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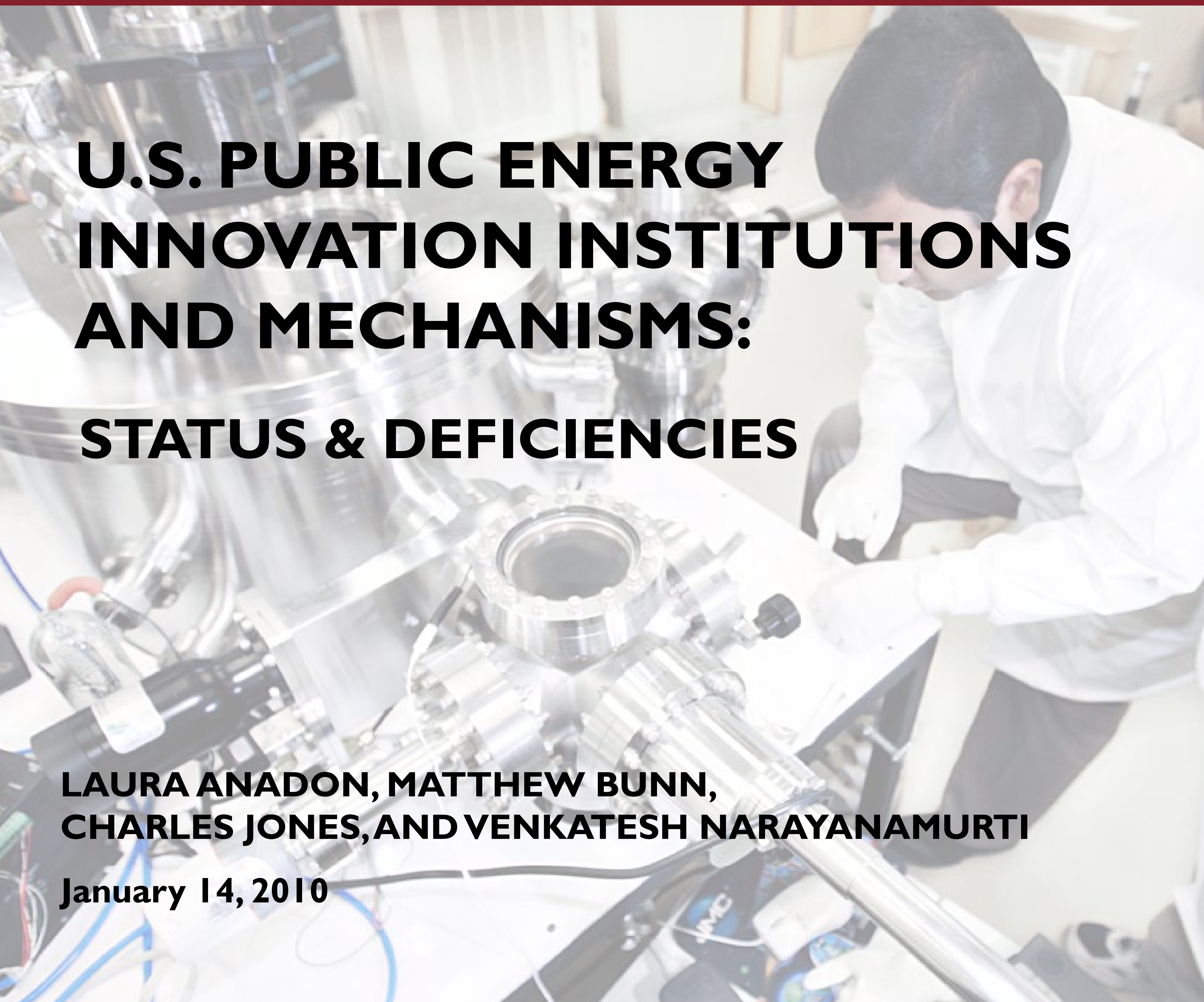

U.S. PUBLIC ENERGY INNOVATION INSTITUTIONS AND MECHANISMS:

STATUS & DEFICIENCIES

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Cover Image: Arun Vijayakumar and Shoufeng Yang at Planar Energy Devices insert a sample into the vacuum chamber of the company's thin-film deposition system. Planar is developing a buried-anode lithium-ion battery using technology licensed from DOE's National Renewable Energy Laboratory (NREL). NREL researchers Ed Tracy and Roland Pitts (currently on sabbatical leave to work at Planar) and former NREL researcher Se-Hee Lee developed the buried-anode technology using thin-film expertise gained from research on electrochromic windows..
Source: Courtesy of DOE/NREL, Credit - Planar Energy Devices, Inc.

