Deputy Director Cheryl Martin 2013 Innovation Summit Keynote Address
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Thinking big has never been easy. Throughout history those who challenged conventional wisdom were not only criticized, but they frequently risked their health, safety, and even freedom. But that did not deter their efforts to tackle complex problems and overcome daunting odds. We call them explorers – those who dared to be different and venture where others would not go. They pushed the envelope and inspired innovation to solve the greatest challenges of their time.

Remember there was a time when everyone thought the world was flat and you couldn't sail west to go east. Explorers proved you could. People dreamed about walking on the moon. Explorers made it happen. Explorers dared to push the technical limits and venture miles under sea. In doing so they changed our understanding about what was possible.

ARPA-E embodies this same spirit of exploration for energy -- to tackle significant problems and take fresh approaches to existing challenges. To think big , to think bold , and to think differently in order to discover new paths, accelerate technology adoption and, ultimately, transform the way our country produces, transports, and consumes energy.

Since I came to ARPA-E, there are two questions that I get asked repeatedly. I'm sure the first one will come as no surprise to all of you. How do I get funding? But you may not expect the second most frequent question. How does ARPA-E measure success?

At ARPA-E we believe big ideas are important but only if they make a difference. I'd like to talk today about four areas where I believe we are making a difference. Convening great minds, fostering public partnerships, forming new companies, and spurring private investment.

The first is convening great minds.

At ARPA-E, we believe that great minds don't think alike. So we deliberately focus on convening people with diverse perspectives from different disciplines and institutions to solve some of our nation's most complex energy challenges. We believe transformational change happens when you dare people to think audaciously. We search out new ways of looking at problems and then fund multiple approaches toward the same goal.

Let me give you a couple of examples.

Our early battery programs at ARPA-E taught us that while new battery chemistries are crucial, there is also an enormous opportunity to improve battery performance – perhaps 25% or more-- through breakthroughs in battery management. Now, battery management is an active area of research today, but we found the various communities attacking parts of the problem without sufficient collaboration. We also saw exciting developments outside of the traditional battery sector - like advanced sensors. We asked the various communities to come together and think holistically about system level solutions incorporating all of the aspects of battery management from sensing to power control to real-time management algorithms. We even set up a teaming partner list to allow experts from these different disciplines to discover one another.

And it worked. Bringing people together in new ways sparked innovations in this space we never would have imagined. Let me highlight two separate projects: one led by PARC and one led by

Battelle. For the first – a group of experts at PARC had recently developed a low-cost optical fiber sensor system and had a bold idea: what if you ripped out all the traditional electrical sensors in a battery and replaced them with a fiber optic battery monitoring system? In responding to ARPA-E's solicitation, they were able to team with one of the top global battery suppliers and are now being funded to prove the concept.

Meanwhile, on the other side of the country, an engineer at Battelle read our solicitation, and walked into his colleague's office with an entirely new approach --- to use the battery itself as an optical sensor medium. They quickly assembled a multidisciplinary team -- an electrical engineer, a battery materials expert, a physicist, and an optics expert -- to brainstorm this self-proclaimed "crazy idea". Well, that idea too is now being funded, in collaboration with a university, under our program.

So here we have two, distinct innovative projects utilizing optical control technologies for batteries – some may say this is serendipity, but we think it may just be exactly the type of new technology inflection point that changes what's possible. We'll just have to stay tuned to find out!

Let me switch gears to another new project for my second example—one involving natural gas. Just over a year ago we convened 100 of the world's leading experts in physics, chemistry, and engineering to explore new options for natural gas conversion. The workshop sparked a connection between material scientists at Ceramatec, and chemists at UC Berkeley – groups that had never met and didn't realize they had solutions to each other's challenges.

The team at Berkeley had been making great strides on gas to liquid catalysis, but was stuck on membrane technology. Only after they partnered with the team at Ceramatec working on advanced membranes, could they chart a path forward.

Now the groups are embarking on a joint program to develop a small-scale membrane reactor to convert natural gas into transportable liquids in one simple process. If successful, this technology could allow efficient use of natural gas in the most remote locations – natural gas that today is just burned.

