BREAKTHROUGH INSTITUTE

A NATIONAL CLEAN ENERGY TESTBEDS PROGRAM

USING PUBLIC LANDS TO ACCELERATE ADVANCED ENERGY INNOVATION AND COMMERCIALIZATION

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→ INTRODUCTION ←

The United States faces a multifaceted set of energy challenges requiring the modernization and diversification of the national energy system. At home, American national and economic security is threatened by our reliance on foreign oil and an undiversified electricity portfolio. Overseas, cumbersome, fossil fuel-based energy supply chains jeopardize the safety of American military personnel. And improving public health while mitigating the risks of climate change demands cleaner energy sources. Tackling these challenges necessitates the invention, commercialization, and widespread deployment of clean and affordable advanced energy technologies that offer improved public health, energy security, and domestic energy production.

To date, the pace of advanced energy invention and commercialization has been too slow to meet this national imperative. Innovative energy technologies must overcome significant barriers to be able to enter and compete in the energy market. These obstacles have, until present, slowed and even blocked progress toward a cleaner, more secure, and more competitive domestic energy system. In particular, many promising advanced energy ventures fall victim to the "**Commercialization Valley of Death**"—the funding gap that occurs as entrepreneurs seek capital to finance scale-up and first-of-a-kind commercial-scale deployment to prove the validity of their technologies in the global marketplace.

While many technologies are plagued by a Commercialization Valley of Death, the challenge is particularly acute for early-stage advanced energy technology ventures, which typically face high capital costs, technology and management risks, policy uncertainty, and thick red tape. As the US Chamber of Commerce's Christopher Guith explains:

"While clean energy projects can mitigate a majority of these risks using normal project development processes, overcoming the technology hurdle will take years if left to business-as-usual market processes. Mitigating technology risk traditionally takes years of waiting for the empirical results of a pilot project, a demonstration facility, a semi-scale facility and then a full commercial scale project. This lengthy process has resulted in multiple technologies demonstrating promising laboratory results but failing to meet national energy goals because they never reached full commercial scale." [2]

Without innovative public policies to bridge these barriers and accelerate the pace of advanced energy commercialization, tomorrow's potentially game-changing energy innovations are at considerable risk of being trapped in this Commercialization Valley of Death and locked out of the global energy market. These persistent market barriers effectively protect today's entrenched energy technologies from full market competition while hamstringing American entrepreneurs and innovative technology ventures working to address the nation's energy challenges.

For more on these challenges, please see "Bridging the Clean Energy Valleys of Death," Breakthrough Institute, Nov. 2011.[3]

To help overcome the Commercialization Valley of Death and foster competition and innovation in the energy sector, the Breakthrough Institute proposes the establishment of a **National Clean Energy Testbeds** program (N-CET). N-CET would accelerate the demonstration and commercialization of innovative clean energy technologies by making select federal lands available as dedicated technology demonstration areas. As a collaboration between the Departments of Energy (DOE), Defense (DOD), and Interior (DOI), N-CET would make select public lands available as "plug and play" demonstration zones for a number of much-needed technologies, each containing several pre-permitted "testbeds" with access to pre-constructed shared infrastructure. By reducing the barriers to full-scale demonstration, N-CET would accelerate the pace of advanced energy commercialization and move the United States toward increased energy, economic, and environmental security.

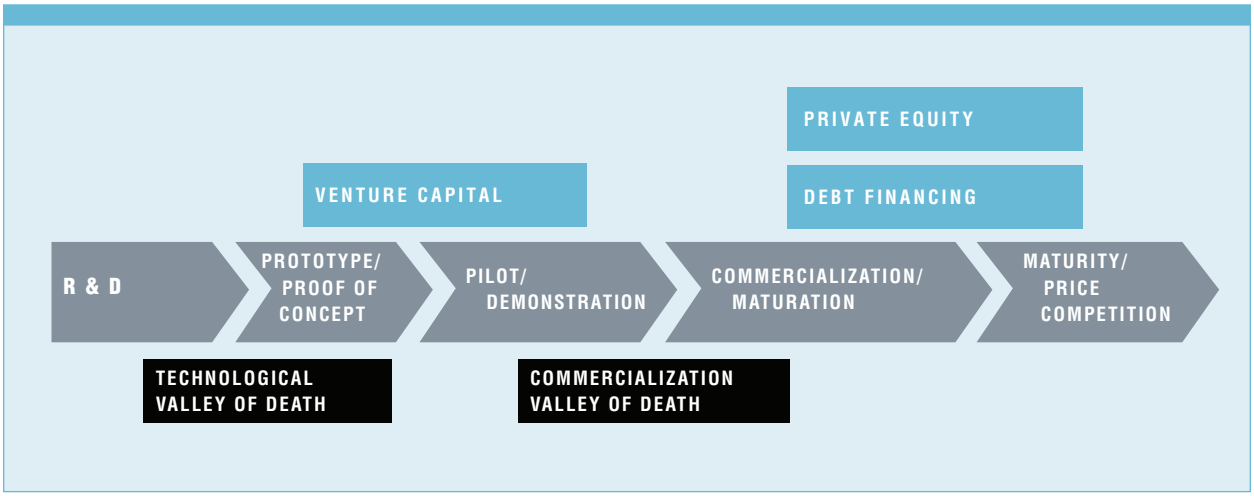
The United States has long made public lands available to help achieve shared national objectives. From homesteading and the transcontinental rail network to land-grant colleges, national forest and rangelands, and our beloved National Parks, uses of federal lands have changed throughout the nation's history to reflect the needs and values of the time. Today, through the N-CET program, America's public lands present a new opportunity to help modernize our antiquated national energy system, accelerate the commercialization of new clean energy technologies, and seed the growth of new advanced energy industries.