U.S. Public Energy Innovation Institutions and Mechanisms: Status & Deficiencies

Laura Anadon, Matthew Bunn, Charles Jones, Venkatesh Narayanamurti

1. INTRODUCTION

The United States needs to transform the way it produces and uses energy. This will require the improvement of current technologies and the development of new ones. To achieve the maximum payoff for public investments in energy technology innovation, the United States will need to improve and better align the management and structure of existing and new energy innovation institutions, and better connect R&D to demonstration and deployment. In what follows, we highlight three general and important recommendations for thinking about different initiatives, and we discuss the merits and challenges of current and new institutions, and the remaining gaps in the U.S. energy innovation system.

2. THREE GENERAL AND IMPORTANT RECOMMENDATIONS

COLLECTING METRICS AND INDICATORS FOR ASSESSING PROGRESS

It is imperative that all initiatives and institutions are required to consistently collect metrics on relevant outputs and outcomes and information about projects. This is essential to sustain public and political support, which will be necessary to ensure that the energy technology innovation effort enjoys the predictability and patience it needs. The U.K. Carbon Trust is an example of a relatively novel organization (it was created in the year 2001) that has achieved sustained political support—which has led to its exponential growth. This success was partly due to a decision that was made from its inception. The decision was to track the impact of their projects (which ranged from auditing services, VC investing, basic research support, demonstration projects, etc) using a consistent set of metrics directly linked to the institution's mission: avoided CO_2 emissions, and cost per ton of CO_2 avoided. While we are not implying that these metrics are sufficient, the U.K. Carbon Trust experience is a testament to the value of collecting data suitable for evaluation from the start. Considerable thought is needed to design metrics that will drive effort in the right directions: with poor metrics, there is always a danger of managers focusing on meeting the metrics rather than the overall goal.

ALIGNING RD&D AND DEPLOYMENT PROGRAMS

Today, many of the specifics of energy research, development, and demonstration (RD&D) programs are decided by DOE headquarters, while many of the most important deployment incentives are decided in Congress or by federal and state standard-setting agencies. To maximize the return on federal investments in energy innovation, it is important to coordinate R&D programs with programs designed to encourage deployment in the marketplace, so that deployment supports are available when the products of RD&D are ready to make use of them.[1]

IMPROVING THE STRUCTURE AND MANAGEMENT OF ENERGY INNOVATION INSTITUTIONS

We maintain that it is possible to identify five elements that are essential to create and run a successful technology innovation institution. These elements, which have largely been absent in policy debates, are: having a clearly defined mission; attracting visionary and technically excellent leaders; cultivating an entrepreneurial and competitive culture; setting up a structure and management system that balances independence and accountability; and ensuring stable, predictable funding.[2] These elements are useful guiding principles for thinking through the design of new institutions and the transformation of existing ones.

3. EXISTING INSTITUTIONS AND MECHANISMS

RESEARCH AT THE NATIONAL LABS

The mission of many of the labs has become too diffuse over time. This makes it difficult to manage them, to integrate their work in the basic science and commercialization domains, and, as a result, to obtain the largest possible investment returns. In addition, in many cases the labs' focus on operational requirements such as safety and security has been pursued at the cost of a decreasing emphasis on the technical mission. Funding for national laboratory energy R&D programs has been inappropriate in two ways: the small basic energy science programs at the labs do not suffice to integrate basic and applied research, and funding for the applied research programs has been much too volatile.[3] Finally, the transition to operation of the labs by for-profit firms has seriously damaged the science culture at these facilities, shifting the focus from national needs to corporate priorities and redirecting substantial funds from programs to company management fees.

What to do? Ongoing research will shed some light into how to attempt to solve these issues (e.g. by redefining the missions of the labs, adopting different 'government-owned contractor-operated mechanisms', and/or modifying personnel evaluation protocols). However, one clear lesson can be applied immediately: longer-term research plans and longer-term funding are needed to provide more continuity to programs and flexibility to explore alternative research pathways. The challenge will be to integrate a certain degree of flexibility into a longer-term funding process to allow adjustments as new relevant information (e.g. project feedback, technical information) becomes available. The creation of a high-level task force to study possibilities of restructuring the national labs would be a very valuable undertaking.

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[1] Anadon, L.D., Gallagher, K.S., Bunn, M. "*Tackling U.S. Energy Challenges and Opportunities: Preliminary Policy Recommendations for Enhancing Energy Innovation in the United States*." Harvard Kennedy School Belfer Center for Science and International Affairs report. February 2009.

[2] Narayanamurti, V., Anadon, L.D., and Sagar, A.D. "Transforming Energy Innovation." *Issues in Science & Technology*, Fall 2009, p. 57-64.

[3] *Idem*. (http://belfercenter.ksg.harvard.edu/publication/19572).

