in additional venture capital funding. GAO notes state that "This funding was finalized in [date withheld] when ARPA-E funding was also being finalized."
- Company C's application for ARPA-E funding strongly indicates that it expected to develop and commercialize its technology regardless of whether it won an ARPA-E award. The application stated that "Without ARPA-E funding, the introduction of the second generation [technology withheld] will be delayed." It also stated that "ARPA-E funding will accelerate [Company C's] ability to successfully bring the [withheld technology] to market in early 2012, with successful commercialization increasing the likelihood…the technology is broadly adopted."

- Company D, which has numerous private equity and venture capital investors, raised [amount withheld] prior to its ARPA-E award. GAO notes stated that "[Company D] estimated that the ARPA-E award allowed them to save 3-5 years on their commercialization timetable."

- Company E received [amount withheld] in venture capital funding prior to receiving its ARPA-E award. A few months after receiving its ARPA-E award, it received [amount withheld] in additional venture capital funding.
  - GAO notes stated that "[Company E] said that once the technical development conditions of the first tranche of private financing were met, the second tranche for work in [location withheld] was automatically funded, and would have occurred irregardless of whether [Company E] received ARPA-E funding or not."
  - Additionally, [Company E] stated in its ARPA-E application that "There is a good chance that our investors will move forward without ARPA-E support, however it will not allow for an accelerated commercialization and job creation within the timetable provided by the ARPA-E funding."

- Company F received [amount withheld] in venture capital funding prior to receiving its ARPA-E award. After receiving its award, it received additional venture capital funding of [amount withheld].
  - GAO notes summarize comments by ARPA-E program director Dr. David Danielson as stating: "The ARPA-E funding will enable [Company F] to accelerate their time to market from six years to one year from what their prior private funding would allow. Acceleration is critical in the alternative energy space. The U.S. needed these technologies yesterday." The assertion by Dr. Danielson (who has since been nominated by President Obama to serve as the DOE Assistant Secretary for Energy Efficiency and Renewable Energy[7]) that ARPA-E projects should accelerate existing private sector activities stands in

[7] http://www.whitehouse.gov/the-press-office/2011/07/27/president-obama-announces-more-key-administration-posts

sharp contrast to repeated statements from Dr. Majumdar that ARPA-E limits projects to unaddressed technology "white spaces".
  - Additionally, Company F's application for ARPA-E funding included letters of support from its venture capital investors stating that "Active support from ARPA-E would accelerate the development effort and expand the range of potential [technology withheld] applications."

Overlap with Other Federal Efforts

To better understand potential overlap between ARPA-E projects and those funded elsewhere in the Federal government, Committee staff reviewed other Federal funding received by the 44 identified small- and medium-size companies through the USASpending.gov website. A search of USASpending.gov shows that 26, or 59 percent, of these companies received other funding from the Federal government.[8] In total, ARPA-E provided $139 million to these 26 companies. Other Federal programs awarded them $62 million.

[NOTE: Committee staff did not attempt to determine the nature of each Federal award identified through this process and its similarity to the work funded by ARPA-E, and acknowledge that in numerous cases funding companies received from other programs and agencies is likely for R&D unrelated to their ARPA-E work. However, there are also numerous indications that raise concerns some ARPA-E awards overlap and may even be duplicative of those supported in other areas. Notable findings related to this are summarized below.]

- Prior to its ARPA-E award, aforementioned Company A received multiple awards from [multiple federal agencies] totaling [amount withheld]. Additionally, at the time it submitted its ARPA-E application, it also applied to another Federal agency for funding to carry out the same research. GAO notes describe this situation as follows:
  - "A [Agency X] grant notice was released about the same time as the ARPA-E funding opportunity announcement (FOA). [Company A] submitted similar grant proposals to [Agency X]. However the officials stated they were aware they could not "double up" on funding for the similar grant proposals. Once [Company A] received notice that they were being awarded funding for each of the grant proposals they submitted to [Agency X] and ARPA-E, [Company A] officials stated they consulted the program directors from each of the agencies. As a result, [Company A] was still awarded funding from [Agency X] and ARPA-E but they developed separate research goals for each of the grant proposals."

- Aforementioned Company C applied for funding from [Office Y and Office Z in one Agency] to advance development and deployment of its renewable energy technology. The company's application to ARPA-E stated it was recently notified that its application to [Office Y] would be awarded a contract.
  - In noting this additional award, the application stated "the importance of this is that potentially duplicative funding for essentially the same work statement is

[8] NOTE: this total does not include two very large DOD contracts of over $300 million each.

presented herein and with the pending grant effort described above" but that "[the agency] and [Company A] are committed as well to ensuring no duplication of effort and expense will occur."

- The ARPA-E application further stated that "In regards to the above [other agency funding] whether the test program at the [location withheld] is funded through ARPA-E or [Office Z] is immaterial to [Company A]. The work must be done and is essentially identical, therefore [the Agency] should make a decision on this matter internally."
- According to USASpending.gov, after its ARPA-E award, Company C also received [amount withheld] from [the Agency]. It is unclear what this funding would be used for or how it might be different than the ARPA-E funded project, but the company's earlier statement that its funding source is "immaterial" to its objective raises significant concerns of overlap and duplication in these awards.

- Company G acknowledged to GAO that it sought funding related to its ARPA-E proposal from several different Federal agencies.
  - Specifically, GAO notes summarizing communications with Company G's representative stated that the representative "said that [Company G] applied for government sources of funding for work related to their successful ARPA-E proposal from [six separate agencies]. Specifically, [Company G] has received funding from [three of these agencies].

Follow-on Private Sector Backing as an ARPA-E Success Metric

In February and August of 2011 speeches by DOE Secretary Chu and Vice-President Biden, respectively, ARPA-E announced that successful technological progress by its awardees had led to them receiving more than $100 million in additional private investment. Specifically, an ARPA-E press release stated that "five innovative companies that received seed funding from ARPA-E in 2009 and 2010 have now attracted more than $100 million in outside private capital investment. The private sector financing reflects the progress these companies have made over the past two years toward developing new technologies that could transform the way Americans use and produce energy. This is in addition to six other companies highlighted by Secretary Chu in February that have also attracted more than $100 million in private financing based on the progress of their work."[9]

There are two important contextual points that raise questions as to whether ARPA-E's use of private sector backing is sufficient and appropriate as a metric for evaluating the agency's success:

1. Private Funding Prior To ARPA-E Award. Committee staff found that, of the eleven awardees touted by ARPA-E, ten had received significant private funding *prior* to winning their ARPA-E award, totaling over $78 million (Table 1). This raises questions regarding the degree to which the ARPA-E award itself was the driver of follow-on private funding.

[9] http://arpa-e.energy.gov/media/news/tabid/83/vw/1/itemid/35/vice-president-biden-announces-new-private-sector-backing-for-five-pioneering-energy-companies-.aspx

2. Timing of follow-on private sector backing. In some cases, the follow-on private sector backing attracted by ARPA-E awardees was received at or around the same time of the ARPA-E award announcement, indicating that private investors' decisions were not based on technological advancements resulting from the ARPA-E award funding itself, but rather a "certification effect" or "halo effect" of confidence in a company's prospects that accompanies the government's financial backing.

   Of particular concern, ARPA-E awarded [amount withheld] to a company on the same day that the company received [amount withheld] in venture capital backing. According to GAO work paper notes, ARPA-E project manager David Danielson was concerned about this arrangement: "Dr. Danielson was surprised and somewhat concerned when [the company] got [amount withheld] in additional venture capital during ARPA-E award negotiations, as ARPA-E is supposed to avoid duplicating private sector efforts. Dr. Danielson wondered why the VC's did not provide the additional money before the ARPA-E award. The CEO, [name withheld], told Danielson that [the company] would have never gotten the money if it had not won the ARPA-E award."

Table 1. Private sector funding for ARPA-E awardees, pre- and post- award date.

Company:	**Funding Prior to Award**	**ARPA-E Funding:**	**Date of ARPA-E Funding:**	**ARPA-E-Touted Follow on Funding**
1366 Technologies	$12.4 million[10]	$4 million	October 26, 2009	$33.4 million
Envia	$3.2 million[11]	$4 million	October 26, 2009	$17 million
FloDesign	$6 million[12]	$8.3 million	October 26, 2009	$27 million
SunCatalytix	$700,000[13]	$4 million	October 26, 2009	$9.5 million
General Compression	$8 million[14]	$750,000	July 12, 2010	$12 million

[10] 1366 Technologies, "1366 Technologies, MIT Solar Start-up, Raises First $12M," March 27, 2008. Accessible at: http://www.1366tech.com/1366-technologies-mit-solar-start-up-raises-first-12m/

[11] Garthwaite, Josie. "Stealthy Battery Startup Envia Systems Dishes On Its Cathode Tech," August 14, 2009. Accessible at: http://gigaom.com/cleantech/stealthy-battery-startup-envia-systems-dishes-on-its-cathode-tech/

[12] Viscarolasaga, Efrain. "FloDesign Finds $6M in First Funding," August 1, 2008. Accessible at: http://www.masshightech.com/stories/2008/07/28/weekly12-FloDesign-finds-6M-in-first-funding.html

[13] Zacks, Rebecca. "A123Systems Counts to $69M, Sun Catalytix Out to Grow Seed From Polaris, Synageva Gets $30M, & More Boston-Area Deals News," April 17, 2009. Accessible at: http://www.xconomy.com/boston/2009/04/17/a123systems-counts-to-69m-sun-catalytix-out-to-grow-seed-from-polaris-synageva-gets-30m-more-boston-area-deals-news/

[14] Roush, Wade. "Wind Power When the Wind Ain't Blowin'," July 25, 2007. Accessible at: http://www.xconomy.com/boston/2007/07/25/wind-power-when-the-wind-aint-blowin/

24M	$10 million[15]	$2.55 million	April 29, 2010	$10 million
Phononic Devices	$530,000[16]	$3 million	October 26, 2009	$11 million
Primus Power	Undisclosed**[17]	$2 million	July 12, 2010	$11 million
OPX Biotechnologies	$17.5 million[18]	$6 million	April 29, 2010	$36.5 million
Stanford University	$0	$4,992,651	October 26, 2009	$25 million
Transphorm	$20.2 million[19]	$3 million	July 12, 2010	$25 million
Total:	$78.53 million	$37.6 million	-	$217.4 million

*24M received its $10 million in venture capital funding on the same day of its ARPA-E award.
**Canadian venture capital firm provided an undisclosed amount of funding to Primus in September 2009.

"Contingently Selected" Awardees

One way to evaluate whether or not ARPA-E awards attract additional private sector funding is to compare award recipient's follow-on funding with applicants that were not selected, but had worthy proposals. ARPA-E identified several applications that it would have funded if they had additional resources. GAO interviewed 22 of these 33 "contingently selected" applicants to track their progress in securing funding after the ARPA-E selection process. Of these, six successfully received funding for related work from either private (two) or public (four) sources, nine were rejected by other funding sources, and three were still awaiting responses (the remaining four companies chose not to seek funding elsewhere).

From this assessment, GAO concluded that "Few contingently selected applicants found funding from private investors or public sources" after applying to ARPA-E. This conclusion warrants further explanation, because 50 percent of the companies seeking funding were either (1) successful in securing funding from either private sources (two) or the government (four) or (2) still awaiting responses at the time GAO concluded its work, indicating further a degree of overlap between ARPA-E endorsed technology projects and those supported elsewhere.

[15] Wauters, Robin. "A123 Systems Spinoff 24M Technologies Raises $16 Million," August 16, 2010. Accessible at: http://techcrunch.com/2010/08/16/a123-systems-spinoff-24m-technologies-raises-16-million/
[16] Bay Area News Group, "VC Funding, First Quarter 2009," March 31, 2009. Accessible at: http://www.bayareanewsgroup.com/multimedia/mn/biz/specialreport/vcchart_q12009.htm
[17] Chrysalix, "Chrysalix Announces First Four Investments in New Cleantech Fund," September 1, 2009. Accessible at: http://www.chrysalix.com/vancouver-british-columbia
[18] Wallace, Alicia. "Boulder's OPX Biotechnologies Sets Sights on 'Sustainable' Acrylic," February 17, 2010. Accessible at: http://www.dailycamera.com/business/ci_14421783
[19] Socaltech.com, "Transphorm Takes $20.2M From KCPB," May 5, 2010. Accessible at: http://www.socaltech.com/transphorm_takes__20.2m_from_kcpb/s-0028450.html

Information in GAO work papers also seems to support this conclusion, and further suggests that some "contingently selected" applicants also received public and private funding *prior* to applying to ARPA-E. For example:

- GAO notes state that one contingently selected applicant received [amount withheld] in venture capital funding in [date withheld], [amount withheld] of which was spent on "the concept subsequently proposed to ARPA-E."
- GAO notes also state that another contingently selected applicant "Received a [Agency Award] around the same time they applied for ARPA-E funds. This funding will allow them to pursue proof of the basic technology concept of the idea they presented to ARPA-E…the ARPA-E funding would have allowed them to pursue the project in a much larger scale."

Technology Readiness Levels

Pursuant to its statutory authority, ARPA-E should be funding high-risk-high reward research. In order to define and characterize the maturity of a technology, the various agencies and private sector entities utilize technology readiness levels. The Department of Energy has detailed the descriptions of each level (ranging from 1-9), but in general, the levels translate to the following stages of technology evolution: 1-2 Basic Technology Research; 2-3 Research to Prove Feasibility; 4 Technology Development; 5-6 Technology Demonstration; 7-8 System Commissioning; and 9 System Operation.

According to a review of GAO work papers, of the proposals selected by ARPA-E, 24 were for technologies that were already at TRL 4 at the time of application; 4 at TRL 5; and two were for a proposal at TRL 6. Similarly, 46 proposals sought to advance a technology two or fewer levels. Five applications sought to only advance a technology one level, of which one technology simply sought to take a technology from TRL 6 to TRL 7. Over 60 percent of proposals funded by ARPA-E sought to advance technology to TRL 6 and beyond—the late stage technology demonstration and system commissioning and operation that is regularly supported by the private sector.

Understanding that TRLs are simply one tool that an agency or funding institution uses to evaluate a technology, it is an interesting data point to observe when assessing whether ARPA-E is funding high-risk high-reward research.

Technology Readiness Levels for the DOE[20]

Technology Readiness Level	Description
TRL 1.	Scientific research begins translation to applied R&D - Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.

[20] "*Technology Readiness Assessment Guide* (DOE G 413.3-4)". United States Department of Energy, Office of Management. October 12, 2009.

TRL 2.	Invention begins - Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
TRL 3.	Active R&D is initiated - Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
TRL 4.	Basic technological components are integrated - Basic technological components are integrated to establish that the pieces will work together.
TRL 5.	Fidelity of breadboard technology improves significantly - The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
TRL 6.	Model/prototype is tested in relevant environment - Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
TRL 7.	Prototype near or at planned operational system - Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.
TRL 8.	Technology is proven to work - Actual technology completed and qualified through test and demonstration.
TRL 9.	Actual application of technology is in its final form - Technology proven through successful operations.

DOE Inspector General Report

Also of interest and importance is ARPA-E's management and oversight of awardee expenditures. The IG audit report questioned costs claimed by two of the three ARPA-E awardees it reviewed, including "**meeting with bankers to raise capital**, securing other government funding…costs which do not appear to be allocable to the cooperative agreement because they are related to selling a piece of equipment, **a fee to appear on a local television program**, and meal costs."[21] [Emphasis added.]

The IG report noted that these costs are typically not allowable under Federal Acquisition Regulations and in any event would require prior justifications before such costs can be incurred.

Of note and concern, ARPA-E disputed this finding, and asserted that such costs are allowable under its Technology Transfer and Outreach (TTO) guidance that it provides to awardees. The policy states that examples of acceptable technology transfer spending include:

[21] DOE IG Report on *The Advanced Research Projects Agency – Energy.* Available at http://energy.gov/sites/prod/files/OAS-RA-11-11.pdf

- Travel and other expenditures relating to conferences and meetings with potential partners, investors, and customers;
- Consulting and other expenditures relating to developing ARPA-E-funded technologies, building business, and identifying potential uses, markets, and customers (e.g., business plan development, market research);
- Marketing and other expenditures relating to promoting an ARPA-E-funded technology;
- Presentation and other expenditures relating to seeking additional funding from the private sector and Government agencies;
- Commercialization expenditures;

Spending taxpayer dollars on meetings with potential investors, marketing, promotion, and commercialization of a technology, and to seek additional funding from the private sector and Government agencies is of great concern. In September, ARPA-E told Committee staff that its TTO guidance was being updated in response to concerns raised by the IG. The Committee has asked for any updates to the policy to be included in ARPA-E's hearing testimony.

MINORITY STAFF REPORT AS SUBMITTED BY RANKING MEMBER PAUL TONKO

United States Government Accountability Office

GAO

Report to Congressional Requesters

January 2012

DEPARTMENT OF ENERGY

Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding

GAO

Accountability * Integrity * Reliability

GAO-12-112

January 2012

GAO
Accountability * Integrity * Reliability

Highlights

Highlights of GAO-12-112, a report to congressional requesters

DEPARTMENT OF ENERGY

Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding

Why GAO Did This Study

The Department of Energy's (DOE) Advanced Research Projects Agency-Energy's (ARPA-E) purpose is to overcome long-term and high-risk technological barriers in the development of energy technologies. Since 2009, ARPA-E has awarded $521.7 million to universities, public and private companies, and national laboratories to fund energy research projects.

GAO was asked to examine (1) ARPA-E's use of criteria and other considerations for making awards and the extent to which applicants identify and explain other private funding information, (2) the extent to which ARPA-E-type projects could have been funded through the private sector, and (3) the extent to which ARPA-E coordinates with other DOE program offices to avoid duplicating efforts. GAO interviewed ARPA-E program directors, award winners, and nonwinners with characteristics similar to those of award winners. GAO also analyzed private venture capital funding data and spoke with venture capital firms.

What GAO Recommends

GAO recommends that ARPA-E consider providing applicants guidance with a sample response explaining prior sources of funding, requiring applicants to provide letters from investors explaining why they are not willing to fund proposed projects, and using third-party venture capital data to identify applicants' prior funding. ARPA-E commented on a draft of this report and concurred with key findings and recommendations.

What GAO Found

ARPA-E uses four selection criteria, such as the potential impact of the proposed technology relative to the state of the art, and other considerations in awarding funds. Other considerations include balancing a variety of technology approaches and the likelihood the technology would be brought to market. GAO identified 18 out of 121 award winners through ARPA-E's first three funding rounds that had received some prior private sector investment, and ARPA-E took steps to identify and understand how this funding was related to proposed projects. Beginning with the third funding round, ARPA-E began requiring that applicants explain why private investors were not willing to fund proposed projects. However, ARPA-E did not provide applicants with guidance, such as a sample response, to assist them in completing this requirement, and responses were generally limited. Some applicants provided general information about prior research but did not specifically explain why private investors would not support their projects. When applicants provided little prior funding information, ARPA-E's program directors spent time and resources to determine the extent of such funding for proposed ARPA-E projects. One applicant included a letter from its venture capital investor to explain why the investor was not willing to fund the work proposed to ARPA-E, an approach the National Institute of Standards and Technology uses as a check in its funding applications for advanced research but that ARPA-E currently does not use. Also, ARPA-E officials said that they have considered but have not used venture capital data to identify applicants with prior private investors. Examining such data allowed GAO to quickly cross-check applicants' prior private funding.

GAO's review suggests that most ARPA-E projects could not have been funded solely by private investors. Private venture capital firms told GAO that, among other considerations, they generally do not fund projects that rely on unproven technologies and tend to invest in projects that can be commercialized in less than 3 years. Data from ARPA-E on award winners show that 91 out of 121 ARPA-E projects from the first three funding rounds had technological concepts that had not yet been proven in a laboratory setting. Also, nearly all of the ARPA-E award winners and applicants GAO spoke with estimated that their projects were at least 3 years away from potential commercialization. In addition, GAO found that few eligible applicants that were not selected for an award later secured private funding.

ARPA-E officials have taken steps to coordinate with other DOE offices to avoid duplication. For example, ARPA-E program directors told GAO they engage in outreach with officials from related DOE offices in advance of funding announcements to identify funding gaps in research. In addition, program directors have recruited officials from other DOE offices and the Department of Defense (DOD) to review ARPA-E applications. This cross-agency interaction may also reduce the potential for overlap in funding.