I. CLEAN ENERGY AND THE COMMERCIALIZATION VALLEY OF DEATH

The current rate of advanced energy development and deployment will not be sufficient to meet national priorities, suggesting a serious need to accelerate innovation and the commercialization of clean and affordable advanced energy technologies.[4] Deploying clean energy technologies on the scale necessary to meet the nation's multifaceted energy innovation imperative will depend on achieving incremental advancements in today's technologies as well as the development and commercial deployment of next-generation, advanced energy technologies.[5] However, emerging clean energy technologies often have very large capital requirements and are seen as high-risk investments. Consequently, financing is often difficult to obtain, leaving potential breakthrough technologies in the Commercialization Valley of Death.[6]

Figure 1:

THE ENERGY INNOVATION CYCLE AND THE CLEAN ENERGY VALLEYS OF DEATH



Nascent technologies are traditionally financed by venture capital firms, which support the early development and commercialization of a promising new technology or business venture.[7] These firms fund technologies that are novel and high-risk, yet offer potentially high returns. Venture capital financing generally averages around $10 million per investment.[8] In many sectors, these funds are sufficient to advance many technologies out of the laboratory and catapult a new innovation into commercial production. In the energy sector, however, demonstration of emerging and unproven energy technologies

on a commercial scale can require hundreds of millions of dollars or more—greater sums than most venture capital firms are willing or even able to finance.[9]

Debt and equity project finance also supports the deployment of innovative technologies, but these investors are far more risk averse than their venture capital counterparts. Consequently, project finance is often available solely for proven technologies that offer low-risk, high-return profiles. Thus, if developers of emerging clean energy technologies wish to access traditional project finance, they will have to demonstrate their technologies at commercial scale in order to reduce the perceived risks of the projects.[10]

A funding gap is therefore created when risky emerging technologies exhaust the capital of high-risk venture capital, but remain unattractive to traditional debt financiers with stringent risk requirements. This frequently fatal gap is known as the Commercialization Valley of Death (see Figure 1 above).[11]

This valley of death presents a significant barrier to the commercialization and advancement of clean energy technologies. To address these challenges, the process of demonstrating clean energy technologies on a commercial scale should be streamlined, to reduce both the excessive costs and timing delays associated with the demonstration phase of commercialization. In doing so, it will be possible to reduce the perceived risks to the investment community and help open up the capital markets necessary to increase the rate of commercialization and deployment of these emerging clean energy technologies.[12]

While commercialization is frequently seen as the purview of the private sector, the US history of technological innovation is actually one of frequent collaboration between public and private sectors to advanced breakthrough technologies to the market, from modern aircraft and microchips to nuclear power plants, modern wind turbines, and the Internet.[13] Public policy support is needed once again to help risk-taking American entrepreneurs cross the Commercialization Valley of Death and bring potentially game-changing advanced energy technologies through the demonstration phase and into the marketplace.

II. NATIONAL CLEAN ENERGY TESTBEDS

ACCELERATING ADVANCED ENERGY COMMERCIALIZATION

In order to help overcome the Commercialization Valley of Death and accelerate the rate of commercialization for emerging advanced energy technologies, we recommend establishing a National Clean Energy Testbeds program. A collaboration between DOE, DOD, and DOI (including in particular, the Bureaus of Land Management and Ocean Energy Management), the N-CET program would take advantage of the abundant resources presented by America's public lands and waters by identifying and pre-permitting sites on federal land suitable for novel energy technology demonstrations. By reducing the cost, time, and permitting barriers associated with technology demonstration, N-CET will allow more advanced energy ventures the opportunity to prove their market viability, accelerating the commercialization of promising technologies and allowing these technologies to compete on an even keel with conventional energy sources.