COOPERATIVE AGREEMENTS, WORK-FOR-OTHERS ARRANGEMENTS, GRANTS, USER FACILITY AGREEMENTS, AND OTHER MECHANISMS USED FOR TECHNOLOGY TRANSFER AND R&D SUPPORT TO THE PRIVATE SECTOR

The Department of Energy (DOE) uses several mechanisms (cooperative agreements, CRADAs, work for others, user facility agreements, grants, etc.) to facilitate the transfer of lab technology to the private sector, and to leverage private sector innovation funds. Using data on grants and cooperative agreements available at www.usaspending.gov, we have determined that the number and funding for these mechanisms are highly volatile from year to year; that there is no apparent rationale or strategy behind the choices made regarding what type of relationships with the private sector should be used in different cases; that there is no central record or other centralized useful information about DOE's use of these mechanisms (for example, about the types of partners, the technology areas covered, and other details of the arrangements), and that DOE documents show no evidence of any high-level analysis or planning for optimizing interactions with the private sector. In short, although cooperative agreements and other collaboration mechanisms receive a significant portion of energy R&D funds at DOE, they are not being strategically utilized.[4] Furthermore, best practices and failures are not being systematically recorded, and thus, learning is not taking place to the extent it could.

What to do? It is necessary to incorporate some discussion about the nature of DOE interaction with the private sector at higher levels of decision making. DOE should start by recording information on each partnership. This would allow DOE to learn about the needs and capabilities of the private sector and the marketplace, and to improve the selection, negotiation, and execution of individual projects. Mechanisms should also be put in place to reduce the year-to-year volatility, to avoid scaring off potential private sector partners who are likely to interpret this volatility as indicating that DOE will be an uncertain and unreliable partner. Finally, there should be mechanisms that would make it easier for smaller firms to receive support and collaborate with DOE.

4. NEW INSTITUTIONS

DOE ENERGY INNOVATION HUBS (DOE EIH)

The Energy Innovation Hubs represent a major opportunity to provide longer term funding and a seamless integration of basic and applied research through to commercialization to solve the most important S&T challenges in the energy domain. Given that the national labs have generally not succeeded in creating the breakthroughs and technologies the country needs—partly due to their culture, management practices, and insufficient integration of basic and applied research—the creation of the DOE EIHs represents an important opportunity to test a model that has worked in the early years of the national labs and in many large industrial labs (e.g. Bell Labs, Xerox PARC, and IBM Research Labs). The DOE EIHs would provide funding certainties of approximately 5 years, with the possibility of a 5 year renewal, and should reinstate the primacy of scientific excellence (through new hiring practices, performance reviews, etc). The proposed maximum funding amount for a DOE EIH is "$135 million total over the initial 5-year term: $25 million/year with $10 million additional funding in the first year for renovation, equipment, and instrumentation;"[5] this is a very reasonable starting point.

[4] Jones, C., and Anadon, L.D. Ongoing research "Public-Private Partnerships for Energy Innovation."

[5] Jones, R. M. "Administration Highlights Proposed DOE Energy Innovation Hubs." *American Institute of Physics*, Number 101, July 29, 2009. (http://www.aip.org/fyi/2009/101.html).

What to do? DOE should put management systems in place to ensure a good integration and fluidity between the DOE EIHs, the Basic Energy Sciences program, the BioEnergy Sciences Institute, and other relevant efforts in applied RD&D. This could be done by organizing yearly meetings of different subject areas, through the creation of virtual platforms where researchers share their research progress, or other means. The 8 areas of research proposed by Secretary Chu are worthy of the special effort, and hence, we believe they should receive funding over the next couple of years. Although each DOE EIH should have a focal physical location, each of them should utilize expertise and knowledge available elsewhere, and the DOE EIH leadership should have the freedom to partner with a range of entities across the globe.

ARPA-E

ARPA-E is a very valuable addition to the set of funding tools for energy technology innovation available to the U.S. federal government. Although it provides funding for lengths of approximately 3 years—ARPA-E's funding for projects allows for a more sustained effort than that from the traditional DOE programs, but it is shorter than that for the DOE EIHs—its structure should be very nimble: personnel and focus should be able to change very quickly depending on the opportunities and challenges at hand. ARPA-E should be, by definition, a risk-taking organization.

What to do? ARPA-E must now focus on hiring leading technical experts in relevant technology areas to work on 3-5 year terms as ARPA-E program managers. These experts should pay attention not only to funding high-risk high-payoff projects wherever they may be, but also the full range of technologies and pathways that would allow ARPA-E to achieve a particular goal.[6] Building a culture that rewards risk-taking and allows some projects to fail will be essential. DOE should communicate aggressively to policymakers and the public that because of the high-risk nature of ARPA-E projects and the long time-frames of technology development, their success rate is not likely to be high and that they need to be patient. DOE and ARPA-E should develop a set of appropriate metrics to assess the quality of the organization over a range of timeframes.

