Witness Testimony of
Stephen R. Forrest
Vice President for Research
The University of Michigan

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Hearing on
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Introduction

Chairman Lampson, Ranking Member Inglis and members of the Subcommittee, thank you for the invitation to testify today. It is my great pleasure to contribute to the ongoing debate over the establishment of a new energy research agency at the Department of Energy (DOE) to fill an unmet need: the nimble transfer of revolutionary energy research results out to the commercial marketplace. I know Congress first started working on this issue last year and I would like to take this opportunity to commend you for your leadership in the campaign to find new ways to address American's energy crisis.

As you may know, I joined the University of Michigan in January 2006 as its Vice President for Research. Prior to moving to Ann Arbor, I held several positions in academia and in industry. Over the years I have worked at places ranging from Bell Labs to USC and Princeton. I have more than 150 U.S. patents and have published over 400 papers in scientific journals, many of them in the field of energy generation and use, and have co-founded several successful companies, including Sensors Unlimited, Epitaxx, Inc., Global Photonic Energy Corp., Universal Display Corporation, and Apogee Photonics.

It is an honor to be part of higher education, but with that honor also comes responsibilities. Universities must contribute their wealth of intellectual depth and productivity to help the nation survive what will be a disruptive and long-term transition in its energy use away from traditional fossil fuel sources. Thus, one of first acts of the

university after I joined as Vice President for Research has been to initiate a unique research institute called the Michigan Memorial Phoenix Energy Institute. It is named after our Physics Memorial Laboratory, home of the Ford Nuclear Reactor that was founded by the Atoms for Peace Program started in the 1950s. The name of the institute historically honors University of Michigan alumni, students and faculty who gave their lives in World War II. The new Energy Institute's goal is to convene world experts in energy, science and technology to explore how to best find alternatives to fossil fuel to meet the growing the energy needs of our nation. Unlike other university-based energy research centers, our institute combines science, engineering, economics and public policy expertise to address the challenges facing us. Its interdisciplinary culture is essential simply because, as the subcommittee knows all too well, the pathway to successful implementation of technological solutions in our communities is guided by public policy decisions, economics and societal change.

Our Nation's Energy Crisis

There are few contemporary challenges facing the nation – and the world -- more threatening than the unsustainable nature of our current energy infrastructure. Our communities are dependent upon the continuing availability of clean, affordable and flexible energy resources.

Yet, our current fossil fuels-dependent energy infrastructure is unsustainable. This is a problem with potentially catastrophic consequences. Global oil production is expected to peak within the next several decades, with natural gas production peaking soon thereafter. While there are substantial reserves of coal and tar sands, the mining, processing and burning of these fossil fuels poses increasingly unacceptable biological and environmental risks, particularly within the context of global climate change. Furthermore, the security of our nation is threatened by our reliance on foreign energy imports from unstable regions of the world.

At this critical juncture, a bold and broad approach is needed to radically transform how the United States meets its energy needs. Inexpensive and carbon-free energy solutions that are renewable must be found – and I am confident that they are out there.

To just put things into context, in 20 minutes enough energy to power the earth to meet mankind's demand for a solid year is provided by the sun. If you want to think of it another way, if we constructed six solar cell fields 120 miles on a side and placed them in the temperate zones of the earth, we would more than exceed today's demand for electrical energy. The problem with solar, and other forms of renewable energy, is that they still are not cost-competitive with that supplied by fossil fuels purchased on the world's markets.

To uncover practical applications of new ideas such as solar energy, we must harness the brainpower of scientists and entrepreneurs across the country. The problems confronting mankind through the use of energy are far greater than any one institution, or one sector of our scientific and industrial infrastructure can solve. This is not a time to go it alone.