This originated from a one-day workshop. Again, some might call this serendipity. At ARPA-E, this is a core part of our strategy.

The next three areas where we are making a difference involve handoffs. The greatest discoveries take time, money and patience. After all, it took Christopher Columbus three funded trips to explore the new world. Because we focus exclusively on early stage R&D, many of our projects need additional investment to achieve their technical breakthroughs and move into the marketplace. When we launch projects, we expect a credible path to additional funding and commercialization. We have a dedicated tech to market team that partners with project teams from day one to help them identify the path that is right for them based on their technology and target market — think of it as market-oriented exploration.

PUBLIC PARTNERSHIPS

The first handoff is through fostering public partnerships. We have a number of projects that have obtained their next stage funding from another government partner. I'd like to highlight one of these.

We are all aware of the human and financial costs of moving fuel to our military bases on the front lines around the world. However, today there is no good alternative to using diesel generators to run the air conditioning and heating units, like you see here, needed to keep equipment and people functioning in these remote areas.

To address this challenge we recently announced a partnership with the U.S. Navy to advance research in 5 projects from ARPA-E's BEETIT program that has been focused on changing what's possible for air conditioning efficiency.

Infinia is one of these projects. They are developing an air conditioner and heater in a single unit that uses an unconventional, high-efficiency technology. Their cost-effective design uses a Stirling cycle machine with helium as a working fluid to heat or cool more efficiently than conventional systems. Infinia's improvements to these systems will enable the cost-effective, mass production of compact, high-efficiency air conditioners.

This partnership with Navy will give Infinia the resources necessary to customize their technology for military applications. If they're successful, they could reduce the amount of fuel used at war zone bases for cooling and heating by up to 50 percent. These same developments could also be applied in the commercial marketplace to make the heating and cooling systems we use every day more efficient.

ENCOURAGING NEW COMPANY FORMATION

The second handoff for our technologies is the formation of a new company. Since we began just over four years ago, we've witnessed technologies invented in university labs launch into new companies in energy storage, biofuels, and efficient thermo devices. The explorers leading these new start-ups believe in the promise of their technology and are taking the initiative to commercialize them.

One example involves the challenge of grid level storage. The capability to store electricity would provide the flexibility and reliability needed to transform the power grid from an electrical design that would still be recognizable to our grandparents, to a modern electric system capable of dealing with the complexities and challenges of the 21st Century. The engineers at City University in New York took up this challenge and recognized the key was to develop new battery chemistry with the right balance of ultra-low cost, long life and high efficiency.

Their approach was to develop a new zinc-manganese battery for storage – inspired by the very low cost 'non-rechargeable' flashlight batteries – but re-engineered to make them rechargeable. At last year's summit, they had demonstrated this approach on a lab scale, with thousands of recharging cycles at substantially less cost than the rechargeable batteries in laptops, or even less than lead-acid batteries used in cars.

Since then they formed a new company, Urban-Electric Power, right in the heart of Harlem. Their first test is in their own building, where they are running a demonstration system to manage peak

power and minimize electric demand charges. If they are successful, their energy storage systems will enable a robust, reliable, and more secure electrical grid.

There are ideas moving from lab toward the market across the board. As you know creating options for transportation fuels is critical. At ARPA-E we're exploring new possibilities to address this challenge: from thinking about how to make biofuels more easily, to how to power our vehicles with abundant natural gas, to literally inventing new sources – like electrofuels – created through pathways that have never before been considered.

We're working on the creation of a diverse portfolio of ways to power America. While most of our fuel technologies are still early in their development, we continue to see signs of progress in new approaches--for example those at UCLA and the University of Florida.

UCLA, in close partnership with Easel Biotechnologies, has developed and demonstrated a fully integrated prototype process. Their system integrates electrochemical reduction of carbon dioxide to produce formate that microorganisms then utilize for the production of biofuels.