View GAO-12-112 or key components. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

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Abbreviations

ADEPT	Agile Delivery of Electrical Power Technology
America COMPETES Act	America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act
ARPA-E	Advanced Research Projects Agency-Energy
BEEST	Batteries for Electrical Energy Storage in Transportation
BEETIT	Building Energy Efficiency Through Innovative Thermodevices
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
DOE	Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
GENI	Green Electricity Network Integration
GRIDS	Grid-Scale Rampable Intermittent Dispatchable Storage
HEATS	High Energy Advanced Thermal Storage
HVAC	heating, ventilating, and air conditioning
IMPACCT	Innovative Materials and Processes for Advanced Carbon Capture Technologies
NIST	National Institute of Standards and Technology
NVCA	National Venture Capital Association
PASTA	Panel of Senior Technical Advisors
PETRO	Plants Engineered To Replace Oil
REACT	Rare Earth Alternatives in Critical Technologies for Energy
PHEV	plug-in hybrid electric vehicle
SBIR	Small Business Innovation Research
TRL	technology readiness level

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United States Government Accountability Office
Washington, DC 20548

January 13, 2012

The Honorable Ralph M. Hall
Chairman
Committee on Science, Space, and Technology
House of Representatives

The Honorable Paul Broun, M.D.
Chairman
Subcommittee on Investigations and Oversight
Committee on Science, Space, and Technology
House of Representatives

U.S. energy consumption has increased by 20 percent over the past 20 years and is projected to continue to grow.[1] Volatile prices, global supply disruptions, and the impacts of energy use on climate and the environment have driven interest in reducing energy demand, improving energy efficiency, and expanding supplies with both renewable and traditional energy sources. In 2005, members of Congress asked the National Academies what actions federal policymakers could take to enhance the nation's science and technology enterprise so that the United States could successfully compete, prosper, and be secure in the global community of the 21st century.[2] The National Academies compiled their findings and recommendations in a report that identified two key challenges: (1) creating high-quality jobs for Americans, and (2) responding to the nation's need for clean, affordable, and reliable energy.[3] The report also highlighted the idea that scientific and technical innovations are key drivers of economic growth in the United States. Among the report's recommendations was the creation of an organization within DOE to sponsor energy research that industry by itself cannot or

[1]U.S. Energy Information Administration, *Annual Energy Review 2009*. (Washington, D.C.: 2009).

[2]The National Academies comprise four organizations: the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council; they advise policymakers on scientific and technical matters.

[3]The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, D.C.; 2007).

will not support and in which risk may be high but success would provide dramatic benefits for the nation in meeting long-term energy challenges.

In 2007, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (America COMPETES) established the Advanced Research Projects Agency-Energy (ARPA-E) within the Department of Energy (DOE) to overcome the long-term and high-risk technological barriers in the development of energy technologies.[4] ARPA-E borrows from the Defense Advanced Research Projects Agency (DARPA) model, an agency created within the Department of Defense (DOD) in 1958 to direct and perform advanced research and development projects. As specified in statute, ARPA-E's program goals are to enhance U.S. economic and energy security through the development of certain energy technologies and to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.

Since first receiving an appropriation in 2009 in the American Recovery and Reinvestment Act of 2009, ARPA-E has awarded $521.7 million to universities, public and private companies, and national laboratories to fund 181 projects that attempt to make transformational—rather than incremental—advances to a variety of energy technologies, including high-energy batteries and renewable fuels.[5] Award winners must meet cost share requirements, through either in-kind contributions or outside funding sources.[6]

ARPA-E is required by statute to achieve its goals through energy technology projects that, among other things, accelerate transformational technological advances in areas that industry by itself is not likely to

[4]Pub. L. No. 110-69, § 5012 (2007).

[5]ARPA-E generally uses cooperative agreements to make funding awards, which involve the transfer of a thing of value to the recipient to carry out a public purpose authorized by law. Cooperative agreements differ from grants because substantial involvement is expected between ARPA-E and the recipient. ARPA-E uses similar funding agreements for national laboratories.

[6]The cost share requirement for award winners is generally at least 20 percent of total allowable costs, although under section 988(b)(3) of the Energy Policy Act of 2005, ARPA-E has reduced the cost share requirement for certain applicants, such as universities, to 5 percent or 10 percent for all of the funding rounds except the first. Award winners' cost share must be provided by a nonfederal source.

undertake because of technical and financial uncertainty. At the same time, the Director of ARPA-E is required to ensure, to the maximum extent practicable, that ARPA-E's activities are coordinated with, and do not duplicate the efforts of, programs and laboratories within DOE and other relevant research agencies. This report responds to your request that we examine ARPA-E awards. Our objectives were to examine (1) ARPA-E's use of criteria and other considerations for making awards, and the extent to which applicants identify and explain other private funding information; (2) the extent to which ARPA-E-type projects could have been funded through the private sector; and (3) the extent to which ARPA-E coordinates with other DOE program offices to avoid duplicating efforts.

To address these three objectives, we reviewed ARPA-E applications and conducted interviews with applicants, award winners, representatives of venture capital firms and other experts, and DOE and other federal agency officials. ARPA-E has released a total of four funding announcements—meaning the agency was accepting project proposals for a set period of time—in April 2009, December 2009, March 2010, and April 2011. Our review focused on ARPA-E's first three funding rounds, which had closed prior to the start of our review. The fourth funding round did not close until September 2011.[7] ARPA-E awarded funds for 121 projects out of 4,788 applicants across the three funding rounds we examined. To address these three objectives, we reviewed ARPA-E applications and conducted interviews with applicants, award winners, DOE officials, and representatives of venture capital firms, among other activities. Specifically,

- To examine ARPA-E's use of criteria and other considerations for making awards, we selected a nonprobability sample of 20 applications from the 4,788 applications in the first three funding rounds and reviewed these 20 applications. To examine the extent to which applicants identify and explain other private funding information, we searched for evidence of prior private funding for all 121 award

[7]In the fourth round of funding, ARPA-E awarded 60 projects out of 427 applicants.

winners in VentureDeal, a venture capital database.[8] As a result of our search, we identified 18 award winners that had some prior private venture capital funding from the 121 award winners. We then reviewed the applications of these 18 award winners and interviewed their representatives.[9]

- To analyze the extent to which ARPA-E projects could have been funded through the private sector, we analyzed data on the state of technology and potential time to commercialization for the 121 award winners from ARPA-E's first three funding rounds. In addition to analyzing data for the 121 award winners, we conducted structured interviews with 22 of 33 "contingently selected" applicants chosen by ARPA-E during its second and third funding rounds. Contingently selected applicants are those applicants that met ARPA-E's selection criteria but were ultimately not awarded funds.[10] We also conducted structured interviews with a nonprobability sample of 13 award winners selected from ARPA-E's first three funding rounds and we spoke with the 18 ARPA-E award winners mentioned above that we identified through the VentureDeal database to discuss key differences between their prior research and their ARPA-E-funded projects.[11] We also conducted interviews with a variety of companies and individuals knowledgeable about research associated with ARPA-E-type projects, including six venture capital firms.

- To examine the extent to which ARPA-E coordinates with other DOE programs to avoid duplicating efforts, we spoke with the ARPA-E program directors as well as officials from other DOE program offices, DARPA, and the DOE Office of Inspector General. We also asked

[8]We were not able to verify the completeness of VentureDeal data, and there may have been ARPA-E award winners that had prior private funding that did not appear in these data. To compile data on venture capital funding, VentureDeal uses (1) Securities and Exchange Commission regulatory filings, (2) survey information collected directly from venture capital firms, (3) financial news media announcements and press releases from venture capital firms or recipient companies, and (4) local business journals.

[9]Eight of these 18 companies also appeared in the sample of 20 applicants that we selected to examine ARPA-E's use of criteria and other considerations for making awards.

[10]According to ARPA-E officials with whom we spoke, these applicants would have been selected for an award had additional funds been available. The remaining 11 contingently selected applicants did not respond to our requests for an interview.

[11]Four of these 18 award winners also appeared in our nonprobability sample of 13 award winners.

award winners and contingently selected applicants to discuss their understanding of other potential sources of DOE funding for their projects.

We provide a more in-depth discussion of our methods in appendix I.

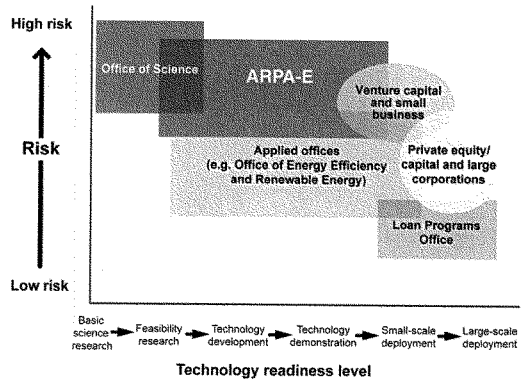
We conducted this performance audit from November 2010 to December 2011 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

In 2005, the National Academies recommended to Congress the creation of an organization within DOE like DARPA. In 2007, the America COMPETES Act created a new agency within DOE called ARPA-E. In line with the National Academies' recommendation, the America COMPETES Act as amended directs ARPA-E to achieve its goals by identifying and promoting revolutionary advances in fundamental and applied sciences, translating scientific discoveries and cutting-edge inventions into technological innovations, and accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty. As such, ARPA-E officials told us that ARPA-E was designed to sponsor research beyond basic science, yet riskier than what the private sector alone or DOE's applied offices would support.[12] (See fig. 1.) The National Academies recommended that ARPA-E should not perform research and development itself, but should fund it to be conducted by universities and others in the private sector. In 2009, the American Recovery and Reinvestment Act of 2009 appropriated $400 million for ARPA-E.

[12]DOE funds the development of energy technologies ranging from basic and applied energy research to loan guarantees for clean energy generation facilities. For example, DOE's Office of Science supports basic scientific research, including chemistry, biology, and materials sciences, as foundational research for a number of energy technologies. DOE's Office of Energy Efficiency and Renewable Energy applies established research to alternative and clean energy technologies, such as improving existing lithium ion batteries for use in electric or hybrid vehicles. DOE's Loan Programs Office offers loans to commercialize clean energy projects, such as wind farms.

Figure 1: ARPA-E's Described Role within DOE and the Private Sector



Source: ARPA-E and GAO.

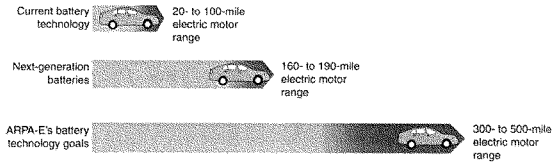
Note: Private sector groups are in oval boxes and DOE offices are in rectangular boxes. According to ARPA-E officials, higher-risk research is less likely to be successful in being brought to market but may have greater potential benefits in increasing energy supplies and creating jobs. Technology readiness levels are used by DOE to categorize research according to its proximity to basic science or large-scale deployment.

ARPA-E is an agency with fewer than 30 federal employees, and its eight program directors, who are generally scientists and engineers, create and manage funding programs for the agency. ARPA-E's program development and award selection process takes 6 to 8 months from start to finish, beginning when the agency hires a program director for a 3-year term and tasks the program director with identifying a gap in energy technology research and developing a program to fill that gap. For example, ARPA-E's batteries for transportation program, called the Batteries for Electrical Energy Storage in Transportation (BEEST) program, was established to fill a gap in existing federal research programs on batteries for electric vehicles. Identifying these gaps and designing the program involves research; consultation with scientific experts, including a workshop with outside experts; and internal discussion at ARPA-E. From this process, program directors develop funding announcements that describe the technical requirements specific to each program's technology area that applicants

have to meet and the four criteria that ARPA-E uses in its selection process.[13] The four criteria are the

- *Impact of the proposed technology relative to the state of the art.* The applicant must demonstrate the potential for a transformational—not incremental—advancement over current technologies. (See fig. 2.) More specifically, the applicant must demonstrate an awareness of competing commercial and emerging technologies and identify how its proposed concept/technology provides significant improvement over these other solutions.
- *Overall scientific and technical merit.* The applicant must demonstrate that the work is unique and innovative. The applicant must also demonstrate a sound technical approach to accomplish the proposed research and development objectives. The outcome and deliverables of the program, if successful, should be clearly defined. Specific technical requirements that are unique to each individual ARPA-E program funding announcement must also be addressed.
- *Qualifications, experience, and capabilities.* The applicant must demonstrate that it has the expertise and experience to accomplish the proposed project. In addition, the applicant must have access to all facilities required to accomplish the research and development effort.
- *Sound management plan.* The applicant must have a workable plan to manage people and resources. Major technical research and development risks should be identified. The schedule and budget should be reasonable.

Figure 2: Current Battery Range for Electric Vehicles and Goals of ARPA-E Research



Source: GAO.

[13]ARPA-E program directors developed funding announcements for six program technology areas that made up the agency's second and third funding rounds. (See table 1.)

ARPA-E employs the following three-stage application process:

- *Concept paper.* Applicants initially submit a 5- to 7-page abstract of their projects. Scientific experts from industry, government, and academia serve as reviewers.

- *Full application.* After reviews of the concept paper, ARPA-E encourages some applicants to submit full applications using ARPA-E's online application system. ARPA-E's current instructions request that applicants provide, among other things, information about other prior, current, and pending public and private sources of funding, as well as why other funding sources are not willing to fund the projects. Full applications are then reviewed by leading scientific experts in the field, who evaluate them against the four criteria and assign numerical scores.

- *Reply to reviewer comments.* After assessing the full applications, reviewers provide comments and questions to the applicants, who then have the opportunity to respond.

The applications with the reviewers' comments are forwarded to a three-person panel beginning the next three phases of ARPA-E's award funding process, which are as follows:

- *Selection.* The three-person panel, usually chaired by the relevant program director, considers the reviewers' comments and numerical scores, and recommends applications to award. The final decisions on which applicants to select are made by the selecting official, which is usually the ARPA-E Director.
- *Award negotiations.* Negotiations proceed for approximately 2 months. Program directors work closely with the award winners to set up a project plan with technical milestones that are to be met during the funding of the award, which are planned to last between 2 and 3 years. Funds are awarded following the negotiations.

- *Monitoring.* ARPA-E monitors and supports the project through quarterly reviews and site visits. After about 1 year, the agency decides whether to continue or terminate the project if the agreed-to milestones are not met.

In April 2009, ARPA-E started its funding award process by releasing a funding announcement soliciting proposals for all energy ideas and technologies. Following the review process, 36 projects were awarded funds after being selected from 3,700 applications that spanned the

technology areas of 10 programs. ARPA-E released additional funding announcements in December 2009, March 2010, and April 2011. (See table 1.) Money appropriated by the American Recovery and Reinvestment Act of 2009 funded ARPA-E's first three funding rounds. After receiving an appropriation in DOE's fiscal year 2011 appropriations act, ARPA-E announced a fourth round of funding in April 2011.

Table 1: ARPA-E Funding Announcement Program Technology Areas

(Dollars in millions)

	Funding announcements			
	1	2	3	4
	April 2009	**December 2009**	**March 2010**	**April 2011**
Program (number of projects)	Biomass energy (5)	Batteries for transportation (10)	Grid-scale electricity storage (12)	Advanced thermal storage (15)
	Building efficiency (3)	Materials for carbon capture (15)	Building efficiency (16)	Electricity network integration (14)
	Carbon capture (5)	Electrofuels (13)	Electrical power electronics (14)	Plants engineered to replace oil (10)
	Conventional energy (1)			Rare earth alternatives for energy technologies (14)
	Direct solar fuels (4)			Solar electrical power technology (7)
	Energy storage (6)			
	Energy-efficient water purification (1)			
	Renewable power (4)			
	Vehicle technologies (5)			
	Waste heat capture (2)			
Total funding	**$150**	**$113**	**$94**	**$156**

Source: GAO analysis of ARPA-E data.

Note: The table shows 116 total projects funded by ARPA-E in its first three funding rounds. In August and September 2010, ARPA-E selected 5 additional projects for funding, raising total funded projects over these three rounds to 121. These 5 projects were in the following program technology areas: building efficiency, vehicle technologies, renewable power, and energy storage. Funds awarded across the four funding rounds totaled $521.7 million. For further details on ARPA-E's program technology areas, see appendix II.

In Addition to Its Selection Criteria, ARPA-E Also Considers Applicants' Prior Sources of Private Funding; However, Most Award Winners We Reviewed Did Not Explain This Information

In addition to applying its four criteria, ARPA-E gives program directors discretion to use additional considerations to award funds to projects, including whether ARPA-E applicants received private funding. Most ARPA-E award winners did not receive prior private funding, but for those that did, most award winners we reviewed did not explain these funds.

ARPA-E Program Directors Use the Agency's Four Selection Criteria and Other Considerations to Select Projects

Of the 20 applications we reviewed for award selection criteria, all contained supporting information addressing the agency's four criteria. In our analysis of the ARPA-E reviewers' evaluations from these 20 applications, we noted regular assignment of numerical scores rating applicants on the extent to which they met the criteria. All eight ARPA-E program directors told us they considered or, if they were recently hired, will consider all four criteria, but several focused more heavily on two criteria—the impact of the proposed technology relative to the state of the art and its overall scientific and technical merit.

In addition to basing the numerical scores applicants receive on the extent to which they meet the four selection criteria, program directors told us the agency gives them the ability to take other qualitative considerations into account when awarding funds. One of those considerations is to fund a broad range of potential technological solutions with varying levels of risk in solving a given technical problem. Two program directors selected projects to reflect a variety of technologies, and they told us they believe that this approach increases their programs' overall chances of success. Specifically, one program director told us he chose projects that employed a variety of new battery technologies, a strategy that should increase the likelihood that at least one of them will work. This program director also chose some battery projects with much higher potential storage capacity but with a lower

probability of success in achieving project milestones and in ultimately being brought to market. In those cases, ARPA-E provided smaller awards to the projects with the lower probability of success.[14]

Several program directors also told us that during the selection process, they considered the applicants' projects' proposed project scope and duration, requested funding levels, and technical milestones and negotiated to revise these, if necessary, to better align applicants' projects with ARPA-E's program goals. According to our review of ARPA-E data from the first three rounds of funding, the agency reduced requested award amounts by 5 percent or more on 31 out of 121 projects, for a total of $59 million below total requested award amounts for these rounds. When ARPA-E makes these kinds of adjustments, the agency may also reduce the proposed project scope to fund only what the program directors consider to be the transformational part of the project and to avoid funding applied research or development work that would be outside ARPA-E's program goals. For example, the agency reduced the award amount and proposed project scope for an energy storage technology project designed to improve energy storage on the electrical grid. The project proposal initially requested nearly $5 million to demonstrate the technology at nearly full scale. During award negotiations, ARPA-E reduced this amount to $750,000 to focus the project only on smaller-scale development and testing of the technology. ARPA-E officials told us the larger-scale demonstration could likely be funded by the private sector.[15]

[14]All the ARPA-E program directors who had finished their selection process at the time we spoke with them told us that for a project to have a high risk level is not one of their other considerations when evaluating projects, but that the nature of the agency's work has the effect of ultimately funding high-risk projects. Several program directors said that a high risk level is inherent in projects with high technological impact.

[15]Alternatively, ARPA-E can consider only funding a specific part of research that must be proven before additional work is funded. For example, one applicant's carbon capture project involved a new means of solidifying carbon dioxide. The program director told us he wanted the applicant to first demonstrate that the approach would work, so he reduced the initial amount of funding by over 60 percent.

