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.

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.