In addition, we're exploring how to make fuel directly from sunlight via a project at the University of Florida. They have developed a reactor technology that converts concentrated solar thermal energy to Syngas which can be used to produce liquid fuel. They are currently scaling the process to 10 kW and have formed a new company, Solar Fuels, which is currently mapping out the funding and relationships necessary to move this technology forward.

SPURRING PRIVATE INVESTMENT

The final handoff is spurring private investment from established companies. Many technologies related to energy require significant capital investment and extensive market reach to be fully implemented. We are proud of the partnerships we have already established with companies that are providing expertise and cost share for our projects. We are now seeing even further engagement to move projects one step closer to the market. Let me tell you two of those stories.

In today's increasingly electrified world, a significant amount of energy is lost when electricity has to be modified to a different current, voltage, or frequency. Most power converters are based on decades-old technology and rely on expensive, bulky, and failure-prone components. By 2030, 80 percent of the electricity used in this country will flow through power converters. This presents a significant opportunity to save energy.

At ARPA-E, we have funded a number of technologies to provide solutions to these problems, including one at Virginia Tech. We're finding bold, new solutions for converting electricity between different currents, voltage levels, and frequencies with minimal energy loss. The Virginia Tech project is developing a voltage regulator that uses semiconductors made of gallium nitride on silicon and high-frequency soft magnetic material. These materials can be used to build voltage regulators that are 10 times smaller than those in use today. These advances promise to eliminate the tradeoffs product designers must often make between size and efficiency. To date, the project has demonstrated power densities 5x better than the best that are commercially available today.

After proving their technology in the lab at Virginia Tech, the project team is now partnering with Enpirion to commercialize the integrated magnetic components. Virginia Tech aims to demonstrate

the manufacturability of the new magnetic materials with Enpirion's voltage regulators to enable converters with high efficiency, low noise, exceptional thermal performance, and reliability. These efforts could lead to a new generation of electrical products that would increase the efficiency of everything from data center power supplies to smart phones.

An additional story involves internal technical development. To expand electric vehicles we need batteries with significantly lower cost, longer range and improved reliability than today's battery packs. If we can achieve this, we'd have a real breakthrough.

When Applied Materials researchers submitted an application for ARPA-E funding, they were looking to grow beyond Semiconductors, Displays, and Solar. As the world's leading supplier of equipment to the chip-making, flat panel display, and crystalline silicon solar industries what Applied does best is build world-class materials engineering manufacturing equipment. The project they proposed to ARPA-E was the development of radically new equipment that could manufacture batteries faster, cheaper, and with better performance, higher capacity than anything else on the market –a truly bold idea.

With ARPA-E funding, the project has progressed technically to the point that Applied now sees the energy storage space as a potential strategic business opportunity--and as such they plan to double down with their own money in order to bring this technology to market. With ARPA-E's small catalytic funding to overcome early stage technology risks, Applied Materials is now positioned to develop a totally new line of business for America.

In addition to the partnerships I have highlighted here, we've also seen direct investment into companies we have funded – 17 companies have attracted over $450 mm in follow-on funding. This private capital will allow these companies to further their technologies and map pathways to the market.

Conclusion

Today I've shared with you four ways we are making a difference: bringing people together to think of bold ideas and solve the greatest energy challenges of our time.

I've highlighted just a few of our projects that are gaining speed in moving toward the market. But these are just a fraction of the 285 projects we have launched to date at ARPA-E. These are today's explorers and we are drawn by the boldness of their ideas, inspired by their determination, and encouraged by their progress.

Just as past explorers charted their course and set off on their voyages, not knowing what lay ahead, ARPA-E takes bold chances, explores new ways of operating, discovers new partners, and creates communities focused on transformational change.

While I'm sure there will be challenges on the horizon, I have no doubt that market-oriented exploration is the answer to securing a bright and prosperous future for America. All great civilizations have focused on exploration to address the challenges of their day and secure their future. We are no different.

I am heartened by the strong partnerships and signs of technical progress in both the public and private sectors. Together we have embarked on a journey to change what's possible and I am confident we can do just that.

Thank you.