ARPA-E Also Considers Applicants' Prior Sources of Private Funding, but Most Award Winners We Reviewed Did Not Explain This Information

When making award decisions or adjusting the scope of proposed projects, ARPA-E program directors may also consider the identification in applications of sources of private funding and the extent to which that funding might support the proposed projects. This information can help provide program directors with assurance that ARPA-E funds do not overlap with private investment. During the first two funding rounds, ARPA-E required that applicants identify relevant private investors if the applicant believed these funds were related to the proposed project. Of the 18 applications we reviewed from award winners that we identified as having received private venture capital, 14 applied during ARPA-E's first and second funding rounds. Most of these award winners did not explain why investors were not willing to fund proposed work. ARPA-E program directors and an ARPA-E official, speaking on behalf of the agency, told us they took additional steps to clarify outstanding prior funding questions when ARPA-E was aware that applicants had received private sector funding. For example, one applicant we reviewed from the first funding round had previously received substantial private funding for work that appeared very similar to its proposed ARPA-E project. ARPA-E officials told us they were initially unable to determine why the private investor was not willing to also fund the proposed ARPA-E project and that the company's application did not include an explanation. ARPA-E officials told us that getting this information required them to draft a series of direct and detailed questions that elicited several pages of written responses from the applicant. ARPA-E officials also told us they conducted multiple rounds of written and oral follow-up with the applicant and the private investor. Through these efforts, ARPA-E determined that the technological risks of key parts of the project were too high for the private investor and therefore decided to fund the research.[16]

Because ARPA-E officials recognized the need for applicants to provide better prior funding explanations, beginning with its third funding announcement, the agency required applicants to explain why proposed work was not sponsored internally if the applicant was a large company, or why private investors were not willing to support the project if the applicant was a small business or start-up company. ARPA-E did not provide guidance on how applicants should respond to this additional requirement by, for example, providing a sample response. Of the 18

[16]ARPA-E program directors told us they also conducted review efforts in a number of other cases where it was initially unclear why other entities would not provide additional funds to ARPA-E award winners.

ARPA-E award-winning companies, 4 applied during the third funding round, and these companies provided a range of information in response to this new requirement in their funding applications. Two explained how ARPA-E funds would allow them to go beyond currently funded work but did not provide reasons why investors were not willing to support the proposed work. Another wrote only that the ARPA-E research was too risky for the company's private investors. One application contained an explanation outlining the specific research its private investors were and were not willing to fund. This applicant explained that private funds were directed toward lower-risk and higher-cost technologies.[17] This application also included a letter from the company's venture capital investors that explained which parts of its research the investors were planning to continue funding and which research was too risky for them, although not requested by ARPA-E. This letter provided additional third-party support for the funding information in the application. Officials from the National Institute of Standards and Technology's (NIST) Technology Innovation Program told us they request that applicants provide letters from private investors to document why applicants' projects could not be privately funded.[18]

When we followed up with the 18 companies, they were generally able to explain to us why their private investors were not willing to undertake the additional risk and uncertainty associated with the proposed projects.[19] When we examined the data in the VentureDeal database for a number of applicants, the data allowed us to quickly cross-check the names of prior private investors that applicants reported to ARPA-E. ARPA-E officials said that they have not used such data for these purposes but that they have considered doing so. Without an examination of outside venture capital data on its applicants, the agency may be missing a time-saving opportunity to check information on private funding provided in applications, especially in instances where applicants may not have been thorough in their explanations. We found a number of readily available subscription-based venture capital data services that provided company

[17]ARPA-E officials told us that they funded only the parts of this project that were too risky for the private investors.

[18]According to NIST, the Technology Innovation Program funds advanced research in areas of critical national need including health care, robotics, and civil infrastructure.

[19]Most of these explanations related to the risk or uncertainty associated with the proposed projects.

names, transaction amounts, and funding purposes. We found that the web-based VentureDeal database matched formats and data available from other venture capital data services.

Most ARPA-E Projects Likely Could Not Have Been Funded Solely by Private Investors

Our review suggests that most ARPA-E-type projects could not be funded solely by private investors. Private venture capital firms told us that, among other considerations, they generally do not invest in projects that cannot be commercialized in less than 3 years. Nearly all of the 13 ARPA-E award winners and most of the 22 of the contingently selected applicants we spoke with estimated that their projects were 3 or more years away from a potential market-ready product (i.e., commercialization). In addition, we found that only 2 of the 22 contingently selected applicants we spoke with that met ARPA-E's selection criteria but were not selected for an award subsequently secured private funding.

Venture Capitalists Generally Do Not Fund Projects That ARPA-E Looks to Fund

The representatives we spoke with from six venture capital firms identified three factors that limit the general availability of venture capital funding for new energy technologies. These factors were consistent with data we analyzed for the 121 award winners from ARPA-E's first three funding rounds, the sample of 13 award winners we interviewed from these funding rounds, and the 22 contingently selected applicants we interviewed.

First, venture capital firms generally do not fund projects that rely on unproven technological concepts or lack working prototypes demonstrating the technology. A number of venture capital firm representatives told us that they are generally not willing to fund the applied scientific research sometimes required by ARPA-E-type projects. Projects they fund generally focus on developing technologies based on known scientific principles. Data from ARPA-E on award winners show that 91 out of 121 ARPA-E projects from the first three funding rounds had technological concepts that had not yet been demonstrated in a laboratory setting.[20] According to a recent report from the American Energy Innovation Council, private investors consider these projects too

[20]These data showed that most ARPA-E award winners were at or below technology readiness level (TRL) 3. TRL 3 represents a level where potential technologies are still unproven.

high risk for investment, even for concepts with promising technological potential.[21] Most of the contingently selected applicants we spoke with—17 out of the 22—told us they were unlikely to receive funding from other sources for their proposed projects because of high levels of scientific uncertainty, an unavailable or undeveloped market, or a lack of a working prototype. For example, one such applicant said that he only had a computer model suggesting that his high-efficiency air conditioning device would work, which was insufficient to convince potential private investors. In addition, many of the ARPA-E award winners we surveyed also recognized the inherent uncertainty in their research; 5 of the 13 told us that their projects had a fairly low probability of success.[22]

Second, venture capital firms seek more rapid returns on investment and closely analyze a project's potential return on investment over time, a factor that influences their decisions to invest in projects that are in later stages of development and closer to commercialization. Venture capital firm officials told us that they focused closely on the timeliness of investment returns, with one firm noting that the industry tended to invest in technologies that could be commercialized in less than 3 years and that would potentially exhibit exponential market growth in approximately 5 to 7 years. However, we found that nearly all of the ARPA-E award winners and most contingently selected applicants we spoke with estimated that their projects were 3 or more years away from potential commercialization.[23] For example, 12 out of 13 ARPA-E award winners estimated that it would take at least 3 years for their ARPA-E projects to reach the commercialization stage with ARPA-E funding.[24] Had they not

[21]American Energy Innovation Council, *Catalyzing American Ingenuity: The Role of Government in Energy Innovation* (Sept. 2011). The American Energy Innovation Council is a bipartisan group of American business leaders.

[22]The 18 award winners we identified as having received prior private venture capital told us they were generally able to pursue the development of energy technologies with greater scientific or technical uncertainty with the ARPA-E funding than what they were working on with their private funding. See appendix III for more detail on these companies' prior privately funded research.

[23]On the basis of the initial testing of our questions, we determined that these estimates may be optimistic, given that respondents are invested in attempting to bring a technology to market as soon as possible.

[24]For the 12 award winners, 6 estimated their projects would take 3 to 5 years to reach commercialization, and the remaining 6 estimated their projects would take more than 5 years to do so.

received ARPA-E funding, most of these award winners—10 out of 13—told us they either would not have pursued their ARPA-E project or that they would not have been able to develop a commercial product in less than 10 years. At the same time, 18 out of 22 ARPA-E contingently selected applicants estimated it would take at least 3 years for their projects to reach commercialization if they had been able to secure funding for the proposal they submitted to ARPA-E.

Third, venture capital firms may not be comfortable investing in new energy technologies, noting the historical lack of successful venture capital investments in these types of projects. Venture representatives said that venture firms were more comfortable investing in software companies or other businesses with higher potential profit margins and less costly product development than new energy technologies. One venture representative noted that his firm looked to invest in products with potential gross profit margins of 50 percent or more. In addition, these representatives noted that it is difficult for new advanced energy technologies to compete with well-established and low-margin traditional sources of energy like natural gas. Venture representatives also noted that venture firms had become more risk averse and reluctant to fund new energy technologies after lackluster investment returns have made the venture industry more aware of the challenges associated with investing in unproven energy technologies.

While venture capital firms generally do not fund projects that ARPA-E looks to fund, our work suggests that receiving ARPA-E project funding may have a positive effect on some award winners' ability to attract follow-on funding from the private sector for their ARPA-E work. For example, ARPA-E's data indicate that 18 out of 121 ARPA-E award winners from ARPA-E's first three rounds of funding had received private sector funding totaling $318 million after receiving ARPA-E funding.[25] In some cases, award winners received private follow-on funding immediately after receiving ARPA-E funding. A number of the award winners we spoke with stated that, given the highly competitive nature of the program, receiving ARPA-E funding served as a "stamp of approval" to venture capital or other private firms.[26] These award winners told us

[25]A number of these 18 award winners with follow-on funding were part of the 18 companies we identified as having received private funding prior to ARPA-E.

[26]These award winners included those that had prior venture funding as well as the others we interviewed.

that an ARPA-E award served as a signal of scientific and financial approval for potential investors. Economists call this rapid follow-on private funding a certification effect, which may explain the experiences of some of these award winners.[27] This effect suggests that public awards address information gaps that might have otherwise precluded private investment. Some award winners and economists we spoke with told us that the government was suited to identifying technical risks because of its ability to draw on the expertise of many scientific reviewers, while venture firms may not have the scientific expertise on hand to fully understand potential investments. Furthermore, economic literature suggests that the certification effect may be particularly relevant in the high-technology industries, where the venture capital community plays an important role and in which traditional financial measures of risk and returns on investments may prove insufficient.[28] Appendix III has more information on the difference between research funded by selected award winners' prior investors and ARPA-E funded work.

Few Contingently Selected Applicants Found Funding from Private Investors or Public Sources

Eighteen of the 22 ARPA-E contingently selected applicants we interviewed sought funding after being turned down for ARPA-E funds. Of the 18 that sought funding elsewhere, 13 submitted project proposals to government sources, such as other DOE offices, the National Science Foundation, or nonprofit academic research institutes, and the remaining 5 submitted proposals to private investors such as venture capital firms.[29] As of September 2011, we found that 2 out of the 22 contingently selected applicants secured funding from venture capital firms for work that was very similar to their ARPA-E project proposals.[30] We also found that 4 contingently selected applicants secured funding from a

[27]See Andrew A. Toole, Calum Turvey. "How Does Initial Public Financing Influence Private Incentives for Follow-on Investment in Early-Stage Technologies?" *Journal of Technology Transfer*, 34: 43-58 (2007). See also Josh Lerner. "The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program," *Journal of Business*, vol. 72, no.3, 285-318 (1999).

[28]Lerner, "The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program."

[29]One of the 5 contingently selected applicants that sought funding from a private investor also sought public funding.

[30]In addition, our review of venture capital funding data for the other 11 contingently selected applicants with whom we did not speak did not show that any had received venture capital funding since not being awarded ARPA-E funds.

government or nonprofit source for their projects.[31] In addition, we found that most contingently selected applicants modified their ARPA-E project proposals to attract subsequent funding for their projects by reducing the scope of their proposals or by focusing on more basic science research. For example, the 4 contingently selected applicants that secured funding from a government or nonprofit source modified their ARPA-E proposals to be more focused on basic science research, rather than on developing a commercial technology. In addition, 1 of these applicants told us that the funding will allow it to continue exploring fundamental materials science rather than developing a product. Also, many contingently selected applicants and award winners said that other government sources were limited. Some noted that Small Business Innovation Research (SBIR) grants would not allow them to make as much progress as larger ARPA-E awards.[32] Finally, a number of others mentioned that military funding agencies were not as focused on developing low-cost technologies with broader market appeal, because aerospace or military applications do not need to achieve the same low costs and market appeal as consumer or commercial applications.

[31]Three contingently selected applicants that submitted proposals to government or nonprofit sources were still awaiting responses.

[32]Federal agencies that have budgets in excess of $100 million for research conducted by others (extramural research) are required to use 2.5 percent of these budgets to establish and operate a Small Business Innovation Research program. The program is intended to stimulate technological innovation, use small businesses to meet federal research and development needs, foster and encourage participation by minority and disadvantaged persons in technological innovation, and increase private sector commercialization of innovations derived from federal research and development. Eleven federal agencies participate in the SBIR program, with $16 billion awarded to date. Initial SBIR awards normally do not exceed $150,000 and are usually for a period of 6 months.

ARPA-E Officials Have Taken Steps to Coordinate with Other Department of Energy Offices in Advance of Awarding Funds

According to ARPA-E officials and documents, agency officials have taken steps to coordinate with other DOE offices in advance of awarding ARPA-E funds to help avoid duplication of efforts. These coordination efforts can be categorized into three areas:

Prefunding coordination. ARPA-E officials told us that program directors engage with officials from related DOE offices in advance of announcing the availability of ARPA-E funds. ARPA-E program directors told us that early in the development of a funding announcement, they conduct outreach with industry, academic, and government officials both inside and outside of DOE in an attempt to identify funding gaps related to the technology they wish to develop. For example, by doing such outreach, one program director determined that there had been little funding at DOE or elsewhere for lithium air or lithium sulfur batteries, which have the potential to last significantly longer than existing lithium ion batteries. Program directors also hold workshops and invite relevant participants, including those from other DOE offices and from other federal agencies, to identify technologies that have little to no existing research funding but that have transformational potential. ARPA-E officials told us that directors use the workshops and other meetings to identify research areas that other DOE offices are not working on, and the other DOE officials provide insights on funding areas where they are not active. For example, one of these ARPA-E program directors told us that he met with officials from DOE's Office of Electricity Delivery and Energy Reliability and the Solar Energy Technologies Program within the Office of Energy Efficiency and Renewable Energy (EERE) before announcing available funds for the electrical power electronics funding announcement.[33] According to this program director, this coordination helped him identify that there had been little funding for the development of magnetic devices for use in electrical power electronics. He ultimately designed the ARPA-E electrical power electronics funding announcement to focus, in part, on the development of improved magnetic devices because of the lack of funding elsewhere.

In addition to inviting officials from other DOE offices to ARPA-E workshops, program directors told us they also engage with other DOE officials in other ways, both formally and informally. The program director

[33]Electrical power electronics modify electrical energy (i.e., change its voltage, current, or frequency) and can be found in applications like lighting, motors, and electric vehicles.

responsible for ARPA-E's work on advanced batteries said that he was a member of DOE's Energy Storage Technology Development Team and regularly met with other officials who are engaged in applied battery research. This director said that it had become clear that DOE's Vehicle Technologies Program will continue to focus on incremental improvements to existing lithium ion battery technologies that are currently on the market, while ARPA-E will fund newer, alternative battery technologies. Other program directors told us that they have regular discussions with counterparts within DOE to avoid duplicating efforts, although through other means than a formal committee.

Coordination of application reviews. Some ARPA-E program directors told us that they have recruited officials from other DOE offices to review applications submitted to ARPA-E and that these officials made up as many as one-third of the reviewers for one director. These application reviewers rate and recommend proposals for potential ARPA-E funding. ARPA-E program directors told us that these DOE reviewers help them stay aware of the types of projects that other DOE offices are funding. For example, according to one program director, DOE reviewers indicated on a number of occasions that an ARPA-E advanced battery applicant would be better suited for funding under DOE's Vehicle Technologies Program because it was for a more developed technology. ARPA-E has also used application reviewers from other federal agencies, such as the Department of Defense. One program director told us that these reviewers have also helped avoid funding projects similar to those potentially funded elsewhere.

Official DOE coordination groups. ARPA-E is also a participant in DOE's SunShot Initiative within the Solar Energy Technologies Program. The SunShot Initiative is an effort to coordinate solar energy research across DOE's Office of Science, four national laboratories, the National Science Foundation, and ARPA-E, with the goal of achieving costs of $1 per watt for solar-generated electricity. One ARPA-E program director is a member of the SunShot Initiative advisory board and therefore able to coordinate ARPA-E solar-related activities with other SunShot Initiative members. SunShot Initiative officials told us that DOE plans to make it a

model for DOE's internal coordination efforts and that DOE hopes to expand the approach to other research areas.[34]

Additionally, the ARPA-E Director created the Panel of Senior Technical Advisors (PASTA), which is a group of high-level DOE managers that meet periodically to discuss current and future DOE research efforts. ARPA-E officials told us that PASTA is an attempt to avoid duplicating efforts within DOE. PASTA meeting attendees have included officials from DOE's applied and basic science offices.

We were not able to directly evaluate the effectiveness of ARPA-E's efforts to coordinate with other DOE offices. Nevertheless, we found that on the basis of our interviews with ARPA-E award winners and contingently selected applicants, four award winners and two contingently selected applicants had received prior funding from other DOE offices.[35] According to these award winners and contingently selected applicants, the prior funding was either for more proven technologies or was focused on more basic or foundational research than was the ARPA-E funded project.

Conclusions

ARPA-E recognizes the need to ensure that the agency is not funding projects that would be otherwise funded by the private sector, and has taken steps to get information from applicants on their other sources of funding. The agency has also taken steps to coordinate with other DOE offices in advance of awarding ARPA-E funds. However, for the applications we reviewed, we found that ARPA-E's current funding announcements have generally yielded limited information from applicants that had prior sources of private funding. Where applicants provided little information, ARPA-E's program directors spent time and resources to determine the extent of such funding for projects related to or similar to the applicants' proposed ARPA-E projects. The agency's

[34]In addition, SunShot Initiative program officials told us they are trying to share elements of ARPA-E's selection process with other offices within DOE—current DOE funding announcements generally take 15 months to carry out, compared with 6 to 8 months for ARPA-E. For example, ARPA-E officials also told us that DOE's Energy Efficiency and Renewable Energy office is adopting their online application system because of its advantages over paper-based systems.

[35]These award winners included those in our nonprobability sample of 13, as well as the 18 we identified with VentureDeal data.

requirements for information on private sector funding could be improved. For example, ARPA-E does not provide guidance to applicants, such as a sample response, on how to meet its information requirement on prior private funding. An approach used by another federal program that funds advanced research is for applicants to provide letters from private investors to document why their projects could not be privately funded. This approach was used by one ARPA-E award winner, who included a letter from the company's venture capital investors to explain why the investors were not willing to fund the project proposed to ARPA-E. Also, ARPA-E officials said that they have not used venture capital data to identify applicants with prior private investors and to check information applicants provide to them, but that they have considered doing so. Examining such data allowed us to quickly cross-check applicants' self-reported prior private funding. Without additional tools to better understand prior private funding, ARPA-E program directors will continue to spend time and agency resources taking additional steps to clarify prior private funding and may miss opportunities to avoid duplication with private investors.

Recommendations for Executive Action

To ensure that ARPA-E uses a more complete range of methods to ensure that limited federal funds are targeted appropriately, we recommend that the Secretary of Energy consider taking the following three actions:

- provide guidance with a sample response to assist applicants in providing information on sources of private funding for proposed ARPA-E projects,
- require that applicants provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E, and
- use venture capital funding databases to help identify applicants with prior private investors and to help check information applicants provide on their applications.

Agency Comments and Our Evaluation

We provided a copy of our draft report to ARPA-E for review and comment. ARPA-E concurred with key findings and our recommendations in its written comments, which are reproduced in appendix IV. In its comments, ARPA-E outlined the steps that the agency plans to take to address our recommendations. ARPA-E also provided additional clarifying comments, which we incorporated.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees, the Secretary of Energy, and other interested parties. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.

Frank Rusco

Frank Rusco
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

To examine the Advanced Research Projects Agency-Energy's (ARPA-E) use of criteria and other considerations for making awards and the extent to which applicants identify and explain other private funding information, we reviewed 20 applications drawn from a nonprobability sample of the 4,788 applicants ARPA-E received during its first three funding rounds. We selected applications from a range of ARPA-E technology program areas to which the applications were submitted and applicant institution types (e.g., small company or university). Because we selected a nonprobability sample of applications to review, information we collected cannot be generalized to all applicants; however, it provided us with an understanding of ARPA-E's criteria and other considerations for making an award. We also interviewed and reviewed the applications from our sample of 18 award winners, which were private companies that we identified as having received funding from private investors prior to receiving an ARPA-E award. We identified these 18 companies by searching for evidence of prior private funding for the 121 award winners in the VentureDeal venture capital database.[1] In our review of these applications, we focused on the extent to which applicants disclosed prior private funding.[2] We also spoke with all eight ARPA-E program directors to discuss ARPA-E's process for making awards and managing projects of award winners.