ARPA-E: Essential to Meeting the Grand Challenge

I strongly support the National Academies recommendation made in its 2005 report, *Rising Above the Gathering Storm*: create an Advanced Research Projects Agency for Energy, or ARPA-E – a small flexible and independent federal agency that "would be charged with sponsoring research and development programs to meet the nation's long-term energy challenges."[1] According to the report, the new agency "would support creative 'out-of-the-box' transformational generic energy research."[2]

ARPA-E would be modeled on the Pentagon's successful Defense Advanced Research Projects Agency (DARPA). Created in response to the Soviet technological threat, DARPA became a critical bridge between the defense needs of the time and experts at universities and private corporations who could provide the answers.[3] While its main client has been the Department of Defense, DARPA also has supported the collaborative development of defense-based technologies for the commercial sector. Over the course of its history, it has nurtured long-term innovative research and development investments in a way that private industry could not always afford to. Through DARPA's financial awards came ground-breaking technological advances such as the internet, GaAs technology that is now the backbone of cell phones, and wavelength division multiplexed high volume optical communications.

Today, the United States faces an even bigger and more tangible threat to our environment, our economic and intellectual competitiveness, and our national security. A new independent research agency at DOE would bring together the best minds from around the country to guide us in developing solutions for the future. It would have the autonomy and freedom from bureaucratic impediments to encourage flexibility and collaboration to solve immense and common problems facing the energy sector. Ultimately, funding from this new agency would lead to the generation of a robust private industry that would provide solutions while strengthening our domestic markets.

Universities also stand to play a key role in achieving the ARPA-E agenda. The academic environment is one in which professors are rewarded for work that their peers believe makes significant contributions to the existing foundation of knowledge. For this

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[1] The National Academies, *Rising Above the Gathering Storm: Executive Summary*, Washington, DC (2005), page 7.
[2] Ibid.
[3] William Bonvillian, Power Play: the DARPA Model and U.S. Energy Policy, The American Interest, Washington, DC (November/December 2006), p. 44.

reason, universities have traditionally been incubators for out-of-the-box ideas that the private sector by itself often cannot afford to undertake because the risks may outweigh potential payoffs. Today, universities are looking for solutions to the energy independence challenge from all vantage points – hydrogen research, improved lighting sources, biofuels, energy storage, urban planning, semiconductors, alternative fuel cars, and solar cells to name a few.

An agile, mission-oriented ARPA-E would, like DARPA, connect universities with large and small industry hungry for new advances in technology. With their more practical perspectives, the companies can take the universities' advances through to commercialization. With ARPA-E as abridge between the two worlds, the best ideas would rapidly emerge to find their place in the commercial marketplace.

Furthermore, ARPA-E sponsorship of university research would contribute to the training of the workforce – helping to ensure a steady stream of future scientists, engineers and entrepreneurs who would continue to bring talent and innovation to solving the energy crisis in years to come. As America fights to maintain its competitive edge in the world, this next generation of experts will become increasingly important.

DOE Research: Flexibility and Agility Needed

I would like to take a moment to talk about the division of research at DOE. As you know, DOE does play a critical role in advancing U.S. scientific interests. Today, it is the leading source of federal funds and resources for research in the physical sciences – providing two-thirds of the federal investment in this area.[4] In high energy and nuclear physics, nuclear medicine, heavy element chemistry, plasma physics, and magnetic fusion, DOE is the primary government sponsor. It also ranks high in overall federal support for research in computer science and engineering and sponsors significant research in biology and environmental sciences.

DOE's programs and facilities have promoted the work of thousands of researchers and played vital roles in many significant discoveries. However, to face today's energy predicament head on, the Department must take a new perspective on how it supports research.

Essentially, DOE's research is segmented into two parts. The Office of Science supports basic research. Applied research is conducted in the offices organized around fuel sources, such as Energy Efficiency and Renewable Energy, Fossil Energy and Electricity Delivery and Energy Reliability.

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[4] American Association for the Advancement of Science, *DOE Science Leads the Pack in 2008*, Washington, DC (March 21, 2007), page 6.

