Energy Policy 119 (2018) 367–376

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Beyond the Technology Pork Barrel? An assessment of the Obama administration's energy demonstration projects

David M. Hart

Schar School of Policy and Government, George Mason University, 3351 Fairfax Drive, Arlington, VA 22201, USA

A R T I C L E I N F O

Keywords:
Demonstration projects
Energy innovation
Obama administration
US DOE

A B S T R A C T

This paper provides an assessment of a portfolio of 53 energy technology demonstration projects that were initiated by the Obama administration between 2009 and 2011 and managed by the U.S. Department of Energy (DOE). After reviewing the rationales for conducting such projects and providing partial public funding for them, five assessment criteria derived from the literature are applied to the portfolio, pertaining to project selection and termination, cost-sharing, partnerships, information-sharing, and the environment for follow-on investment. The assessment is mixed. DOE performed best, relative to expectations, on project selection and termination and partnerships, and not as well on cost-sharing, information-sharing, and the follow-on environment. This performance does not warrant establishing a new agency to replace DOE for management of demonstration projects. The recommendations include implementing cost-sharing more flexibly, making information-sharing a higher priority, avoiding too-rapid scale-up of technologies, and being explicit about project milestones and considering termination if they are not met.

1. Introduction

Technology demonstration projects pose a difficult challenge in United States energy-innovation policy. They are necessary to build an adequate portfolio of clean-energy options that have the potential to be deployed globally on a massive scale in the coming decades. They require public investment; private investors will not fully fund them. But the federal government's track record of selecting, funding, and managing these projects is not encouraging. The title of the leading study of the subject, Linda R. Cohen and Roger G. Noll's *The Technology Pork Barrel*, conveys its conclusion: Demonstration projects almost inevitably become “technological turkeys.” (Cohen and Noll, 1991, 296).

Defying this quarter-century-old conventional wisdom, the Obama administration initiated the first major new energy technology demonstration program in the United States in decades. This paper provides an assessment of a portfolio of 53 projects with planned budgets of $4.2 billion. It spans eight technology fields (although it contains no nuclear power projects) and is dominated from a fiscal perspective by large carbon capture, utilization and storage projects. The analysis applies five criteria, which are drawn from the scholarly literature, pertaining to project selection and termination, cost-sharing, partnerships, information-sharing, and the environment for follow-on investment.

We begin by explaining why demonstration is essential to energy innovation and why the private sector is unenthusiastic about it. We then develop the five criteria and apply them to the Obama-era portfolio. The results are more encouraging than *The Technology Pork Barrel* would lead one to expect. We conclude with recommendations for the U.S. Department of Energy (DOE), which managed the program, including that cost sharing criteria be made more flexible, information sharing be made a higher priority, and too-rapid scale-up be avoided in future demonstration projects.

2. Background and literature review

2.1. The rationale for demonstration projects

The literature offers three major reasons for demonstration projects, in which technological systems are put into practical use at scale for the first time: systems integration, tight coupling, and risk reduction. Without such projects, the energy-innovation process, particularly for complex technologies, is likely to founder. As Deutch (2011, 20), a leading scholar in this field, has put it, “energy innovation is constrained not by an absence of new ideas, but by the absence of early examples of successful implementation.”

The distinction between complex systems and commodity goods made by Hobday (1998) forms the conceptual framework for these arguments. Complex systems are composed of many subsystems, draw on a diverse knowledge base, and often must be customized during deployment. Commodity goods are assembled from standardized

E-mail address: dhart@gmu.edu.

https://doi.org/10.1016/j.enpol.2018.04.047
Received 15 August 2017; Received in revised form 13 February 2018; Accepted 22 April 2018
0301-4215/

components, involve less tacit knowledge, and can be mass-produced. Nuclear power is a good example at the complex-systems end of this conceptual spectrum. An innovative nuclear power plant involves millions of components and thousands of designers and builders.

One reason why complex energy systems typically need to be demonstrated before they can diffuse widely is that their numerous and diverse components and subsystems must be integrated. These may interact in unexpected ways at full-scale that cannot be anticipated at the laboratory bench or even in pilot plants. This challenge has vexed the Kemper, Mississippi, demonstration plant that combines coal gasification, carbon capture and use, and combined cycle power generation. "[T]he large increase in project costs …," writes Howard Herzog, "can be attributed to implementing multiple first-of-a-kind technologies and the complexity of integrating them together." (Herzog, 2016, 27).

"Tightly coupling," to use Perrow's (1984) phrase is a second reason for demonstration projects. Failure in one component of a tightly coupled system is more likely to cause the entire system to fail than a similar component failure in a loosely coupled system. Information technology firms like Google can beta test unfinished products on willing customers because the consequences of failure are limited; these early-adopting volunteers serve as the demonstration test bed to debug this loosely-coupled system. Failure of a power plant or an electric grid, by contrast, may have cascading impacts that cripple a city or region. Demonstration projects allow innovations that must be integrated into tightly coupled systems, such as IT-intensive "smart grid" technologies that optimize management of electric power transmission and distribution, to be debugged in more controlled settings than beta testing them on the public.