To analyze the extent to which ARPA-E projects could have been funded through the private sector, we conducted three sets of interviews with ARPA-E applicants and award winners. Specifically,

- We conducted structured interviews with 22 of the 33 contingently selected applicants that ARPA-E encouraged to submit full applications during its second and third funding rounds.[3] Each of the

[1]VentureDeal is a company that maintains data on private venture capital funding. The VentureDeal database only includes businesses and does not include data on venture capital funding secured by universities or national laboratories. However, according to a VentureDeal official, universities and national laboratories are not likely to directly receive venture funding. In addition, we were not able to verify the completeness of VentureDeal data, and there may have been ARPA-E award winners that had prior private funding that did not appear in these data. We identified 1 of these award winners through an examination of ARPA-E data.

[2]Eight of these 18 companies also appeared in the sample of 20 applicants that we selected to examine ARPA-E's criteria for making awards.

[3]The remaining 11 contingently selected applicants did not respond to our requests for an interview.

contingently selected applicants fulfilled ARPA-E's selection criteria, had the same characteristics as ARPA-E award winners, and, according to ARPA-E officials with whom we spoke, would have been selected for an award had additional funds been available.[4] This approach allowed us to consider the potential of ARPA-E-type projects to receive private funding.

- We conducted structured interviews with a nonprobability sample of 13 award winners selected from ARPA-E's first three funding rounds.[5] We selected subjects for this sample across a range of ARPA-E award winner characteristics, including the technology program area for which an award winner received funding, the stage of development of an award winner's project, and an award winner's type of institution (e.g., small company or university). Because this was a nonprobability sample, the information from these structured interviews cannot be generalized to all award winners but can provide examples about award winners' experiences. We conducted content analyses[6] of the award winners' and contingently selected applicants' interview responses to quantify issues such as the ability of each group to secure private sector funding for ARPA-E-type projects.[7]

- Third, we spoke with the 18 ARPA-E award winners we identified through the VentureDeal database to discuss key differences between their prior research and their ARPA-E-funded projects.[8]

[4]We spoke with 1 applicant twice because the applicant applied for two different projects. For each of the 33 contingently selected applicants, we also searched for entries in the VentureDeal database to determine if any had received private venture capital funding prior to and following ARPA-E's selection process.

[5]We selected 15 award winners as part of our nonprobability sample but 2 award winners did not respond to our interview requests.

[6]Content analysis is a systematic research method for analyzing textual information in a standardized way that allows evaluators to make inferences about that information.

[7]We conducted pretests of our structured interview questions with 3 award winners and 3 contingently selected applicants to ensure that the questions were understandable and unbiased.

[8]Four of these 18 award winners also appeared in our nonprobability sample of 13 award winners.

We also conducted interviews with a variety of companies and individuals knowledgeable about research associated with ARPA-E-type projects, including six venture capital firms[9] and the National Venture Capital Association (NVCA), a trade association, to determine the availability of private capital for ARPA-E-type projects and the criteria venture capital firms apply in making their investment decisions; two additional public companies that were awarded ARPA-E funding to discuss the ability of a public company to internally fund research;[10] and three economists to discuss the role and effectiveness of government-funded research and development of technology.[11]

To examine the extent to which ARPA-E coordinates with other DOE programs to avoid duplicating efforts, we spoke with the ARPA-E program directors as well as officials from other DOE program offices including the Office for Energy Efficiency and Renewable Energy (EERE) and the Office of Science. In addition, we met with officials from the SunShot Initiative, which is a collaboration among EERE, the Office of Science, and ARPA-E to make solar energy technologies cost-competitive with other forms of energy. We also spoke with officials from the Defense Advanced Research Projects Agency (DARPA) and the Department of Energy (DOE) Office of Inspector General. During our interviews with the award winners and contingently selected applicants previously mentioned, we asked them to discuss their understanding of other potential sources of DOE funding for their projects.

To assess the reliability of data from ARPA-E and VentureDeal, we reviewed relevant documentation and interviewed key data system officials at ARPA-E and VentureDeal and determined that the data were sufficiently reliable for the purposes of this report.

We conducted this performance audit from November 2010 to December 2011 in accordance with generally accepted government auditing

[9]These firms were Khosla Ventures; Kleiner, Perkins, Caufield, and Byers; U.S. Venture Partners; Rockport Capital; Mohr-Davidow Ventures; and Polaris Ventures. We selected these venture capital firms because they were knowledgeable about ARPA-E-funded companies according to NVCA.

[10]These two companies did not appear in our earlier samples.

[11]We selected these economists based on their publication of literature on the role and effectiveness of government-funded research.

standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: ARPA-E Program Technology Areas

Funding Round 1

- *Biomass energy.* Biomass energy projects focus on means to convert crops, along with plant waste from other industrial processes, into energy through chemical, biological, or thermal techniques.
- *Building efficiency.* Building efficiency projects focus on technologies that heat, power, and maintain buildings.
- *Carbon capture.* Carbon capture and sequestration projects seek to create new methods to prevent the release of carbon dioxide into the atmosphere from traditional fossil fuel sources such as coal, natural gas, and petroleum.
- *Conventional energy.* Conventional energy projects seek to significantly increase the efficiency of traditional fossil fuel power production and reduce waste generated from this use.
- *Direct solar fuels.* Direct solar fuel projects seek to utilize photosynthetic microorganisms to produce liquid fuels and fuel precursors directly from solar energy.
- *Energy storage.* Energy storage projects seek to revolutionize battery, capacitor, and other energy storage methods for significantly improved efficiency.
- *Energy-efficient water purification.* Water technology projects seek to reduce the water intensity of the electricity and fuel sectors and, reciprocally, to reduce the energy intensity of the water sector.
- *Renewable power.* Renewable power projects focus on innovative technologies in several sustainable energy areas such as extremely efficient photovoltaic solar collectors, wind turbines, and geothermal energy.
- *Vehicle technologies.* Vehicle technology projects seek to advance efficiency in vehicles through technologies like new hybrid engines to those that convert on-board waste heat to electricity.
- *Waste heat capture.* Waste heat capture projects seek to use thermal energy expelled by traditional industrial processes, such as coal smokestacks, and efficiently convert that heat into electricity.

Funding Round 2

- *Batteries for transportation.* Batteries for Electrical Energy Storage in Transportation (BEEST) projects seek to develop batteries for plug-in hybrid electric vehicles (PHEV) and electric vehicles (EV) that can make a 300- to 500-mile-range electric car.

- *Materials for carbon capture.* Innovative Materials and Processes for Advanced Carbon Capture Technologies (IMPACCT) projects seek to reduce the cost of carbon capture significantly through a combination of new materials, improvements to existing processes, and demonstration of new capture processes.
- *Electrofuels.* Electrofuels projects intend to explore new paradigms for the production of renewable liquid fuels that are compatible with today's infrastructure. They seek to use microorganisms to harness chemical or electrical energy to convert carbon dioxide into liquid fuels without using petroleum or biomass.

Funding Round 3

- *Grid-scale electricity storage.* Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS) projects seek to develop new energy storage technologies that are comparable in reliability and cost to pumped hydropower and that are modular and can be deployed in any location in the country.
- *Building efficiency.* Building Energy Efficiency Through Innovative Thermodevices (BEETIT) projects focus on developing new approaches and technologies for cooling equipment used in heating, ventilating, and air conditioning (HVAC) systems in buildings, as well as in refrigeration.
- *Electrical power electronics.* Agile Delivery of Electrical Power Technology (ADEPT) projects strive to reinvent the basic building blocks of circuits from transistors, inductors, and transformers to capacitors for a broad spectrum of power applications. ADEPT focuses on two areas: (1) creating the world's first kilovolt-scale integrated circuits, and (2) developing transistor switches operating at grid-level voltages that would exceed 13 kilovolts.

Funding Round 4

- *Advanced thermal storage.* High Energy Advanced Thermal Storage (HEATS) projects seek to develop revolutionary cost-effective thermal energy storage technologies. HEATS focuses on three areas: (1) high-temperature storage systems to deliver solar electricity more efficiently around the clock to allow nuclear and fossil base load resources the flexibility to meet peak demand, (2) fuel produced from the sun's heat, and (3) HVAC systems that use thermal storage to dramatically improve the driving range of electric vehicles.

- *Electricity network integration.* Green Electricity Network Integration (GENI) projects focus on innovative control software and high-voltage hardware to reliably control the grid network. GENI focuses on two areas: (1) cost-optimizing controls to manage sporadically available sources, such as wind and solar, alongside coal and nuclear, and (2) resilient power flow control hardware to enable automated, real-time control of grid components.
- *Plants Engineered To Replace Oil (PETRO).* PETRO projects seek to advance technologies that optimize the biochemical processes of energy capture and conversion in plants to develop farm-ready crops that deliver more energy per acre with less processing.
- *Rare earth alternatives for energy technologies.* Rare Earth Alternatives in Critical Technologies for Energy (REACT) projects work on early-stage technology alternatives that reduce or eliminate dependence on rare earth materials that may jeopardize the widespread adoption of many critical energy solutions by developing substitutes in two key areas: electric vehicle motors and wind generators.
- *Solar electrical power technology.* Solar Agile Delivery of Electrical Power Technology (Solar ADEPT) projects focus on integrating advanced power electronics into solar panels to extract and deliver energy more efficiently. Solar ADEPT projects are centered on advances in magnetics, semiconductor switches, and charge storage.

Appendix III: Description of ARPA-E Award Winners with Prior Private Investment

The 18 award winners we identified as having received prior private venture capital told us that with the ARPA-E funding, they were generally able to pursue the development of energy technologies with greater scientific or technical uncertainty than they had when they were working with their private funding. About two-thirds of these award winners told us that the ARPA-E funding is allowing them to develop prototypes or to prove basic technology concepts on more advanced ideas than their prior work—6 of these award winners said this was for completely new research and 7 said it was for major advancements to prior research. A few of these award winners also told us they were able to work on projects with outstanding scientific research questions that private investors would not have funded. Five of these award winners reported that they would likely have been able to pursue some research similar to their ARPA-E projects, but it would have taken years longer without ARPA-E funding.

The following three examples reflect in more detail much of what we heard from these 18 award winners regarding the distinction between research funded by their prior investors and ARPA-E funded work:

- *Sun Catalytix*. Sun Catalytix was founded by a professor at the Massachusetts Institute of Technology to commercialize a set of catalysts to split water into hydrogen and oxygen gases. This reaction allows these gases to be cheaply produced for a variety of purposes, including renewable energy. Sun Catalytix was initially funded by a Boston area venture capital firm to develop a product based on these catalysts. According to a representative from this firm, the venture capital funding allows Sun Catalytix to attempt to develop a product that would potentially earn the venture firm a return on investment in a reasonable amount of time. At the time of the ARPA-E award, Sun Catalytix representatives told us they were still some years away from a commercial product using this new technology. According to these representatives, had the firm not won an ARPA-E award, further venture capital might not have been available to develop an initial version of their products. Sun Catalytix representatives told us that ARPA-E funds allowed the company to conduct additional applied scientific research that led to their discovery of a new platinum-free and therefore lower-cost catalyst with much wider market potential, including renewable energy applications. A representative from the venture firm told us that the firm would not have funded the additional advanced scientific research needed to develop the new, cheaper catalyst.

- *Agrivida*. This small biotechnology company based in the Boston area is developing genetically modified sorghum, corn, and switchgrass crops for use in biofuel production. Agrivida representatives explained that the goal of their ARPA-E project is to generate crops capable of producing enzymes within the plant itself to internally break down the plant's own cellulose after harvest. This technology would significantly lower the costs of cellulosic biofuel production, because enzyme treatments are currently a large part of the costs of current production methods. Before winning an award from ARPA-E, Agrivida had received venture capital funding to develop the technology. We spoke with a representative of the venture firm that funded Agrivida, who told us that this venture funding was only for research on the corn crop enzymes; the firm was not willing to fund additional research on other crops because the amount of funding it could provide to any one company in the early stages of research was limited. Agrivida officials told us that the ARPA-E award allowed them to expand the scope of their work and conduct additional research on switchgrass, which may have potential to become a major biofuel crop. They said that the ARPA-E funds have enabled rapid progress, allowing them to complete laboratory work in 1 year that would have otherwise taken 5 years. Officials from Agrivida said they hope to have made enough progress by the time they complete their ARPA-E research to be able to attract additional investors and secure commercialization partners.

- *24M*. This is a startup company that is developing flow batteries for use in transportation and electrical grid applications. Unlike normal batteries, flow batteries generate electrical current by internally circulating electrically active liquids, which allows for much lower costs than traditional batteries. However, flow batteries do not exist for use in tight spaces like cars where their cost advantages could allow for significant improvements to electric vehicles. In 2010, concurrent with its ARPA-E award, 24M received $10 million from two venture capital firms to develop flow batteries for consumer and commercial applications. A representative from one of these venture firms told us that his firm would not have been confident in funding the 24M project without ARPA-E involvement. Representatives from 24M said that the ARPA-E award was critical to their ability to secure private investment and to launch the company and that they now expect to have a working prototype by the end of their ARPA-E project.

In addition, the two public companies we spoke with that were awarded ARPA-E money told us that although their companies had internal resources devoted to research and development, they were not able to

internally fund the projects they proposed to ARPA-E. They told us there were two reasons for this. First, the companies said that existing product lines placed heavy demands on their internal research and development budgets, and that there is continuous pressure from existing customers and competitors to improve existing products; since ARPA-E projects were still a number of years away from a return on investment, these investments could not be justified. Second, these companies told us that internal investments had to meet minimum investment return thresholds, and that ARPA-E-type projects were not able to meet these thresholds. Officials from one company told us that the rate of return on investment required by its management was at least 20 percent per year.

Appendix IV: Comments from ARPA-E

arpa·e

TO: FRANK RUSCO
DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT
GOVERNMENT ACCOUNTABILITY OFFICE (GAO)

FROM: ARUN MAJUMDAR
DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY – ENERGY (ARPA-E)
DEPARTMENT OF ENERGY

12/13/2011

RE: ARPA-E's Response to GAO Draft Audit Report on "Advanced Research Projects Agency-Energy Could Benefit from Information on Applicants' Prior Funding"

The Advanced Research Projects Agency – Energy (ARPA-E) thanks the Government Accountability Office (GAO) for the opportunity to comment on the above-referenced draft Report, which is the culmination of a thorough, year-long audit of ARPA-E's operations and programs.

In accordance with its statutory mission, ARPA-E is committed to "accelerating transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty." ARPA-E requires applicants to fully disclose all prior, current, and pending funding from Federal agencies and any prior, current, and pending funding from the private sector that supports the proposed project or work that relates directly or indirectly to the proposed project. ARPA-E carefully structures its projects to avoid any overlap with public and private sources of funding.

ARPA-E agrees with the GAO's finding that "most ARPA-E projects could not have been funded solely by private investors" and "venture capitalist[s] generally do not fund projects that ARPA-E looks to fund." Importantly, GAO did not identify a single instance in which private investors would have funded an ARPA-E project within the same, accelerated timeframe (3 years or less).

GAO notes on the cover page of the report that it identified "18 out of 121 award winners through ARPA-E's first three funding rounds that had received some prior private sector investment." ARPA-E would like to highlight GAO's findings with respect to the 18 award winners, which are found in Appendix IV to the Report:

- ARPA-E enabled about two-thirds of the 18 award winners "to develop prototypes or to prove basic technology concepts on more advanced ideas than their prior work."
  - 6 of the 18 award winners received funding for "completely new research."
  - 7 of the 18 award winners received funding for "major advancements to prior research."
- ARPA-E enabled some of the award winners "to work on projects with outstanding scientific research questions which private investors would not have allowed."
- ARPA-E significantly accelerated the research and development timeframe for 5 of the 18 award winners.

ARPA-E also agrees with the GAO's finding that "ARPA-E officials have taken steps to coordinate with other Department of Energy offices in advance of awarding funds." ARPA-E actively engages with other DOE programs, Federal agencies, national laboratories, industry, and academia to identify "white space" where a strategic infusion of funding would catalyze the development and deployment of transformational and disruptive energy technologies. ARPA-E uses world-class experts from Government, industry, and academia to evaluate applications and assess the technical progress of its projects. In addition, ARPA-E participates in intra- and inter-Departmental initiatives in specific technology areas.

ARPA-E concurs, with comments, on the three recommendations in the Report.

Recommendation 1: Provide guidance with a sample to assist applicants in providing information on sources of private funding for proposed ARPA-E projects.

Management Response: ARPA-E will include a sample response in future funding opportunity announcements (FOAs) in order to assist applicants in providing information on sources of private funding for proposed ARPA-E projects.

Recommendation 2: Require that applicants provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E.

Management Response: In future FOAs, ARPA-E will require applicants to provide letters or other forms of documentation from private investors that explain why investors are not willing to fund the projects proposed to ARPA-E.

Recommendation 3: Use venture capital funding databases to help identify applicants with prior private investors and to help check information applicants provide on their applications.

Management Response: In the future, ARPA-E will use venture capital funding databases, such as VentureDeal, to help identify applicants with prior private investors and to help check information provided by applicants in their applications.

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Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

Frank Rusco, (202) 512-3841 or ruscof@gao.gov

Staff Acknowledgments

In addition to the individual named above, Tim Minelli (Assistant Director), Paola Bobadilla, Cindy Gilbert, Robert Marek, Justin Mausel, Alison O'Neill, Jeanette Soares, and Franklyn Yao made important contributions to this report.

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U.S. Department of Energy
Office of Inspector General
Office of Audits and Inspections

Audit Report

The Advanced Research Projects Agency – Energy

OAS-RA-11-11 August 2011

Department of Energy
Washington, DC 20585

August 22, 2011

MEMORANDUM FOR THE DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY – ENERGY

FROM: George W. Collard
Assistant Inspector General
for Audits
Office of Inspector General

SUBJECT: INFORMATION: Audit Report on "The Advanced Research Projects Agency – Energy"

BACKGROUND

The Advanced Research Projects Agency – Energy (ARPA-E), an agency within the Department of Energy, was authorized in 2007 as part of the America COMPETES Act (COMPETES Act). The goals of ARPA-E are to enhance domestic economic security through the development of energy technologies and to ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies. To accomplish these goals, ARPA-E focuses exclusively on high-risk, high-payoff concepts.

While ARPA-E's creation was authorized in 2007, it did not begin operations until 2009, when the Omnibus Appropriations Act of 2009 provided an initial $15 million in funding. The American Recovery and Reinvestment Act of 2009 (Recovery Act) provided an additional $400 million to ARPA-E. Under the provisions of the COMPETES Act, ARPA-E is required to spend 2.5 percent of its appropriated funds on technology transfer and outreach activities. In January 2011, the requirement increased to 5 percent with the signing of the America COMPETES Reauthorization Act of 2010 (Reauthorization Act). As of April 20, 2011, ARPA-E has issued 12 funding opportunity announcements and made 122 awards valued at $368.6 million to advance battery technology, explore alternative fuels, and improve building efficiencies, among other areas. ARPA-E program directors, with the assistance of support service contractors, provide project oversight.

Due to the importance of its mission and the significant level of Recovery Act funding, we initiated this audit to determine whether ARPA-E implemented safeguards necessary to achieve its goals and objectives and to effectively deploy associated Recovery Act resources.

RESULTS OF AUDIT

ARPA-E generally had systems in place to make research awards and to deploy Recovery Act resources. For example, ARPA-E established selection criteria to make awards that were consistent with its mission objectives and implemented the criteria in award selection. However, we found that ARPA-E:

- Had not established a systematic approach to ensure that it was meeting the technology transfer and outreach requirement of the COMPETES Act. In particular, ARPA-E had not required funding recipients to expend a percentage of their awards on technology transfer; and,

- Had not drafted or, in some cases, approved draft policies and procedures in a number of key areas, including those in the areas of monitoring and oversight of awardees; termination of non-performing awards; technology transfer and outreach; and, invoice review.

Additionally, through transaction testing we performed at three recipient sites, we identified and questioned approximately $280,387 in unsupported, unreasonable, or unallocable costs, or costs considered to be specifically unallowable, that had been incurred by two recipients.

According to an ARPA-E official, ARPA-E focused its attention on meeting the Recovery Act requirement of expeditiously awarding funds to projects by September 30, 2010; and, as a consequence did not have sufficient time and resources to devote to establishing all its operational controls in the area of policies and procedures. ARPA-E did not require recipients to spend a certain percentage of their awards on technology transfer and outreach nor to track and report these expenditures to ARPA-E. We also found that ARPA-E was unaware that recipients had incurred the types of costs we questioned because they did not require submission of transaction details as part of their invoice review process.