These research programs conduct high quality and important work. However, gaps and shortcomings exist. For example, the Office of Science, which has long been the key federal sponsor of physical sciences research, does not have the opportunity to cover all fields – often leaving important disciplines, such as nuclear energy and environmental sciences, insufficiently addressed. Furthermore, there is little communication or coordination between the offices responsible for the two types of research supported by DOE. Another critical aspect of DOE research is that its structure is almost completely focused on supporting its very costly National Laboratories, to the exclusion of universities and the private sector. Nearly half the DOE Science research and development budget goes to operating and constructing facilities.[5]

The National Laboratories play a vital role in a wide range of important issues such as nuclear weapons development, energy security, computational power, new energy sources, determining molecular structure, and homeland security. They set standards, plot specific directions the energy community should follow, implement solutions and provide massive and often costly resources to bear on energy problems. However, these large-scale facilities are not organized, nor structured, to conduct high-risk transformational research in an agile and unbureaucratic manner -- nor do their missions cover finding revolutionary ways of solving energy problems.

Furthermore, historically, federal programs in which universities and the National Laboratories are both allowed to compete are heavily dominated by the Laboratories. Particularly, universities are often not provided with adequate resources to contribute to solving larger problems. This discourages creativity and novel ideas that naturally emerge from the enormous intellectual resources that exist in our academic institutions.

In contrast, DARPA has succeeded because it brings "new blood" at comparatively low prices into the defense field by focusing its awards almost entirely on universities and individual companies. Indeed, over the last 10 years, less than 5% of the DARPA budget has gone to DoD labs, the reminder being split approximately 2 to 1 for industry and academia.[6] To achieve the same degree of sustained success as DARPA, ARPA-E must follow a similar model. That is, to guarantee that ARPA-E truly encourages cutting-edge research, the role of the National Laboratories in this new agency must be limited. Only in unique cases should the national laboratories, in partnership with private and educational enterprises, be recipients of ARPA-E funds.

The institutional knowledge of the Labs, however, could play a constructive role. With their advice, ARPA-E could define new challenges to be addressed. These projects

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[5] Ibid, page 2.

[6] Kei Koizumi, American Association for the Advancement of Science, Washington, DC (April 19, 2007); and National Science Foundation, Division of Science Resources Studies , *Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1951–2002* , Arlington, VA (August 2003).

would then be subcontracted out to the most innovative and cost-effective members of the broadest sector of the energy community.

Guaranteeing a Strong ARPA-E

Other improvements are necessary to solidify ARPA-E's leadership in innovative energy research. I will briefly touch on a few of them. For example, to ensure that the agency does not become subordinate to larger DOE research and development entities, the agency's head should report *directly* to the Secretary of Energy. This again follows the DARPA model, where the Director reports to the Secretary of Defense. Also, a cap on the number of personnel and a relatively short term of service would help keep ARPA-E dynamic and flexible, supported by a continual infusion of new ideas.

Furthermore, adequate funding would be essential. In a tight budget, this will be hard to come by, but the necessity of acting on changing our energy dependencies is of deep national and global concern, and hence the time to act decisively is upon us now. In addition to a "start-up" appropriation from Congress (one that would not be found by 'taxing' existing DOE agencies and labs), independent revenue streams should be considered. These include a trust fund set up from federal oil and gas royalties.[7] Another suggestion is adoption of a macro-pricing system for carbon, such as a cap and trade program, by the United States to address global warming threats.[8]

Finally, steps must be taken to ensure that DOE does not then use ARPA-E's grants, cooperative agreements or contracts to return funds back into DOE. DOE should ensure that most of the agency's budget is spent outside of the Department – whether at universities, large energy companies, start-ups or consortia of academia and industry.

Conclusion

Thank you again for the opportunity to testify today. I look forward to continuing this discussion. Bringing alternative energy technologies to the marketplace is vital as the nation faces the likely collapse of our traditional fossil fuel economy in the not-too-distant future. There is much to be done, with no apparent simple solution, but our nations health can only be assured by making the shift away from a dominant reliance on these fuels our top priority. ARPA-E would play a central role in finding the tools to make this shift.

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[7] Melanie Kenderdine, Gas Technology Institute, "Hearing on ARPA-E Before the House Committee on Science" (March 9, 2006), page. 6.

[8] William Bonvillian, letter to the House Science and Technology Committee, April 2, 2007, page 14.

There is no doubt that successfully creating a new agency at DOE will face profound challenges. It will require careful writing of legislation and directives, sufficient funding, and an energetic and creative staff. But it must be done. If truly given the opportunity, ARPA-E could make a significant contribution to our national energy solutions.