The third reason why demonstration is so important in complex energy system innovation is that it reduces the risks for follow-on projects. Investors in such systems must take economic risks, potentially staking their solvency on a system's success. Demonstration projects that establish cost, reliability, and performance characteristics of the full-scale system in operation can strengthen investor confidence, while also pointing the way toward improvements in future versions of the technology (Reiner, 2016). Innovative energy systems may also present institutional risks. Regulators may be unfamiliar with the innovation and need to develop new procedures to manage it, or the public may have fears about it that a demonstration can help put to rest. Concentrating solar-power installations in fragile desert environments, for instance, may pose environmental risks, while smart-grid technologies that collect "big data" about energy use may raise concerns about privacy and security.

2.2. The rationale for public investment in demonstration projects

The complexity and risks that motivate demonstration projects also deter private investment in them. Three institutional mechanisms, venture capital funding, intellectual property rights, and industry-wide consortia, that address these issues in other sectors do not work well for large-scale energy technologies."Fundamental, structural market shortcomings," in these case, writes Bloomberg New Energy Finance (2010), "cannot be resolved by the private sector acting on its own." Public investment is required to bridge what has come to be known as "second valley of death." (Jenkins and Mansur, 2011). The public value of mitigating climate change provides an additional reason for such investment.

Demonstration projects are designed to create knowledge and reduce risks. Both of these benefits are difficult for private investors to appropriate (Nemet et al., 2016). For example, demonstration projects are intended to show potential users that an innovation can work in practice. Yet, by doing so, they generate understanding of technological configurations, operating procedures, and other technical and managerial details that may become available to firms that do not invest in demonstrations. These free riders, who may include international as well as domestic competitors, may then be able to replicate the innovation at a lower overall cost than the demonstration project's investors. Even without such details, simply knowing whether a project has succeeded or failed may provide significant information about a technology's risks.

Intellectual property (IP) rights sometimes solve the free-rider problem sufficiently to induce investment in risky projects. In the pharmaceutical industry, for example, firms are willing to carry the extraordinarily large costs of clinical trials, which serve a purpose similar to energy technology demonstration projects, because they are able to secure and enforce legal protection for new drugs. This solution is less effective for complex energy technologies. Patents in this area are narrower and more easily "invented around" than in pharmaceuticals, making them less valuable (Cohen et al., 2000). If General Electric were to demonstrate a new type of power plant, it would be less able to use IP protection to defend it from Mitsubishi, Siemens, and other competitors than would a similarly placed drug maker.

Venture capital is another institution that could, in principle, bridge the second valley of death. Venture capitalists (VCs) specifically seek out opportunities that are too risky for banks or institutional investors to fund. However, they typically seek higher rewards than most clean-energy technologies can provide, and on a quicker timetable. In addition, the high cost of many large-scale energy technology demonstration projects would stretch the budget of all but the most deep-pocketed VCs, making it difficult to assemble a portfolio of investments that would limit the risk from any one project. As a result, a recent study by Gaddy et al. (2016) concluded that venture capital is "the wrong model for clean energy innovation."

A third potential mechanism for raising private funding for energy-demonstration projects is the industry-wide consortium. If all firms that stand to gain from advancing a technology can be induced to contribute to such a project, the free rider problem is negated. Such collaborations among erstwhile competitors are difficult to organize, however. Industry-wide R&D consortia, such as the Electric Power Research Institute and Gas Technology Institute, exist in the energy sector, but they have shrunk in scale and scope as deregulation and restructuring deprived participating firms of discretionary funding to support them (Sanyal and Cohen, 2009).

An additional reason for public investment in energy demonstration projects is the negative externality of climate change. Even with a carbon tax and especially in the absence of one, technology development is an important component of a climate change mitigation strategy.

As carbon tax advocate Newell (2015), ordinarily no fan of public subsidies for energy producers, put it, "there may be a compelling rationale for well-designed public support for a limited number of first of a kind mitigation technology projects." It comes as no surprise, then, that a study of 511 demonstration projects by Gregory F. Nemet and his colleagues, which spanned decarbonization in the energy and industrial sectors, found that almost all of those for which data could be found involved a financial contribution from the public sector. The median public share of funding was 64% (Nemet et al., 2016, 23).

3. Assessment criteria for publicly funded clean-energy demonstration projects

Although the case for public investment in demonstration projects is sound in theory, the practice of managing them is not a simple matter. The Department of Energy has a "checkered history" with demonstration projects that includes many "white elephants": expensive projects that did not lead to follow-on investment (Lester and Hart, 2012). Newell's qualification that public support be "well designed" should be taken seriously. This section draws on the empirical as well as theoretical literature to develop five criteria that constitute good management practice for energy demonstration projects.

The Technology Pork Barrel dominates the literature on federally funded demonstration projects in the United States. The book's thesis is