Without improvements in these areas, ARPA-E is at risk of not meeting its goals for the transfer of technology and for reimbursing unallowable recipient costs. Controls to ensure that recipients spend sufficient funds on technology transfer and outreach activities are necessary to help maximize ARPA-E's ability to transfer developed energy technologies to the marketplace as required by the COMPETES Act. Furthermore, without improved controls over costs, such as requiring detailed support for invoiced costs, ARPA-E recipients could incur additional questioned costs similar to those questioned at two of the three recipient sites we visited.

ARPA-E was working to improve its processes and, in doing so, addressed some of the concerns we raised during our audit. For example, ARPA-E finalized the policy governing an invoice review process in October 2010. More recently, in the five funding opportunity announcements it issued in April 2011, ARPA-E included a requirement for recipients to spend a minimum of 5 percent of their awards on technology transfer and outreach and to track and report to ARPA-E on such expenditures. In the interim, ARPA-E surveyed grant recipients about their expenditures for technology transfer and outreach activities. The recipients estimated that, as of February 2011, they had expended approximately $15.3 million on technology transfer and outreach, in comparison to the approximately $10.4 million that was required to meet the 2.5 percent technology transfer requirement. However, the estimated expenditures were not a fully reliable indicator of whether the 2.5 percent requirement was being met since ARPA-E had not required recipients to submit documentation to substantiate the estimated amount of expenditures they reported for technology transfer.

ARPA-E also finalized a policy in February 2011, outlining what were considered to be allowable costs in the area of technology transfer and outreach. However, we are concerned that this policy allows recipients to incur several types of costs that are typically unallowable as direct costs under Federal Acquisition Regulations, such as the costs of procuring additional Government funding and for meeting with investors, without providing a justification as to reasons for their allowability.

We recommended that several management best practices be implemented, all of which are designed to help improve ARPA-E's administration and stewardship of taxpayer furnished resources.

MANAGEMENT REACTION

Management concurred with our recommendations and stated that it had already taken corrective actions or would be taking actions on each of the recommendations. Management stated, for example, that the Contracting Officer made an official determination regarding the direct costs we questioned in the report. Management also stated that it had communicated to recipients the types of costs that are allowable and unallowable as technology transfer and outreach costs. Overall, management's comments were generally responsive to our recommendations.

Management's comments are included in their entirety in Appendix 3.

Attachment

cc: Deputy Secretary
Associate Deputy Secretary
Acting Under Secretary of Energy
Chief of Staff

REPORT ON THE ADVANCED RESEARCH PROJECTS AGENCY – ENERGY

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THE ADVANCED RESEARCH PROJECTS AGENCY – ENERGY

Program Management

The Advanced Research Projects Agency – Energy (ARPA-E) generally had systems in place to make research awards and to deploy American Recovery and Reinvestment Act of 2009 (Recovery Act) resources. However, we found that ARPA-E had not established a systematic approach to ensure that it was meeting the technology transfer and outreach requirement of the America COMPETES Act (COMPETES Act) and had not drafted or, in some cases, approved draft policies and procedures in a number of significant areas. We further identified and questioned approximately $280,387 in unsupported, unreasonable, or unallowable costs, or costs considered to be specifically unallowable at two of the three recipient sites we visited.

Technology Transfer and Outreach

ARPA-E had not established a systematic approach to ensure that it was meeting the technology transfer and outreach requirement of the COMPETES Act that it spend 2.5 percent of its budget on technology transfer and outreach activities. Technology transfer and outreach activities are a means through which ARPA-E can achieve its statutory goal of ensuring that the United States maintains a technological lead in developing and deploying advanced energy technologies.

Senior ARPA-E officials told us that, in addition to an in-house commercialization team, which held summits and workshops to bring researchers and investors together, they included recipient technology transfer and outreach costs in measuring total technology transfer and outreach expenditures. A Headquarters Procurement and Assistance Policy official told us that including recipient efforts was a reasonable approach to meet the requirement, stating that recipients would be in the best position to market their technologies.

However, ARPA-E had not included a requirement for recipients to spend a certain percentage of their awards on technology transfer and outreach activities nor had it required the recipients to track and report to ARPA-E on such expenditures in the funding opportunity announcement. Management, accordingly, determined that imposing these requirements on an after-the-fact basis on current recipients was inappropriate because the requirement was not specified in the funding opportunity announcements. ARPA-E management told us that they were encouraging current recipients to spend project funding on technology transfer and

outreach activities and planned to include the specific expenditure requirement in future funding opportunity announcements.

In February 2011, ARPA-E surveyed award recipients about their technology transfer and outreach activities and expenditures. According to the recipient responses, an estimated $15.3 million had been expended on technology transfer and outreach activities. However, the estimated expenditures was not a reliable indicator of whether ARPA-E was meeting its requirement to expend 2.5 percent of its appropriated funds on technology transfer and outreach activities since ARPA-E had not required recipients to submit documentation to substantiate the estimated amount of expenditures they reported for technology transfer.

In the five funding opportunity announcements it issued in April 2011, ARPA-E included a requirement for recipients to spend a minimum of 5 percent of their awards on technology transfer and outreach activities, consistent with the 5 percent requirement in the America COMPETES Reauthorization Act of 2010, and to track and report to ARPA-E on such expenditures. ARPA-E management officials told us that they plan to notify recipients of the types of costs that qualify as technology transfer and outreach.

Policies and Procedures

ARPA-E had not drafted or, in some cases, approved draft policies and procedures in significant areas such as technology transfer and outreach, monitoring and oversight of awardees, termination of non-performing awards, and the review of awardee invoices. Specifically, at the time of our review, ARPA-E had not drafted policies and procedures for:

- Meeting its expenditure goals for technology transfer and outreach, and tracking and verifying recipient expenditures in such activities. ARPA-E, for example, had not required recipients to include technology transfer and outreach costs in their budgets nor to track their expenditures in this area. Further, existing procedures did not address the type of technology transfer and outreach activities for which expenditures were allowable under the award; and,

- Terminating non-performing awards. As approximately 30 percent of the awards have been in effect for one year or more, policies are needed to document the procedures for how go and no-go milestones are verified, the basis for determining whether to continue or terminate a project, and who has the authority to make such determinations.

Additionally, ARPA-E had not approved draft policies and procedures governing the:

- Monitoring and oversight of awardees. Absent specific guidelines, we noted that the emphasis of monitoring and oversight activities, particularly during site visits, was on technical performance and not on business aspects of the awards such as the recipient's internal control structure. Policies are needed to require an evaluation of awardees' business performance, including an evaluation of the appropriateness of expenditures; and,

- Reviewing grant recipient invoices. Our audit looked at costs from the first funding opportunity announcement and we found issues regarding the consistency of documentation submitted by recipients. Procedures are needed to ensure that all recipients submit consistent levels of supporting documentation.

ARPA-E told us that go/no-go milestones were verified during quarterly reviews. However, these reviews were not documented in any policy or procedures. This is especially important to ensure consistency between program directors who are short-term employees. The COMPETES Act specifies that program directors serve terms of not more than three years, although they may be renewed.

In relation to our concerns, ARPA-E took a number of steps to formalize its operations. For example, ARPA-E developed a policy statement regarding its approach to meeting the COMPETES Act's technology transfer and outreach requirements. Additionally, as discussed below, ARPA-E has approved procedures for reviewing invoices.

Allowable Costs

We identified $280,387 in questionable costs at two of the three recipient sites we visited. We questioned these costs based on the allowable cost provisions contained in Subpart 31.2 of the Federal Acquisition Regulation (FAR). For example, in our visit to one small business recipient, we identified $39,992 in questionable direct costs with respect to:

- meetings with bankers to raise capital;
- securing other government funding that should instead be included in the indirect cost pool;
- costs which do not appear to be allocable to the cooperative agreement because they are related to selling a piece of equipment;
- a fee to appear on a local television program; and,
- meal costs.

We also noted that this recipient did not have support for its indirect cost rate. Rather, it was using the rate of an affiliated firm, to whom the award was originally made, a rate that had not been reviewed by an independent party. The total amount of indirect costs that the recipient had claimed as of June 30, 2010, was $239,497. ARPA-E officials informed us that the delay in having the recipient's indirect rate reviewed by an independent party stemmed from the fact that the award was novated to a spin-off of the original recipient and a review was needed of the recipient's accounting system. The review of the accounting system was completed by an independent party in January 2011, and ARPA-E requested a review of the recipient's indirect rate in April 2011. We also identified $898 in meal costs at a second recipient, a university, which are unallowable per Office of Management and Budget Circular A-21.

Subsequent to our questioning the above costs, the ARPA-E contracting officer told us that he concluded $39,189 of the above direct costs were allowable since they were part of technology transfer and outreach activities. The contracting officer agreed that the $1,701 in meal costs were unallowable. However, according to a Headquarters Procurement and Assistance Policy official, if a determination is made that a

normally unallowable cost will be allowable; it should be made in advance of the cost being incurred and be documented. In the above cases, the costs were not justified in advance and a determination was not contained in the file. While the contracting officer provided us with an oral determination of the allowability of costs, he did not provide his formal determination, in writing, outlining his basis for deviating from the FAR.

Therefore, we question $40,890 in recipient expenditures. In addition we question $239,497 in indirect costs, because the indirect cost rate was unsupported, for total questioned costs of $280,387.

Actions and Organizational Priorities

In response to our concerns, ARPA-E finalized policies governing the invoice review process in October 2010, and technology transfer and outreach in February 2011. However, the policy on technology transfer and outreach allows recipients to incur costs that are typically unallowable per the FAR. The policy does not reference the FAR or refer to the fact that the types of costs listed are typically unallowable and require prior justifications for the costs before they are incurred. According to ARPA-E officials, the policy was developed in part by personnel who were embedded in ARPA-E but who reported directly to the Director, Office of Headquarters Procurement Services and to the Office of General Counsel. However, the Director, Office of Headquarters Procurement Services told us that, while he had seen the draft policy, he supported the need for an in-depth review of the policy.

According to an ARPA-E official, ARPA-E focused its attention on meeting the Recovery Act requirement of expeditiously awarding funds to projects by September 30, 2010; and, as a consequence did not have sufficient time and resources to devote to establishing its operational controls in the area of policies and procedures. While ARPA-E had drafted many policies and procedures, relatively few were finalized.

Goal Achievement

Without improvements in the areas we discovered, ARPA-E is at risk of not meeting its goals for the transfer of technology, and for reimbursing unallowable recipient costs. Controls to ensure that recipients spend sufficient funds on technology transfer and outreach activities are needed to maximize ARPA-E's ability to transfer developed energy technologies to the marketplace as required by the COMPETES Act. Furthermore, without improved controls over costs,

such as requiring detailed support for invoiced costs, ARPA-E recipients could incur additional questioned costs similar to those questioned at two of the three recipient sites we visited.

RECOMMENDATIONS

To address the issues noted in this report and ensure that ARPA-E meets its goals, we recommend that the Director, ARPA-E:

1. Finalize the remaining policies and procedures related to the operation of ARPA-E, such as those related to monitoring and oversight of awardees; and termination of non-performing awards;

2. Consult with the Headquarters Office of Procurement and Assistance Policy on the allowability of costs contained in the newly developed policy on technology transfer and outreach;

3. Establish a process to accurately measure progress toward meeting the technology transfer and outreach spending requirement;

4. Obtain a Contracting Officer official determination regarding the allowability of costs questioned in this report and to recover costs determined to be unallowable; and,

5. Communicate to recipients the types of costs that are allowable and unallowable as technology transfer and outreach costs.

MANAGEMENT AND AUDITOR COMMENTS

Management concurred with the report's recommendations and indicated that it had already taken corrective actions or would be taking action on each of the recommendations.

Management stated that agency specific policies both for the monitoring and oversight of awardees and the termination of non-performing awardees had been developed. For example, management stated that they had developed a written policy related to terminating non-performing awards that is currently under review by the Office of General Counsel and Office of Procurement and Assistance Policy. Management also stated that it is deploying a web-based project management system to facilitate the monitoring and oversight of awardees. Regarding allowable technology transfer and outreach costs, management stated a written policy has been submitted for review by the Office of Procurement and Assistance Policy. Management

also stated that it had established a process to accurately measure progress toward meeting the technology transfer and outreach spending requirement. Specifically, management stated that recipients in the five most recent funding opportunity announcements are required to submit their spending in the area of technology transfer and outreach with each invoice.

Regarding the costs questioned in this report, management stated that the Contracting Officer has made an official determination regarding the questioned direct costs. Management also expressed concern that the inclusion of questioned indirect costs incorrectly implies a failure to comply with Departmental policies and procedures. We acknowledge that ARPA-E has a plan of action to address the unaudited indirect costs; however, we questioned the costs because the basis provided by the recipient for the rate was not reviewed by an independent party.

Finally, management stated that it had communicated to recipients the types of costs that are allowable and unallowable as technology transfer and outreach costs through five funding opportunity announcements issued in April 2011. While ARPA-E listed the allowable cost principles of the FAR in these funding opportunities, management should also distribute the technology transfer and outreach policy after it has been reviewed by Procurement.

Management's comments were generally responsive to the recommendations. Management's verbatim comments can be found in Appendix 3.

Appendix 2

OBJECTIVE

The objective of the audit was to determine whether the Advanced Research Projects Agency - Energy (ARPA-E) implemented safeguards necessary to achieve its goals and objectives and to effectively deploy associated American Recovery and Reinvestment Act of 2009 (Recovery Act) resources.

SCOPE

The audit was performed between May 2010 and August 2011, at ARPA-E headquarters in Washington, DC, and at three recipient sites.

METHODOLOGY

To accomplish our objective, we:

- Reviewed applicable laws and regulations, as well as internal ARPA-E policies and procedures that were in place when the audit started and those that were developed during the course of the audit;
- Selected a sample of 47 applications that were submitted for funding to ARPA-E from the first four funding opportunity announcements (submissions made between May 2009 and March 2010). We reviewed the concept papers and full applications and the associated reviewer comments to determine whether the applications were reviewed consistent with the associated funding opportunity announcement;
- Visited the sites of three recipients who received awards under the first funding opportunity announcement (awards announced in October 2009) and reviewed costs claimed by those recipients to determine allowability of costs;
- Held discussions with recipient personnel to determine the involvement of ARPA-E in the work being performed;
- Assessed ARPA-E's management control structure over the disbursement and reporting processes as they relate to Recovery Act funding, monitoring of research performance, and transfer of technology; and,
- Interviewed ARPA-E and Department of Energy officials.

Appendix 2 (continued)

We conducted this performance audit in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. The audit included tests of controls and compliance with laws and regulations necessary to satisfy the audit objective. Because our review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. During the audit, we assessed ARPA-E's compliance with the *Government Performance and Results Act of 1993* and found that a performance measure had been established related to obligation of funding beginning in Fiscal Year 2011. We utilized computer-processed data to identify the populations of costs incurred by the recipient sites we visited. Based on our comparisons of computer-processed data to supporting documentation, we determined that the data were sufficiently reliable for the purposes of our report.

We held an exit conference with management on August 11, 2011.

Appendix 3

RELATED AUDIT REPORT

Government Accountability Office (GAO)

America COMPETES Act: It Is Too Early to Evaluate Programs Long-Term Effectiveness, but Agencies Could Improve Reporting of High-Risk, High-Reward Research Priorities (GAO-11-127R, October 2010). The audit found that three of the four agencies reviewed – Department of Energy, National Science Foundation, and National Institute of Science and Technology – conducted basic scientific research but did not consistently set a percentage funding goal to support high-risk, high-reward research – as required by Congress. In addition, two of these three agencies did not report this information with their annual budget submissions, as the law provides. Agency officials indicated that they faced challenges in defining such research, and as a result, each program applied the criteria in the America COMPETES Act (COMPETES Act) differently. Because the new programs authorized and funded under the America COMPETES Act had only recently received and obligated funding, and because of the difficulties reported by GAO and others as being inherent in measuring outcomes of research and educational programs, the audit determined that it was too early to assess the effectiveness of these programs.

Appendix 4

TO: GEORGE COLLARD
ASSISTANT INSPECTOR GENERAL FOR AUDITS
OFFICE OF INSPECTOR GENERAL (OIG)

FROM: ARUN MAJUMDAR
DIRECTOR
ADVANCED RESEARCH PROJECTS AGENCY – ENERGY (ARPA-E)

RE: ARPA-E's Response to OIG Draft Audit Report on "The Advanced Research Projects Agency – Energy"

The Advanced Research Projects Agency – Energy (ARPA-E) thanks the Office of Inspector General (OIG) for the opportunity to comment on the above-referenced draft Report, which is the culmination of a thorough, year-long audit of ARPA-E's operations and programs. ARPA-E concurs, with comments, on the five recommendations in the Report. These comments seek to clarify the current disposition of the issues raised in the Report and the accompanying cover memorandum. The Report focuses on awards that were executed under ARPA-E's first funding opportunity announcement (FOA) in December 2009 and January 2010. Of note, at that time ARPA-E had been in existence for less than a year, so it employed approved, pre-existing Federal government and Departmental processes and mechanisms to conduct its operations and FOAs. Approximately 18 months have passed since then, during which time ARPA-E has established its own standard operating procedures. ARPA-E appreciates the Report's finding that ARPA-E "was working to improve its processes and, in doing so, addressed some of the concerns we raised during the audit.". ARPA-E is committed to continuously improving its operations so as to better fulfill its statutory mission to enhance our nation's economic and energy security and maintain a U.S. technological lead in the development and deployment of advanced energy technologies.

Recommendation 1: Finalize the remaining policies and procedures related to the operation of ARPA-E, such as those related to monitoring and oversight of awardees and termination of non-performing awards.

Management Response: ARPA-E's policies and procedures both for the monitoring and oversight of awardees and the termination of non-performing awards have been developed via a process that began before, and continued through, the OIG audit. Initial ARPA-E procedures were based on pre-existing Federal government and Departmental processes, and have since been strengthened through the development of agency-specific processes.

For monitoring and oversight of awardees: Each ARPA-E award agreement includes a detailed schedule of technical milestones and deliverables, which is used to measure recipients' progress on a quarterly basis. ARPA-E program managers hold a meeting or conference call with each recipient every quarter, including at least two site visits per year. ARPA-E is deploying a web-based project management system to facilitate the monitoring and oversight of awardees.

For terminating non-performing awards: Once a program manager determines that a project is non-performing, ARPA-E notifies the awardee in writing that it must achieve specific corrective actions by a certain date. If the awardee fails to do so, the Contracting Officer suspends the award and begins the termination process. Any funding that was obligated under the American Recovery and Reinvestment Act (ARRA) is returned to the U.S. Treasury. Non-ARRA funding is re-invested in other ARPA-E projects. ARPA-E's written policy on terminations is under review by the Office of General Counsel and Office of Procurement and Assistance Policy.

The Report recognizes that "ARPA-E finalized the policy governing an invoice review process in October 2010" and "finalized a policy in February 2011 outlining what were considered to be allowable costs in the area of technology transfer and outreach." (ARPA-E also included specific instructions in its awards on the types of documentation that need to be submitted in order to receive reimbursement for project expenditures.)

Appendix 4

Recommendation 2: Consult with the Headquarters Office of Procurement and Assistance Policy on the allowability of costs contained in the newly developed policy on technology transfer and outreach.

Management Response: ARPA-E's written policy has been submitted for review by Office of Procurement and Assistance Policy. As noted in the Report, ARPA-E finalized the policy in February 2011 "outlining what were considered to be allowable costs in the area of technology transfer and outreach" and that this "policy was developed in part by personnel who were embedded in ARPA-E but who reported directly to the Director, Office of Headquarters Procurement and to the Office of General Counsel."

Recommendation 3: Establish a process to accurately measure progress toward meeting the technology transfer and outreach spending requirement.

Management Response: ARPA-E implemented this recommendation through five FOAs issued in April 2011. ARPA-E required applicants to include technology transfer and outreach (TT&O) costs in their proposed budgets. Every invoice submitted by awardees must provide a breakdown by budget category of all incurred TT&O costs and provide supporting documentation. The invoice must show the TT&O budgeted costs and actual costs incurred for the relevant billing period and cumulative TT&O costs incurred to date. The budgeted and actual costs incurred must comport with the Prime Recipient's budget and particular objectives in the Statement of Project Objectives.