WAXMAN-MARKEY ACES BILL ENERGY INNOVATION HUBS (ACES EIHS)

The funding to constitute each ACES EIH—as currently stated in the version of the American Clean Energy and Security Act of 2009 (ACES) that passed the House on July 7, 2009—would be awarded to a local consortium of very large research universities, and energy-related state/federal institutions and/or NGOs. ACES EIHs would be distributed throughout the country and would be responsible for making 'sub-awards' to entities that would perform a range of innovation functions, termed 'translational research.'[7] According to one estimate, ACES EIHs would receive around $240 million in 2012.[8] Over time, however, this yearly funding would increase because allowance prices are projected to increase, and the fraction of the allowances dedicated to fund the ACES EIHs is expected to remain constant at 0.45%. The legislation currently states that each of the ACES EIHs would receive a minimum of 10% and a maximum of 30% of the allowances dedicated to the hubs—thus, according to the aforementioned estimate, each of them would receive between $24 million/year and $72 million/year. What is not yet clear is how these hubs would intersect with the hubs in particular technology

[6] Fuchs, E.R.H. "Cloning DARPA". *Issues in Science & Technology*, Fall 2009, p. 65-70.

[7] Bill that passed the House on June 26, 2009. (http://www.opencongress.org/bill/111-h2454/text)

[8] RFF estimated that in 2012 1% of allowances would be worth $491 million. (http://www.rff.org/wv/archive/2009/07/01/waxman-markeys-international-reach.aspx).

areas that DOE is already establishing, or with other energy innovation institutions. What gaps are these hubs designed to fill?

What to do? One of the rationales used to support the ACES EIH concept is that they would utilize the benefits to innovation usually present in 'industrial clusters.' But while this concept would be utilized in the award of each ACES EIH, there is no reason why the sub-awards would make any use of the geographic proximity of a critical mass of researchers and entrepreneurs. We encourage asking those who created this provision to flesh out how the cluster concept would be utilized in the sub-awards. Another dimension worth questioning is the range of projects that these institutions would fund. The current House version of the legislation states that ACES EIHs would fund 'translational research", but it is not clear in what way the projects funded by the ACES EIHs would be different from those funded by the other energy innovation institutions described above. If the aim of the legislation is to decentralize decisions about energy R&D funding and take them away from DOE program managers, that should be made clear, and the proposal should be evaluated on that basis. Given OMB projections indicating a poor fiscal situation for the federal government over the coming years, we believe Congress should consider allowing the Secretary of Energy to use part of the revenues from the purchase of allowances in a future cap-and-trade system to support energy technology RD&D initiatives other than those in the ACES EIHs. Concurrently, the Department of Energy should review its own structure and management processes, as well as those of the national labs. In particular, the government-owned contractor-operated (GOCO) system of the labs should be reinvigorated because, even though the GOCO system is still in place, the political climate has changed so that in practice the labs are no longer insulated either from corporate profit imperatives or from the government bureaucracy, and have evolved to a management that is akin to a mixture of corporate and civil service institutions. As a result, their innovative and entrepreneurial culture, as well as their independence, have been significantly compromised.

5. A MISSING INSTITUTION

AN INSTITUTION/S TO SUPPORT LARGE SCALE DEMONSTRATION PROJECTS

Since the 1980s DOE has been reluctant to support large-scale technology demonstrations, but they are badly needed to pave the way for commercialization in several areas of energy technology. DOE's track record in successfully building large demonstration projects is abysmal. Pilot, demonstration, and commercialization stage innovation requires procurement, funding, and decision rules similar to those of private sector enterprises, so that information about genuinely commercialized technology is generated to inform policymakers and the business community. Therefore, a new management structure for such efforts is clearly required.

What to do? Establish a commission or task force to evaluate different proposals to fill in this gap (such as Ogden, Deutch, and Podesta's Energy Technology Corporation[9]), and to propose new ones.

[9] Ogden, P., Podesta, J. & Deutch, J. 2008, "A New Strategy to Spur Energy Innovation", *Issues in Science & Technology*, Winter 2008.

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Science, Technology, and Public Policy Program
The science and technology (S&T) enterprise plays an increasingly central, often essential, role in almost every aspect of our life. It is therefore critical to understand how we may be able to best realize the potential of S&T in improving the human condition, underpinning economic and social development, supporting human endeavors, and in promoting international relations. At the same time, we must also be cognizant of, and address, the societal concerns that often result from advances in S&T.

Public policy plays a critical role in mediating this interface between S&T and society: it should aim to enhance the positive contribution of S&T to society while recognizing, even anticipating, and mitigating, its adverse consequences.

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