Recommendation 4: Obtain a Contracting Officer determination regarding the allowability of costs questioned in this Report and to recover costs determined to be unallowable.

Management Response: The Contracting Officer has made an official determination on the questioned direct costs ($40,890). As noted in the Report, the Contracting Officer "concluded $39,189 of the above direct costs were allowable since they were part of technology transfer and outreach activities," but he "agreed that $1,701 in meal costs were unallowable." The Contracting Officer is seeking recovery of the unallowable costs. The Contracting Officer's written determination will be included in the award file.

The Report refers to a small business that incurred $239,497 in questioned indirect costs. The inclusion of the questioned indirect costs in the Report incorrectly implies a failure to comply with Departmental policies and procedures. At the time of award (January 2010), the Contracting Officer determined to first require an audit of the original recipient's accounting system and then an audit of its indirect rate. The original recipient's proposed indirect rates were provisionally accepted for award by the Contracting Officer, subject to the results of the third party audits and the implementation of the audit findings. In the award, both parties agreed to implement the audit findings retroactive to the effective date of the award. Therefore, any risk to ARPA-E was appropriately minimized. The initial audit was delayed by the novation of the award from the original recipient to a spinoff small business in March 2010. Following the novation, ARPA-E requested the Defense Contract Audit Agency (DCAA) to audit the small business' accounting system. The resulting audit report, which was completed in January 2011, shows that the small business agreed to implement DCAA's recommendations and that DCAA found the small business' proposed corrective actions to be "responsive." In April 2011, the Contracting Officer requested the DCAA to audit the small business' indirect rate. The indirect rate audit is ongoing. In addition to the foregoing audits, the Contracting Officer requested an incurred cost audit to be conducted. Upon completion of these audits, ARPA-E will adjust the indirect rate and recover any excess payments made to the small business, retroactive to the effective date of the award.

Recommendation 5: Communicate to recipients the types of costs that are allowable and unallowable as technology transfer and outreach costs.

Management Response: ARPA-E implemented this recommendation through five FOAs issued in April 2011.

2

IG Report No. OAS-RA-11-11

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GAO

Report to the Committee on Science, Space, and Technology, House of Representatives

June 2012

POLAR-ORBITING ENVIRONMENTAL SATELLITES

Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention

This Report Is Temporarily Restricted Pending Official Public Release.

G A O

Accountability * Integrity * Reliability

GAO-12-604

June 2012

GAO
Accountability * Integrity * Reliability

Highlights

Highlights of GAO-12-604, a report to the Committee on Science, Space, and Technology, House of Representatives

POLAR-ORBITING ENVIRONMENTAL SATELLITES

Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention

Why GAO Did This Study

Environmental satellites provide critical data used in forecasting weather and measuring variations in climate over time. NPOESS—a program managed by NOAA, DOD, and the National Aeronautics and Space Administration—was planned to replace two existing polar-orbiting environmental satellite systems. However, 8 years after a development contract for the NPOESS program was awarded in 2002, the cost estimate had more than doubled—to about $15 billion, launch dates had been delayed by over 5 years, significant functionality had been removed from the program, and the program's tri-agency management structure had proven to be ineffective. In February 2010, a presidential task force decided to disband NPOESS and, instead, to have NOAA and DOD undertake separate acquisitions.

GAO was asked to evaluate (1) efforts to transfer responsibilities from the NPOESS program to the separate NOAA and DOD programs, (2) NOAA's progress in developing its satellite system, and (3) NOAA's efforts to mitigate key project risks. To do so, GAO analyzed program management, contract, cost, and risk data, attended executive program reviews, and interviewed agency and contractor officials.

What GAO Recommends

GAO is making a recommendation to NOAA to establish mitigation plans to address the risk of satellite data gaps. NOAA agreed with GAO's recommendation and noted that the agency is developing a report to address the risk of data gaps.

View GAO-12-604. For more information, contact David Powner at (202) 512-9286 or pownerd@gao.gov.

What GAO Found

Following the decision to disband the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program in 2010, both the National Oceanic and Atmospheric Administration (NOAA) and the Department of Defense (DOD) made initial progress in transferring key management responsibilities to their separate program offices. Specifically, NOAA established a Joint Polar Satellite System (JPSS) program office, documented its requirements, and transferred existing contracts for earth-observing sensors to the new program. DOD established its Defense Weather Satellite System program office and modified contracts accordingly. However, recent events have resulted in major program changes at both agencies. NOAA plans to revise its program requirements to remove key elements, including sensors and ground-based data processing systems, to keep the program within budget. Further, in early 2012, DOD decided to terminate its program and reassess its requirements.

Over the past year, NOAA has made progress in developing its satellite system, but critical decisions and milestones lie ahead. In October 2011, the JPSS program office successfully launched a satellite originally called the NPOESS Preparatory Project (NPP). Data from the satellite are currently being calibrated and validated, and NOAA meteorologists started using selected satellite data products in their weather forecasts in May 2012. Further, the three major components of the JPSS program (the flight, ground, and free-flyer projects) are at different stages of development. Within the flight project, development of the sensors for the first JPSS satellite is well under way; however, selected sensors are experiencing technical issues. The ground project is currently in operation supporting NPP and NOAA is planning to upgrade parts of the ground system infrastructure to increase its security and reliability. The free-flyer project, intended to integrate and launch key instruments that could not be accommodated on the JPSS satellites, is still in a planning stage because NOAA has not yet decided which satellites will host the instruments or when these satellites will launch.

The JPSS program office has implemented elements of an effective risk management process; however, the program still faces significant risks. It does not yet have a cost and schedule baseline in place, the program office is not yet fully staffed, and there will likely be a gap in satellite data lasting 17 to 53 months from the time NPP is projected to cease operations and the first JPSS satellite begins to operate. There are also potential satellite data gaps in the DOD and European polar satellite programs, which provide supplementary information to NOAA forecasts. The JPSS program office is managing the first two risks, but NOAA has not established plans to mitigate potential satellite gaps. Until these risks are mitigated and resolved, civilian and military satellite data users may not have the information they need for timely weather forecasting, thereby risking lives, property, and commerce.

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Abbreviations

ATMS	Advanced Technology Microwave Sounder
CERES	Cloud and Earth's Radiant Energy System
CrIS	Cross-Track Infrared Sounder
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DWSS	Defense Weather Satellite System
IDPS	Interface Data Processing Segment
JPSS	Joint Polar Satellite System
MetOp	Meteorological Operational (satellite)
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project (original)/ National Polar-orbiting Partnership (current)
OMPS	Ozone Mapping and Profiler Suite
POES	Polar-orbiting Operational Environmental Satellites
VIIRS	Visible/Infrared Imager/Radiometer Suite

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GAO
Accountability * Integrity * Reliability
United States Government Accountability Office
Washington, DC 20548

June 15, 2012

The Honorable Ralph Hall
Chairman
The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) program was planned to be a state-of-the-art, environment-monitoring satellite system that would replace two existing polar-orbiting environmental satellite systems. Managed jointly by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), the Department of Defense (DOD)/U.S. Air Force, and the National Aeronautics and Space Administration (NASA), the program was considered critical to the nation's ability to maintain the continuity of data required for weather forecasting and global climate monitoring through the year 2026.

However, in the 8 years after the development contract was awarded in 2002, the NPOESS cost estimate had more than doubled—to about $15 billion, launch dates had been delayed by over 5 years, significant functionality had been removed from the program, and the program's tri-agency management structure had proven to be ineffective. Importantly, delays in launching the satellites put the program's mission at risk. To address these challenges, a task force led by the White House's Office of Science and Technology Policy reviewed the management and governance of the NPOESS program. In February 2010, the Director of the Office of Science and Technology Policy announced a decision to disband the NPOESS acquisition and, instead, to have NOAA and DOD undertake separate acquisitions, with NOAA responsible for satellites in the afternoon orbit and DOD responsible for satellites in the early morning orbit. After that decision, both agencies began developing plans for their separate programs, called the Joint Polar Satellite System (JPSS) and the Defense Weather Satellite System (DWSS), respectively.

This report responds to your request that we (1) evaluate efforts to transfer management and contract responsibilities from the NPOESS program to the separate NOAA and DOD programs, (2) assess NOAA's progress in developing the NPOESS Preparatory Project (NPP) and JPSS, and (3) evaluate NOAA's efforts to mitigate key project risks.

To evaluate efforts to transfer management and contract responsibilities from NPOESS programs to separate NOAA and DOD programs, we compared NOAA's and DOD's plans for establishing program management offices and transferring contracts to each agency's actual accomplishments. We also observed NOAA's monthly program management briefings and interviewed NOAA, NASA, and DOD officials to obtain insights into risks, issues, and transition schedules. To assess progress in developing the NPP and JPSS satellite systems, we compared NOAA's plans for key milestones to its accomplishments and interviewed agency and contractor officials. We also interviewed key NOAA and DOD satellite data users to determine their experiences in working with NPP data as well as their plans for working with JPSS data. To evaluate NOAA's efforts to mitigate key project risks, we compared the agency's risk management process to best practices in risk management as identified by leading systems engineering organizations, and interviewed agency officials.

We conducted this performance audit from May 2011 to June 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. Additional details on our objectives, scope, and methodology are provided in appendix I.

Background

Since the 1960s, the United States has operated two separate operational polar-orbiting meteorological satellite systems: the Polar-orbiting Operational Environmental Satellite (POES) series, which is managed by NOAA, and the Defense Meteorological Satellite Program (DMSP), which is managed by the Air Force.[1] These satellites obtain environmental data that are processed to provide graphical weather images and specialized weather products. These satellite data are also the predominant input to numerical weather prediction models, which are a primary tool for forecasting weather days in advance—including forecasting the path and intensity of hurricanes. The weather products and models are used to predict the potential impact of severe weather so that communities and emergency managers can help prevent and

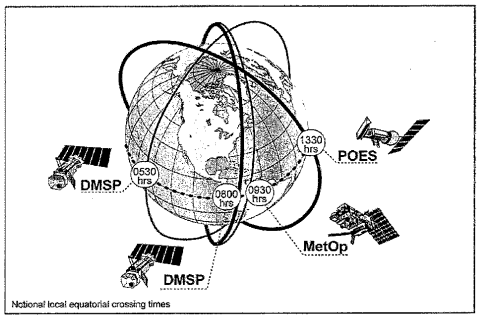
[1]NOAA provides command and control for both the POES and DMSP satellites after they are in orbit.

mitigate its effects. Polar satellites also provide data used to monitor environmental phenomena, such as ozone depletion and drought conditions, as well as data sets that are used by researchers for a variety of studies such as climate monitoring.

Unlike geostationary satellites, which maintain a fixed position relative to the earth, polar-orbiting satellites constantly circle the earth in an almost north-south orbit, providing global coverage of conditions that affect the weather and climate. Each satellite makes about 14 orbits a day. As the earth rotates beneath it, each satellite views the entire earth's surface twice a day. Currently, there is one operational POES satellite and two operational DMSP satellites that are positioned so that they cross the equator in the early morning, midmorning, and early afternoon. In addition, the government relies on a European satellite, called the Meteorological Operational (MetOp) satellite, for satellite observations in the midmorning orbit.[2] Together, the satellites ensure that, for any region of the earth, the data provided to users are generally no more than 6 hours old. Besides the operational satellites, six older satellites are in orbit that still collect some data and are available to provide limited backup to the operational satellites should they degrade or fail. The last POES satellite was launched in February 2009. The Air Force plans to launch its two remaining DMSP satellites as needed. Figure 1 illustrates the current operational polar satellite constellation.

[2]The European Organisation for the Exploitation of Meteorological Satellites' MetOp program is a series of three polar-orbiting satellites dedicated to operational meteorology. MetOp satellites are planned to be launched sequentially over 14 years. The first of these satellites was launched in 2006 and is currently operational. The next two are expected to launch in 2012 and 2017, respectively.

Figure 1: Configuration of Operational Polar Satellites

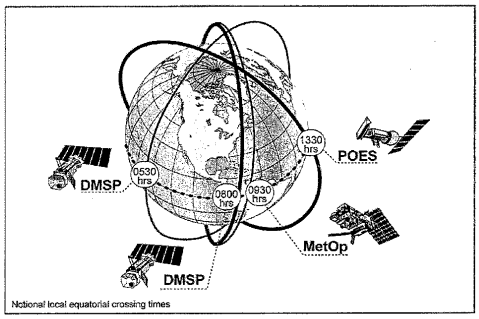


Sources: GAO, based on NPOESS Integrated Program Office and DOD data, Map Resources (globe).

Polar Satellite Data and Products

Polar satellites gather a broad range of data that are transformed into a variety of products. Satellite sensors observe different bands of radiation wavelengths, called channels, which are used for remotely determining information about the earth's atmosphere, land surface, oceans, and the space environment. When first received, satellite data are considered raw data. To make them usable, processing centers format the data so that they are time-sequenced and include earth-location and calibration information. After formatting, these data are called raw data records. The centers further process these raw data records into channel-specific data sets, called sensor data records and temperature data records. These data records are then used to derive weather and climate products called environmental data records. These environmental data records include a wide range of atmospheric products detailing cloud coverage, temperature, humidity, and ozone distribution; land surface products showing snow cover, vegetation, and land use; ocean products depicting sea surface temperatures, sea ice, and wave height; and characterizations of the space environment. Combinations of these data records (raw, sensor, temperature, and environmental data records) are also used to derive more sophisticated products, including outputs from

Figure 1: Configuration of Operational Polar Satellites



Sources: GAO, based on NPOESS Integrated Program Office and DOD data, Map Resources (globe).

Polar Satellite Data and Products

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The NPOESS Program: Inception, Challenges, and Divergence

With the expectation that combining the POES and DMSP programs would reduce duplication and result in sizable cost savings, a May 1994 Presidential Decision Directive required NOAA and DOD to converge the two satellite programs into a single satellite program—NPOESS—capable of satisfying both civilian and military requirements.[3] The converged program, NPOESS, was considered critical to the nation's ability to maintain the continuity of data required for weather forecasting and global climate monitoring. NPOESS satellites were expected to replace the POES and DMSP satellites in the morning, midmorning, and afternoon orbits when they neared the end of their expected life spans.

To manage this program, DOD, NOAA, and NASA formed a tri-agency Integrated Program Office, with NOAA responsible for overall program management for the converged system and for satellite operations, the Air Force responsible for acquisition, and NASA responsible for facilitating the development and incorporation of new technologies into the converged system.

When the primary NPOESS contract was awarded in August 2002, the program was estimated to cost about $7 billion through 2018. The program was to include the procurement and launch of 6 satellites over the life of the program, with each satellite hosting a subset of 13 instruments. The planned instruments included 11 environmental sensors, and two systems supporting specific user services (see table 1). To reduce the risk involved in developing new technologies and to maintain climate data continuity, the program planned to launch the NPP demonstration satellite in May 2006.[4] NPP was to demonstrate selected instruments that would later be included on the NPOESS satellites. The first NPOESS satellite was to be available for launch in March 2008.

[3]Presidential Decision Directive NSTC-2, May 5, 1994.

[4]In January 2012, the name of the satellite was changed to the Suomi National Polar-orbiting Partnership satellite. The NPP acronym remained the same.

Table 1: Anticipated NPOESS Instruments, as of July 2002

Instrument	Instrument type	Description
Advanced technology microwave sounder (ATMS)	Environmental sensor	Measures microwave energy released and scattered by the atmosphere; to be used in combination with the cross-track infrared sounder to produce daily global atmospheric temperature, humidity, and pressure profiles.
Aerosol polarimetry sensor	Environmental sensor	Retrieves specific aerosol (liquid droplets or solid particles suspended in the atmosphere, such as sea spray, smog, and smoke) and cloud measurements.
Conical microwave imager/sounder	Environmental sensor	Collects microwave images and data needed to measure rain rate, ocean surface wind speed and direction, amount of water in the clouds, and soil moisture, as well as temperature and humidity at different atmospheric levels.
Cross-track infrared sounder (CrIS)	Environmental sensor	Collects measurements of the infrared radiation emitted and scattered by the Earth and atmosphere to determine the vertical distribution of temperature, moisture, and pressure in the atmosphere.
Data collection system	System providing services to selected users	Collects environmental data from platforms around the world and delivers them to users worldwide.
Earth radiation budget sensor	Environmental sensor	Measures solar short-wave radiation and long-wave radiation released by the Earth back into space on a worldwide scale to enhance long-term climate studies.
Global positioning system occultation sensor	Environmental sensor	Measures the refraction of radio wave signals from the Global Positioning System and Russia's Global Navigation Satellite System to characterize the ionosphere and information related to the vertical distribution of temperature and moisture of the atmosphere.
Ozone mapper/ profiler suite (OMPS)	Environmental sensor	Collects data needed to measure the amount and distribution of ozone in the Earth's atmosphere. Consists of two components (nadir and limb) that can be provided separately.
Radar altimeter	Environmental sensor	Measures variances in sea surface height/topography and ocean surface roughness, which are used to determine sea surface height, significant wave height, and ocean surface wind speed and to provide critical inputs to ocean forecasting and climate prediction models.
Search and rescue satellite-aided tracking system	System providing services to selected users	A subsystem that detects and locates aviators, mariners, and land-based users in distress.
Space environmental sensor suite	Environmental sensor	Collects data to identify, reduce, and predict the effects of space weather on technological systems, including satellites and radio links.
Total and spectral solar irradiance sensor	Environmental sensor	Monitors and captures total and spectral solar irradiance data.
Visible/infrared imager radiometer suite (VIIRS)	Environmental sensor	Collects images and radiometric data used to provide information on the Earth's clouds, atmosphere, ocean, and land surfaces.

Source: GAO analysis of data from the former NPOESS Integrated Program Office.

In the years after the program was initiated, NPOESS encountered significant technical challenges in sensor development, program cost growth, and schedule delays. By November 2005, we estimated that the

program's cost had grown to $10 billion, and the schedule for the first launch was delayed by almost 2 years.[5] These issues led to a 2006 decision to restructure the program, which reduced the program's functionality by decreasing the number of planned satellites from 6 to 4, and the number of instruments from 13 to 9. As part of the decision, officials decided to reduce the number of orbits from three (early morning, midmorning, and afternoon) to two (early morning and afternoon) and to rely solely on the European satellites for midmorning orbit data.

Even after the restructuring, however, the program continued to encounter technical issues in developing two sensors, significant tri-agency management challenges, schedule delays, and further cost increases. Because the schedule delays could lead to satellite data gaps, in March 2009, agency executives decided to use NPP as an operational satellite.[6] Later, in August 2009, faced with costs that were expected to reach about $15 billion and launch schedules that were delayed by over 5 years, the Executive Office of the President formed a task force, led by the Office of Science and Technology Policy, to investigate the management and acquisition options that would improve the NPOESS program. As a result of this review, in February 2010, the Director of the Office of Science and Technology Policy announced that NOAA and DOD would no longer jointly procure the NPOESS satellite system; instead, each agency would plan and acquire its own satellite system.[7] Specifically, NOAA would be responsible for the afternoon orbit and the observations planned for the first and third satellites. DOD would be responsible for the early morning orbit and the observations planned for the second and fourth satellites. The partnership with the European satellite agencies for the midmorning orbit was to continue as planned. When this decision was announced, NOAA immediately began planning for a new satellite program in the afternoon orbit—called JPSS—and DOD began planning for a new satellite program in the morning orbit—called DWSS.

[5]GAO, *Polar-Orbiting Operational Environmental Satellites: Technical Problems, Cost Increases, and Schedule Delays Trigger Need for Difficult Trade-off Decisions*, GAO-06-249T (Washington, D.C.: Nov. 16, 2005).

[6]Using NPP as an operational satellite means that the satellite's data will be used to provide climate and weather products.

[7]The announcement accompanied the release of the President's fiscal year 2011 budget request.

Overview of Initial NOAA and DOD Plans for Replacement Satellite Programs

After the decision was made to disband the NPOESS program in 2010, NOAA and DOD began planning for their respective satellite programs. For NOAA, these plans included:

- relying on NASA for system acquisition, engineering, and integration;
- completing, launching, and supporting NPP;
- acquiring and launching two satellites for the afternoon orbit, called JPSS-1 and JPSS-2;
- developing and integrating five sensors on the two satellites;
- finding alternate host satellites for selected instruments that would not be accommodated on the JPSS satellites; and
- providing ground system support for NPP, JPSS, and DWSS; data communications for MetOp and DMSP; and data processing for NOAA's use of microwave data from an international satellite.

In 2010, NOAA estimated that the life cycle costs of the JPSS program would be approximately $11.9 billion for a program lasting through fiscal year 2024, which included $2.9 billion in NOAA funds spent on NPOESS through fiscal year 2010.[8]

Alternatively, DOD planned that its DWSS program would be comprised of two satellites, the first to be launched no earlier than 2018. Each satellite was to have three sensors: a Visible/Infrared Imager/Radiometer Suite, a Space Environment Monitor, and a microwave imager/sounder. As of September 2011, DOD planned to conduct a thorough system requirements review before finalizing DWSS functionality, cost, and schedule. Table 2 compares the planned cost, schedule, and scope of the three satellite programs at different points in time.

[8]This figure does not include approximately $2.9 billion in sunk costs that DOD spent on NPOESS through fiscal year 2010.

Table 2: A Comparison of NPOESS and the NOAA and DOD Plans for Replacing NPOESS, at Different Points in Time

Key area	NPOESS program before it was restructured (as of May 2006)	NPOESS program after it was restructured (as of June 2006)	NPOESS program prior to being disbanded (as of February 2010)	NOAA and DOD acquisition plans (as of May 2010)
Life cycle range	1995-2020	1995-2026	1995-2026	JPSS: 1995-2024 DWSS: not determined
Estimated life cycle cost	$8.4 billion	$12.5 billion	$13.95+ billion[a]	JPSS: $11.9 billion (which includes about $2.9 billion spent through fiscal year 2010 on NPOESS) DWSS: not determined
Number of satellites	6 (in addition to NPP)	4 (in addition to NPP)	4 (in addition to NPP)	JPSS: 2 (in addition to NPP) DWSS: 2
Number of orbits	3 (early morning, midmorning, and afternoon)	2 (early morning and afternoon; would rely on European satellites for midmorning orbit data)	2 (early morning and afternoon; would rely on European satellites for midmorning orbit data)	JPSS: 1 (afternoon orbit) DWSS: 1 (early morning orbit) (European satellites would provide midmorning orbit)
Launch schedule	NPP by October 2006 First NPOESS (C1) by November 2009 Second NPOESS (C2) by June 2011	NPP by January 2010 C1 by January 2013 C2 by January 2016 C3 by January 2018 C4 by January 2020	NPP no earlier than September 2011 C1 by March 2014 C2 by May 2016 C3 by January 2018 C4 by January 2020	JPSS: • NPP –no earlier than September 2011 • JPSS-1 (C1 equivalent) available in 2015 • JPSS-2 (C3 equivalent) available in 2018 DWSS: no earlier than 2018
Number of sensors	11 sensors and 2 user services systems	NPP: 4 sensors C1: 6 sensors C2: 2 sensors C3: 6 sensors C4: 2 sensors	NPP: 5 sensors C1: 7 sensors[b] C2: 2 sensors C3: 6 sensors C4: 2 sensors	NPP: 5 sensors JPSS-1 and 2: 5 sensors[c] DWSS: 3 sensors

Source: GAO analysis of NOAA, DOD, and task force data.

[a]Although the program baseline was $13.95 billion in February 2010, we estimated in June 2009 that this cost could grow by about $1 billion. In addition, officials from the Executive Office of the President stated that they reviewed life-cycle cost estimates from DOD and the NPOESS program office of $15.1 billion and $16.45 billion, respectively.

[b]In May 2008, the NPOESS Executive Committee approved an additional sensor—the Total and Spectral Solar Irradiance Sensor—for the C1 satellite.

[c]The five sensors are ATMS, the Clouds and Earth's Radiant Energy System (CERES), CrIS, OMPS, and VIIRS. NOAA also committed to finding an alternative spacecraft and launch accommodation for the Total and Spectral Solar Irradiance Sensor, the Advanced Data Collection System, and the Search and Rescue Satellite-Aided Tracking system.

Prior GAO Work Recommended Actions to Solidify Plans and Address Risks

We have issued a series of reports on the NPOESS program highlighting technical issues, cost growth, and key management challenges affecting the tri-agency program structure.[9] For example, in June 2009, we added to our previous concerns about the tri-agency oversight of the NPOESS program.[10] We reported that the Executive Committee responsible for providing direction to the program was ineffective because the DOD acquisition executive did not attend committee meetings; the committee did not track action items to closure; and many of the committee's decisions did not achieve the desired outcomes. We also reported that the program's cost estimates were expected to rise and that the launch schedules were expected to be delayed. To help address these issues, we made recommendations to, among other things, improve executive-level oversight and develop realistic time frames for revising cost and schedule baselines. Agency officials agreed with our recommendations and took steps to improve executive oversight.

More recently, in May 2010, we reported on NOAA's and DOD's preliminary plans for initiating new environmental satellite programs and noted that agency officials had not yet made key decisions on their programs' cost, schedule, and capabilities and we highlighted key risks in transitioning from NPOESS to their new programs.[11] These risks included the loss of key staff and capabilities, delays in negotiating contract changes and establishing new program offices, the loss of support for the other agency's requirements, and insufficient oversight of new program management. We recommended that the Secretaries of Defense and Commerce direct their respective NPOESS follow-on programs to expedite decisions on the expected cost, schedule, and capabilities of their planned programs, and to develop plans to address the key transition risks we identified. As discussed later in this report, both agencies subsequently made decisions about the scope of their respective programs and took steps to mitigate the transition risks we

[9]For a full list of our reports on polar-orbiting environmental satellites, see "Related GAO Products" at the end of this report.

[10]GAO, *Polar-orbiting Environmental Satellites: With Costs Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making,* GAO-09-564 (Washington, D.C.: June 17, 2009).

[11]GAO, *Polar-Orbiting Environmental Satellites: Agencies Must Act Quickly to Address Risks That Jeopardize the Continuity of Weather and Climate Data,* GAO-10-558 (Washington, D.C.: May 27, 2010).

identified. For example, NOAA transferred key staff from the NPOESS program to the JPSS program and coordinated with the Air Force to negotiate contract changes.

Agencies Transferred Responsibilities to Their Respective Programs, but NOAA's Is Being Downsized, and DOD's Has Been Terminated

Following the decision to disband NPOESS, both NOAA and DOD were responsible for transferring key management responsibilities to their respective programs. This entailed (1) establishing separate program offices for their respective follow-on programs, (2) establishing requirements for their respective programs, and (3) transferring contracts from NPOESS to the new programs.

Both agencies made progress on these activities, but recent events have resulted in major program changes. Specifically, NOAA established its JPSS program office, established program requirements, and transferred most sensor contracts. However, the agency now plans to remove key requirements, including selected sensors and ground systems, to keep the program within budget. DOD established its DWSS program office and modified its contracts accordingly before deciding in early 2012 to terminate the program and reassess its requirements (as directed by Congress).

NOAA Established the JPSS Program and Contracts for Most Components, but Plans to Modify Requirements to Limit Costs

After the February 2010 decision to disband NPOESS, NOAA transferred management responsibilities to its new satellite program, defined its requirements, and transferred contracts to the new program. Specifically, NOAA established a program office to guide the development of the NPP and JPSS satellites. NOAA also worked with NASA to establish its program office to oversee the acquisition, system engineering, and integration of the satellite program. By 2011, the two agencies had established separate—but colocated—JPSS program offices, each with different roles and responsibilities. NOAA's program office is responsible for programmatic activities related to the satellites' development, including managing requirements, budgets, and interactions with satellite data users. Alternatively, NASA's program office is responsible for the development and integration of the sensors, satellites, and ground systems. In January 2012, both agencies approved a management control plan that delineates the two agencies' roles, responsibilities, and executive oversight structure.

In September 2011, NOAA established its official requirements document for the JPSS program. This document defines the components of the program as well as the expected performance of the satellites and ground

systems. Key components include NPP, the two JPSS satellites, the five sensors, a distributed ground-based network of satellite data receptor sites, and four ground-based data processing systems. This system is to deliver 31 satellite data products within 80 minutes of observation on the first satellite and within 30 minutes on the second satellite.

Over the 2 years since the decision to disband NPOESS, NOAA has also been working to transfer and refine the contracts for four of the sensors that are to be launched on the first JPSS satellite from the Air Force to NASA.[12] The program completed the transfer of all of the contracts by September 2011 and then began the process of updating the contracts to match JPSS' requirements. This process has been completed for three sensors (CrIS, OMPS, and ATMS). Program officials expect to finalize changes to the contract for the last sensor (VIIRS) in June 2012.

NOAA Plans to Modify Requirements and May Remove Program Elements to Keep Costs at $12.9 Billion

While NOAA and NASA have made progress in transferring management and contract responsibilities from NPOESS to the JPSS program, NOAA recently decided to modify its requirements in order to limit program costs. From January to December 2011, the agency went through a cost estimating exercise for the JPSS program. This exercise included identifying key program elements, documenting assumptions, performing historical and parametric analysis to determine reasonable estimates for the elements, seeking an independent cost estimate, and reconciling the two estimates. At the end of this exercise, NOAA validated that the cost of the full set of JPSS functions from fiscal year 2012 through fiscal year 2028 would be $11.3 billion. After adding the agency's sunk costs of $3.3 billion, the program's life cycle cost estimate totaled $14.6 billion.[13] This amount is $2.7 billion higher than the $11.9 billion estimate for JPSS when NPOESS was disbanded in 2010. According to NOAA officials, this increase is primarily due to a 4-year extension of the program from 2024 to 2028, the addition of previously unbudgeted items such as the free flyers, cost growth associated with transitioning contracts from DOD to NOAA, and the program's decision to slow down work on lower-priority elements because of budget constraints in 2011.

[12]CERES was already a NASA contract during the NPOESS program, so this contract did not need to be transferred from the Air Force.

[13]NOAA's $3.3 billion sunk costs included $2.9 billion through fiscal year 2010 and about $400 million in fiscal year 2011.

In working with the Office of Management and Budget to establish the president's fiscal year 2013 budget request, NOAA officials stated that they agreed to fund JPSS at roughly $900 million per year through 2017, to merge funding for two climate sensors into the JPSS budget, and to cap the JPSS life cycle cost at $12.9 billion through 2028. Because this cap is $1.7 billion below the expected $14.6 billion life cycle cost of the full program, NOAA decided to remove selected elements from the satellite program. While final decisions on what will be removed are expected by the end of June 2012, NOAA may discontinue:

- support for OMPS operations on JPSS-1;
- development of two of the three planned Total and Spectral Solar Irradiance Sensors, the spacecraft for all three of these sensors, and the launch vehicle for the three sensors;
- development of the OMPS and CERES sensors on JPSS-2;
- plans for a network of ground-based receptor stations;
- planned improvements in the time it takes to obtain satellite data from JPSS-2 (the requirement was to provide data in 30 minutes; instead, the requirement will remain at the JPSS-1 level of 80 minutes);
- plans to install an Interface Data Processing Segment (IDPS) at two Navy locations; and
- plans to support ground operations for DOD's future polar satellite program.

NOAA anticipates modifying its official requirements documents to reflect these changes by the end of 2012. The removal of these elements will affect both civilian and military satellite data users. The loss of OMPS and CERES satellite data could cause a break in the over 30-year history of satellite data and would hinder the efforts of climatologists and meteorologists focusing on understanding changes in the earth's ozone coverage and radiation budget.[14] The loss of ground-based receptor stations means that NOAA may not be able to improve the timeliness of

[14]The radiation budget is the amount of the solar energy entering and leaving the earth's atmosphere.

JPSS-2 satellite data from 80 minutes to the current 30 minute requirement, and as a result, weather forecasters will not be able to update their weather models using the most recent satellite observations. Further, the loss of the data processing systems at the two Navy locations means that NOAA and the Navy will need to establish an alternative way to provide data to the Navy.

DOD Established and Subsequently Terminated Its DWSS Program

After the February 2010 decision to disband NPOESS, DOD transferred management responsibilities to its new satellite program, started defining its requirements, and modified contracts to reflect the new program. Specifically, in 2010, DOD established a DWSS program office and started developing plans for what the satellite program would entail. The DWSS program office, located at the Space and Missile Systems Center in Los Angeles, California, was given responsibility for the acquisition, development, integration, and launch of the DWSS satellites. Because this is considered a major acquisition, it is overseen by the Defense Acquisition Board and the Under Secretary of Defense for Acquisition, Technology, and Logistics.

In August 2010, the agency determined that the DWSS program would include two satellites and that each satellite would host three sensors.[15] Over the following year, the program office developed a program plan and a technical description, and planned to define requirements in early 2012. Further, the agency started modifying its existing contracts with the NPOESS contractor to reflect the new program. By May 2011, the program office had contracted for DWSS activities through the end of 2012.

These efforts, however, have been halted. In early 2012, with congressional direction, DOD decided to terminate the DWSS program because it still has two DMSP satellites to launch and it did not yet need the DWSS satellites.[16] In January 2012, the Air Force halted work on the

[15]These sensors included VIIRS, a space environment monitor, and a microwave imager/sounder.

[16]DOD officials stated that they plan to launch DMSP-19 in 2014 and DMSP-20 when needed. If DMSP-19 lasts 6 years, there is a chance that DMSP-20 would not be launched until 2020. Thus, in a best-case scenario, the follow-on satellites would not need to be launched until 2026.

program. DOD is currently identifying alternative means to fulfill its future environmental satellite requirements.

NPP Is in Orbit and Transmitting Data; Development of the First JPSS Satellite Has Begun, but Critical Steps Remain

In September 2010, shortly after NPOESS was disbanded, NOAA and NASA established plans for both NPP and JPSS. These plans included

- launching NPP by the end of October 2011 and completing an early on-orbit check out of the NPP spacecraft and sensors (called commissioning) by the end of January 2012;
- completing all NPP calibration and validation activities[17] by October 2013; and
- developing, testing, and launching JPSS-1 by the end of 2014 and JPSS-2 by the end of 2017.[18]

Program officials currently estimate that JPSS-1 will launch by March 2017 and JPSS-2 will launch by December 2022. NOAA officials explained that part of the reason for the change in launch dates is that the program's budget under the 2011 continuing resolution was only one third of what NOAA had anticipated. Thus, program officials decided to defer development of the first JPSS satellite in order to keep NPP on track.

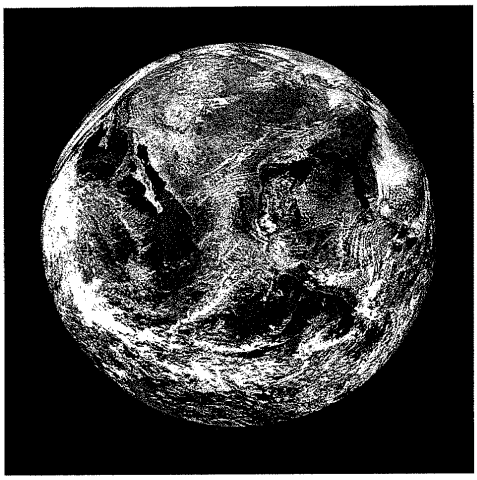
[17]After a satellite has been launched, scientists perform an on-orbit accuracy check, called calibration and validation, to verify that the sensors accurately report ground and atmospheric conditions. These activities ensure that satellite data products are ready for operational use.

[18]NOAA officials noted that the JPSS launch dates could change as the agency finalized its program planning activities.

NPP Is in Orbit; Sensor Data Are Being Calibrated for Use

NPP was successfully launched on October 28, 2011. After launch, NASA began the process of activating the satellite and commissioning the instruments. This process ended at the beginning of March 2012, which was a little over a month after the planned completion date at the end of January 2012. The delay was caused by an issue on the VIIRS instrument that caused the program to halt commissioning activities in order to diagnose the problem. Specifically, the quality of VIIRS data in certain bands was degrading much more quickly than expected. NASA and the JPSS program office subsequently identified the problem as contamination on VIIRS mirrors. NOAA and NASA program officials, including the JPSS director and project manager, reported that this issue is not expected to cause the instrument to fall below its performance specifications. Figure 4 depicts an image of Earth using VIIRS data from NPP.

Figure 4: Composite of VIIRS Images



Source: NASA.

Program officials are working to complete NPP calibration and validation activities by October 2013, but they acknowledge that they may encounter delays in developing satellite products. NOAA is receiving data from the five sensors on the NPP satellite, and has begun calibration and validation. According to NOAA and NASA officials, during this time, the products go through various levels of validation, including a beta stage (products have been minimally validated, but are available to users so that they can begin working with the data); a provisional stage (products are not optimal, but are ready for operational evaluation by users); and a validated stage (products are ready for operational use). The amount of time it takes for a product to be fully validated depends on the sensor and

the type of product. For example, NOAA provided a provisional ozone environmental data record from the OMPS sensor in April 2012 and expects to provide three beta environmental data records from the CrIS sensor by October 2012. NOAA's users began to use validated ATMS products in May 2012, and NOAA expects that they will increase the amount and types of data they use in the following months.

Development of JPSS Is Under Way; Critical Decisions and Milestones Are Pending

The major components of the JPSS program are at different stages of development, and important decisions and program milestones lie ahead. NASA's JPSS program office organized its responsibilities into three separate projects: (1) the flight project, which includes sensors, spacecraft, and launch vehicles; (2) the ground project, which includes ground-based data processing and command and control systems, and (3) the free-flyer project, which involves developing and launching the instruments that are not going to be included on the JPSS satellites. Table 3 shows the three JPSS projects and their key components.

Table 3: JPSS Projects and Components

Project	Key components and responsibilities
Flight	• Sensors: ATMS, CERES, CrIS, OMPS, VIIRS • Spacecraft • Launch vehicle
Ground	• Satellite command, control, and communications • Interface data processing segment (IDPS)
Free Flyer	• Sensor: Total and Spectral Solar Irradiance Sensor • Subsystems: Search and Rescue Satellite-aided Tracking System and the Advanced Data Collection System • Spacecraft • Launch vehicle

Source: NOAA's JPSS Program Office.

Within the flight project, development of the sensors for the first JPSS satellite is well under way; however, selected sensors are experiencing technical issues and the impact of these issues had not yet been determined. The ground project is currently in operation supporting NPP, and NOAA is planning to upgrade selected parts of the ground systems to increase security and reliability. The free-flyer project is still in a planning stage because NOAA has not yet decided which satellites will host the instruments or when these satellites will launch. One of these projects has recently completed a major milestone and one project has its next milestone approaching. Specifically, the flight project completed a

Table 4: Status of Key Components of the Flight Project Supporting the First JPSS Satellite, as of April 2012

Component	Status
Sensor	
ATMS	NASA estimates that this sensor is about 85 percent complete. However, the sensor is experiencing technical issues in development. For example, a mixer used in support of high-frequency sensing failed during development, and needs to be replaced. Program officials have not yet determined the impact of this issue on the sensor's cost and schedule.
CERES	According to NASA, this sensor has been developed, and completed environmental testing in May 2012. Pre-ship review is currently planned for June 2012.
CrIS	NASA estimates that this sensor is about 60 percent complete. The program office decided to move to a new data bus[a] because the one used on NPP is now obsolete. At present, this sensor has an 8-month schedule buffer.
OMPS- Nadir	NASA estimates that OMPS-Nadir is approximately 70 percent complete. Unlike NPP, there will not be a Limb component on JPSS-1.
VIIRS	NASA estimates the sensor is about 65 percent complete. The sensor has encountered a number of technical and workmanship issues that need to be addressed. For example, program and contract officials reported experiencing problems with the manufacturing and testing of parts by subcontractors, including a recent issue with one of the sensor's mirrors. In addition, the program office decided to move to a new data bus because the one used on NPP is now obsolete. Further, the program will need to address communication issues that could affect VIIRS' ability to provide data in every orbit, but they have not identified the potential cost and schedule impact of this issue.
Spacecraft	Development of the spacecraft has begun. A key milestone, the spacecraft's critical design review, is currently planned for early 2013. The spacecraft is currently on the critical path, which means that any delay in development will delay the launch date of the satellite.
Launch vehicle	The launch vehicle is currently being competed and NASA officials anticipate making a selection this year. However, each potential launch vehicle has different risks and costs associated with it. We recently reported that multiple NASA projects have encountered challenges with their launch vehicles, including the cost and availability of the vehicles and the uncertainty of using new, unproven vehicles.[b]

Source: GAO analysis of NOAA and NASA data.

[a]A data bus is used to allow high-speed communications and data transfer between the sensor and the spacecraft.

[b]GAO, *NASA: Assessments of Selected Large-Scale Programs*, GAO-12-207SP (Washington, D.C.: Mar. 1, 2012).

Ground Project: NOAA Plans Upgrades to Strengthen the Infrastructure

While NOAA ground systems for satellite command, control, and communications and for data processing are currently supporting NPP operations, the agency plans to upgrade the ground systems to improve their availability and reliability. In 2010, we reported that NPP's ground systems had weaknesses because they were developed using outdated security requirements approved in 1998. These weaknesses were highlighted soon after NPP was launched, when the communications links providing satellite data from the satellite receiver in Svalbard, Norway, to the United States were severed. NOAA immediately established a temporary backup capability, and plans to upgrade its communications

systems to establish permanent backup capabilities by the end of 2012. In addition, NOAA plans to enhance the backup capabilities of its data processing system infrastructure by November 2015.

Free Flyer Project: Key Decisions Have Been Made; Others Are Pending

The instruments in the free flyer project, including the Total and Spectral Solar Irradiance Sensor and two user services systems (the Search and Rescue Satellite-Aided Tracking system and an Advanced Data Collection system), are currently under development. However, in early 2012, NOAA decided to consider not launching the Total and Spectral Solar Irradiance Sensor as an option for staying within its budget cap. Moreover, the agency is still considering its options for the spacecraft that will carry the other two instruments to space. For example, it is considering contracting for a spacecraft or having the instruments hosted on some other organization's satellite. Table 5 depicts the status of the components of the free-flyer project.

Table 5: Status of Key Free Flyer Components, as of April 2012

Component	Status
Total and Spectral Solar Irradiance Sensor	Delivery of the first of three sensors is expected in March 2013.
Advanced Data Collection System	Delivery of this system by France's space agency is expected in May 2013.
Search and Rescue Satellite-Aided Tracking system	While one component of this system is five months behind schedule, delivery of this system, provided jointly by the France and Canadian space agencies, is scheduled for January 2015.
Free Flyer-1 spacecraft	NOAA is considering the possibility of not acquiring a spacecraft for the Total and Spectral Solar Irradiance Sensor. It is considering its alternatives for a spacecraft for the two other subsystems.
Launch vehicle	NOAA is considering the possibility of not launching the Total and Spectral Solar Irradiance Sensor. The program office has not decided on the launch vehicle for the two other subsystems.

Source: GAO analysis of NOAA and NASA data.

JPSS Risk Management Process in Place; Key Risks Remain

The JPSS program has a structured risk management process in place and is working to mitigate key program risks; however, NOAA faces key risks involving the potential for satellite gaps and does not yet have mitigation plans. According to best practices advocated by leading system engineering and program management organizations, effective risk management addresses four key areas: preparing for risk management, identifying and analyzing risks, mitigating risks, and providing executive

oversight.[19] The JPSS program office has implemented elements of an effective risk management process. Specifically, the program documented its risk management strategy; identified relevant stakeholders and designated responsibilities for risk management activities; established and implemented standards for categorizing and prioritizing risks; instituted a program to identify, track, and mitigate risks; and established a process for regularly communicating risks to senior NASA and NOAA management.

The JPSS program is working to mitigate the risks of a lack of a cost and schedule baseline and program office staffing shortfalls, but NOAA has not established mitigation plans to address the risk of a gap in the afternoon orbit or potential satellite data gaps in the DOD and European polar satellite programs, which provide supplementary information to NOAA forecasts. Because it could take time to adapt grounds systems to receive alternative satellites' data, delays in establishing mitigation plans could leave the agency little time to leverage its alternatives. Until NOAA identifies its mitigation options, it may miss opportunities to leverage alternative satellite data sources. Moreover, until NOAA establishes mitigation plans for a satellite data gap, it runs the risk of not being able to fulfill its mission of providing weather forecasts to protect lives, property, and commerce.

NOAA Is Working to Mitigate Delays in Establishing Cost and Schedule Baselines

NOAA oversaw the establishment of contracts for the JPSS-1 sensors and spacecraft and NASA is managing the cost, schedule, and deliverables on these contracts using discrete task orders, but the agencies have not established a contractual cost and schedule baseline that would allow them to monitor contractor deliverables within an earned value management system.[20] In addition, program officials have not yet established an overall program baseline that delineates the cost, schedule, and content of the entire program. Under NASA's acquisition life cycle, a program baseline is due at the key decision milestone

[19]See, for example, Carnegie Mellon University's Software Engineering Institute, *Capability Maturity Model® Integration for Acquisition, Version 1.3 (CMMI-ACQ, V1.3)* and Project Management Institute Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Third Edition*, (Newtown Square, PA: 2004).

[20]Earned value management is a technique for monitoring the cost and schedule of each work activity performed. It allows managers insights into the contractor's productivity and provides an early warning on cost and schedule variances.

scheduled to be completed by July 2013. Managing a program without a baseline makes it more difficult for program officials to make informed decisions and for program overseers to understand if the program is on track to successfully deliver expected functionality on cost and schedule.

Program officials acknowledge that the lack of a baseline is a risk, and they are tracking it through their risk management program. Program officials explained that after transferring the contracts from the Air Force to NASA, they needed to definitize the contracts to reflect JPSS program requirements instead of NPOESS program requirements. The JPSS program office has completed this process for three sensors (CrIS, OMPS, and ATMS) and is working to complete the process for one other sensor (VIIRS) by June 2012. After definitizing each contract to JPSS requirements and schedules, NASA and the contractors will perform an integrated baseline review before implementing an earned value management system. NOAA officials reported that they are working to establish contractual baselines as rapidly as practical for each of the contracts.

Program officials also plan to establish an overall program baseline. Actions planned to mitigate this risk include

- establishing a stable and realistic 5-year budget profile, which was completed in December 2011;
- refining the program requirements to match the expected budget by October 2012;
- definitizing contracts to address any changes in requirements in September 2012; and
- establishing the overall program baseline by the end of November 2012.

NOAA Is Working to Mitigate Risks in Program Staffing

NOAA and NASA have not yet fully staffed their respective JPSS program offices. While having a knowledgeable and capable program management staff is essential to any acquisition program, it is especially critical given the history of management challenges on the NPOESS program. However, NOAA has not yet filled 18 of the 64 positions it plans for the program office, including those for a program scientist and system engineers for the JPSS satellite, ground systems, and overall mission. In addition, NASA has not yet filled 6 positions it plans for its ground project.

Until these positions are filled, other staff members are supporting the workload and this could delay the schedule for implementing improvements in the ground systems.

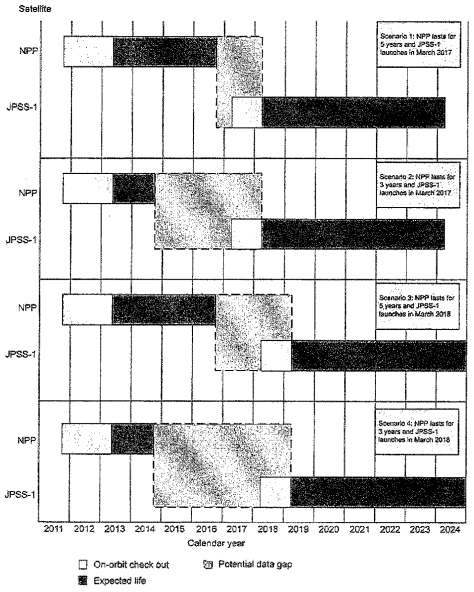
Both agencies are actively tracking their respective program offices' staffing and plans for filling vacancies. According to NOAA officials, the agency is mitigating this risk by filling three of the vacant positions with long-term detailees. Further, NOAA plans to fill most of the positions, including that of the technical director, by July 2012. NASA has started the process to fill its vacancies, and plans to fill these by the end of September 2012.

NOAA Has Not Established Plans to Mitigate an Expected Gap in Satellite Data Continuity

In September 2011, we reported that NOAA was facing a gap in satellite data continuity; the risk of that gap is higher today. When NPOESS was first disbanded, program officials anticipated launching the JPSS satellites in 2015 and 2018 (while acknowledging that these dates could change as the program's plans were firmed up). Over the past year, as program officials made critical decisions to defer work on JPSS in order to keep NPP on track, the launch dates for JPSS-1 and JPSS-2 have changed. Program officials currently estimate that JPSS-1 will be launched by March 2017 and JPSS-2 will be launched by December 2022.

NOAA officials acknowledge that there is a substantial risk of a gap in satellite data in the afternoon orbit, between the time when the NPP satellite is expected to reach the end of its life and the time when the JPSS-1 satellite is to be in orbit and operational. This gap could span from 17 months to 3 years or more. In one scenario, NPP would last its full expected 5-year life (to October 2016), and JPSS-1 would launch as soon as possible (in March 2017) and undergo on-orbit checkout for a year (until March 2018). In that case, the data gap would extend 17 months. In another scenario, NPP would last only 3 years as noted by NASA managers concerned with the workmanship of selected NPP sensors. Assuming that the JPSS-1 launch occurred in March 2017 and the satellite data was certified for official use by March 2018, this gap would extend for 41 months. Of course, any problems with JPSS-1 development could delay the launch date and extend the gap period. Given the history of technical issues and delays in the development of the NPP sensors and the current technical issues on the sensors, it is likely that the launch of JPSS-1 will be delayed. Figure 5 depicts four possible gap scenarios.

Figure 5: Potential Gaps in Polar Satellite Data in the Afternoon Orbit



Source: GAO analysis of NOAA data.

According to NOAA, a data gap would lead to less accurate and timely weather prediction models used to support weather forecasting, and advanced warning of extreme events—such as hurricanes, storm surges, and floods—would be diminished. To illustrate this, the National Weather

Service performed several case studies to demonstrate how its weather forecasts would have been affected if there were no polar satellite data in the afternoon orbit. For example, when the polar satellite data were not used to predict the "Snowmaggedon" winter storm that hit the Mid-Atlantic coast in February 2010, weather forecasts predicted a less intense storm, slightly further east, and producing half of the precipitation at 3, 4, and 5 days before the event. Specifically, weather prediction models under-forecasted the amount of snow by at least 10 inches. The agency noted that this level of degradation in weather forecasts could place lives, property, and critical infrastructure in danger.

NOAA officials have communicated publicly and often about the risk of a satellite data gap; however, the agency has not established plans to mitigate the gap. NOAA officials stated that the agency will continue to use existing POES satellites, as well as NPP, as long as they provide data and that there are no viable alternatives to the JPSS program. However, it is possible that other governmental, commercial, or international satellites could supplement the data. If there are viable options for obtaining data from external sources, it would take time to adapt NOAA systems to receive, process, and disseminate the data. Until NOAA identifies these options, it may miss opportunities to leverage these satellite data sources.

NOAA Has Not Established Plans to Mitigate the Risk That the Polar Satellite Constellation Is Becoming Increasingly Unreliable

Since its inception, NPOESS was seen as a constellation of satellites providing observations in the early morning, midmorning, and afternoon orbits. Having satellites in each of these orbits ensures that satellite observations covering the entire globe are no more than 6 hours old, thereby allowing for more accurate weather predictions. Even after the program was restructured in 2006 and eventually terminated in 2010, program officials and the administration planned to ensure coverage in the early morning, midmorning, and afternoon orbits by relying on DOD satellites for the early morning orbit, the European satellite program for the midmorning, and NOAA's JPSS program for the afternoon orbit. However, recent events have made the future of this constellation uncertain:

- **Early morning orbit**—As discussed earlier in this report, in early fiscal year 2012, DOD terminated its DWSS program. While the agency has two more satellites to launch and is working to develop alternative plans for a follow-on satellite program, there are considerable challenges in ensuring that a new program is in place

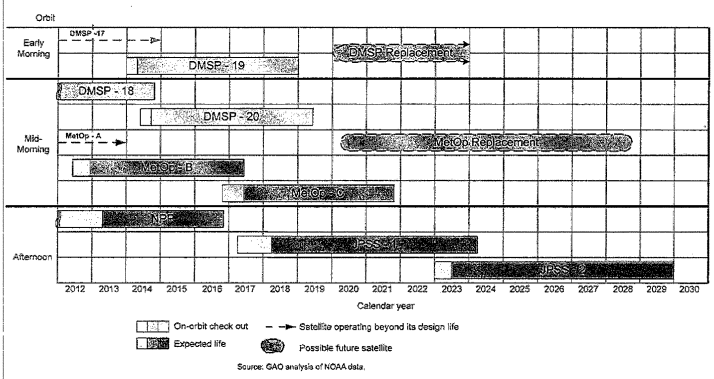
and integrated with existing ground systems and data networks in time to avoid a gap in this orbit.

DOD officials stated that they plan to launch DMSP-19 in 2014 and DMSP-20 when it is needed. If DMSP-19 lasts 6 years, there is a chance that DMSP will not be launched until 2020. Thus, in a best-case scenario, the follow-on satellites will not need to be launched until roughly 2026. However, civilian and military satellite experts have expressed concern that the DMSP satellites are quite old and may not work as intended. If they do not perform well, DOD could be facing a satellite data gap in the early morning orbit as early as 2014.

- **Midmorning orbit**—The European satellite organization plans to continue to launch MetOp satellites that will provide observations in the midmorning orbit through October 2021. The organization is also working to define and gain support for the follow-on program, called the Eumetsat Polar System-2nd Generation program. However, in 2011, NOAA alerted European officials that, because of the constrained budgetary environment, they will no longer be able to provide sensors for the follow-on program. Due to the uncertainty surrounding the program, there is a chance that the first European follow-on satellite will not be ready in time to replace MetOp at the end of its expected life. In that case, this orbit, too, would be in jeopardy.
- **Afternoon orbit**—As discussed previously, there is likely to be a gap in satellite observations in the afternoon orbit that could last well over one year. While our scenarios demonstrated gaps lasting between 17 and 53 months, NOAA program officials believe that the most likely scenario involves a gap lasting 18 to 24 months.

Figure 6 depicts the polar satellite constellation and the uncertain future coverage in selected orbits.

Figure 6: The Polar Satellite Constellation



Source: GAO analysis of NOAA data.

The NOAA Administrator and other senior executives acknowledge the risk of a data gap in each of the orbits of the polar satellite constellation and are working with European and DOD counterparts to coordinate their respective requirements and plans; however, they have not established plans for mitigating risks to the polar satellite constellation. As in the case of the anticipated gap in the afternoon orbit, NOAA plans to use older polar satellites to provide some of the necessary data for the other orbits. However, it is also possible that other governmental, commercial, or international satellites could supplement the data. For example, foreign nations continue to launch polar-orbiting weather satellites to acquire data such as sea surface temperatures, sea surface winds, and water vapor. Also, over the next few years, NASA plans to launch satellites that will collect information on precipitation and soil moisture.[21] If there are viable

[21]NASA plans to launch the Global Precipitation Measurement Mission satellite by June 2014 and the Soil Moisture Active and Passive satellite by January 2015.

options from external sources, it could take time to adapt NOAA systems to receive, process, and disseminate the data to its satellite data users. Until NOAA identifies these options and establishes mitigation plans, it may miss opportunities to leverage alternative satellite data sources.

Conclusions

After spending about $3.3 billion on the now-defunct NPOESS program, NOAA officials have established a $12.9-billion JPSS program and made progress in launching NPP, establishing contracts for the first JPSS satellite, and enhancing the ground systems controlling the satellites and processing the satellite data. JPSS program officials are currently working to calibrate NPP data so that they are useable by civilian and military meteorologists and to manage the development of sensors for the first JPSS satellite. In coming months, program officials face changing requirements, technical issues on individual sensors, key milestones in developing the JPSS satellite, and important decisions on how to accommodate instruments that are not included on the JPSS satellite.

While the JPSS program office is working to mitigate risks associated with not having a program baseline or a fully staffed program management office, NOAA has not established plans to mitigate the almost certain satellite data gaps in the afternoon orbit or the potential gaps in the early and mid-morning orbits. These gaps will likely affect the accuracy and timeliness of weather predictions and forecasts and could affect lives, property, military operations, and commerce. Because it could take time to adapt ground systems to receive an alternative satellite's data, delays in establishing mitigation plans could leave the agency little time to leverage alternatives. Until NOAA identifies its mitigation options, it may miss opportunities to leverage alternative satellite data sources.

Recommendations for Executive Action

Given the importance of polar-orbiting satellite data to weather forecasts, we recommend that the Secretary of Commerce direct the Administrator of NOAA to establish mitigation plans for risks associated with pending satellite data gaps in the afternoon orbit as well as potential gaps in the early morning and midmorning orbits.

Agency Comments and Our Evaluation

We sought comments on a draft of our report from the Department of Commerce, DOD, and NASA. We received written comments from the Secretary of Commerce, who transmitted NOAA's comments. In its comments, NOAA agreed with the report's recommendation and noted that the National Environmental Satellite, Data, and Information Service—

a NOAA component agency—has performed analyses on how to mitigate potential gaps in satellite data, but has not yet compiled this information into a report. The agency plans to provide a report to NOAA by August 2012. The department's comments are provided in appendix II. The department also provided technical comments, which we incorporated as appropriate.

While neither DOD nor NASA provided comments on the report's findings or recommendations, they offered technical comments, which we incorporated as appropriate. Specifically, the Staff Action Officer for the Space and Intelligence Office within the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics provided technical comments both orally and via e-mail, and a commander within the Navy's Oceanographer staff provided oral technical comments. In addition, the Project Manager of the JPSS flight project—a NASA employee—provided technical comments via e-mail.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution of it until 30 days from the date of this letter. We are sending copies of this report to interested congressional committees, the Secretary of Commerce, the Secretary of Defense, the Administrator of NASA, the Director of the Office of Management and Budget, and other interested parties. In addition, this report will be available on the GAO Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-9286 or at pownerd@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix III.

David A. Powner
Director, Information Technology Management Issues

Appendix I: Objectives, Scope, and Methodology

Our objectives were to (1) evaluate efforts to transfer management and contract responsibilities from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program to the separate satellite programs being established at the National Oceanic and Atmospheric Administration (NOAA) and Department of Defense (DOD), (2) assess NOAA's progress in developing the NPOESS Preparatory Project (NPP) satellite and the Joint Polar Satellite System (JPSS), and (3) evaluate NOAA's efforts to mitigate key project risks.

To evaluate efforts to transfer responsibilities from NPOESS to the separate NOAA and DOD programs, we compared the agencies' plans for establishing program management offices, developing program requirements, and transferring contracts to each agency's actual accomplishments. We analyzed key program documents, including acquisition decision memorandums, requirements documents, and the management control plan. We observed NOAA's monthly program management briefings and obtained detailed briefings on efforts to establish a program cost estimate, NOAA's fiscal year 2013 budget for JPSS, and decisions to remove selected program elements. To assess the reliability of the program's cost estimate, we compared agency documentation of the program office estimate and the independent cost estimate, and interviewed program officials and cost estimators to understand key aspects of and differences between the estimates. We determined that the estimates were sufficient for our purposes of providing summary data. We interviewed program officials from NOAA, DOD, and the National Aeronautics and Space Administration (NASA), to obtain information on transition schedules, progress, program requirements, and challenges.

To assess NOAA's progress in developing the NPP and JPSS satellite systems, we compared NOAA's plans for key milestones to its actual accomplishments. We reviewed monthly progress reports, draft program schedules, and the NPP operational readiness review package. We observed NOAA's monthly program management briefings to determine the status of key components. We interviewed both agency and contractor officials, including officials at Ball Aerospace, Inc. and Raytheon Space and Airborne Systems, Inc. We also interviewed key NOAA satellite data users, including officials involved in weather forecasting and numerical weather prediction, to identify their experiences in working with NPP data as well as their plans for working with JPSS data.

To evaluate NOAA's efforts to mitigate key project risks, we compared the agency's risk management process to best practices in risk management as identified by the Software Engineering Institute. We reviewed NOAA's program risk lists on a monthly basis to obtain insights into management issues and actions. We interviewed agency and contractor officials to evaluate actions to address each transition risk. In addition, we interviewed NOAA satellite data users to determine the impact of any changes in requirements.

We performed our work at NASA, NOAA, and DOD offices in the Washington, D.C., area and at contractor facilities in Los Angeles, California; Aurora, Colorado; and Boulder, Colorado. We conducted this performance audit from May 2011 to June 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.