N-CET Builds on Successful Models

Historical Federal Support for Energy Technology Demonstration

The US federal government has long supported demonstrations of innovative energy technologies, leading to game-changing advancements. The National Reactor Testing Station, now Idaho National Labs, was one such demonstration site. Established in 1949 as a center for research and demonstration of nuclear reactors, the National Reactor Testing Station (NRTS) housed more than fifty 50 uniquely designed reactors.[14] It was the site of many important industry firsts, including generating the first usable amount of electrical power from nuclear fission in 1951 with the Experimental Breeder Reactor-1.[15] Other NRTS achievements include the first use of U-235 fuel and liquid-metal coolant, the development of nuclear reactors for use on submarines, and the demonstration of electricity production from a boiling water nuclear reactor.[16] These breakthroughs were achieved because the US government prioritized the advancement of nuclear technologies and provided the resource, land, and infrastructure to ensure success.

Today, the federal government continues to support innovation in energy technologies through the DOE's National Renewable Energy Laboratory (NREL), which contracts with private technology developers to research and build new energy technologies. In particular, NREL's National Wind

Technology Center (NWTC) demonstrates that the public maintenance of a fully equipped technology demonstration site can accelerate technology development and commercialization and support private-sector investment and innovation. NWTC has successfully reduced the cost of both large and small wind turbines and decreased risk for investors by proving performance and design.[17]

N-CET would build on these historical precedents through a new collaboration between DOE, DOD, and DOI to identify and pre-permit suitable sites and provide appropriate infrastructure to streamline the demonstration of a full suite of advanced energy technologies.

Plug and Play Model

Efforts to reduce the burden of site identification and permitting in order to reduce the costs of demonstration are central to N-CET's design. Thus, N-CET would expand upon a "plug and play" model already proven by the European Marine Energy Center (EMEC) and various other programs, to effectively reduce the burden of demonstration by establishing pre-approved, monitored, grid-connected sites.

EMEC is a wave and tidal power research center located in the Orkney Islands in Scotland, which facilitates full-scale, grid-connected demonstration of wave and tidal-powered electricity generation with purpose-built "berths," or aquatic test sites.[18] EMEC's wave energy site, completed in 2003, includes four test berths, and the tidal power site, completed in 2007, includes five berths. In both locations, test berths are connected to the mainland grid via undersea cables and an onshore substation. High demand for test sites led EMEC to lay seabed transmission cables for three new berths in 2010, a testament to the efficiency of the plug and play system and the industry demand for the services offered by this clean energy testbed center.[19]

Building on Momentum Already Underway

N-CET would build on several programs currently underway that aim to link advanced technology research and development with the commercialization of these technologies. A similar plug and play site for concentrated solar power (CSP) is just getting underway in the United States. The Solar Demonstration Zone, located in Nevada, is a partnership between DOE and the DOI's Bureau of Land Management (BLM) to accelerate the demonstration of CSP technologies.[20] The 25-square mile project area will house a number of ready-for-use demonstration sites and is expected to reduce costs and environmental impact as well as site selection and permitting time, helping CSP technologies through the gulf between development and commercialization.[21] N-CET would follow a similar structure and build on this key model of interagency collaboration to facilitate advanced energy technology demonstration. By creating multiple testbed centers across the country, N-CET would ensure that a wide array of innovative energy technologies have access to plug and play demonstration sites.

DOE and DOI are also actively collaborating on a second project to identify public lands that will be suitable for solar production projects.[22] While these "solar energy zones" target later stage commercial projects than the demonstration-stage ventures facilitated by N-CET, this program is illustrative of a partnership between the DOE and DOI to facilitate permitting and planning for innovative technology projects on public lands that should be emulated by N-CET.

A third project currently underway on the federally owned Savannah River Site in Georgia provides a further precedent for N-CET. This public-private partnership between the DOE and several private companies will establish a demonstration site for multiple prototypes of small modular nuclear reactors (SMRs) on the Savannah River Site, a former nuclear reserve owned by the DOE. The first in this series of projects is a recently announced collaboration between the nuclear energy startup company Hyperion Power Generation and the Savannah River Site. This partnership will provide the licensing and site access for demonstration of this capital-intensive technology, and is expected to cut ten years out of the development lifecycle for small modular reactors through accelerated licensing and reduced overhead costs.[23] Advocates argue that these projects will allow the United States to maintain its leadership in SMR technology, by acting as an early-stage demonstration and commercialization host site. These projects will tentatively be used to launch the development of an energy park that would eventually help "bridge the technology gap" for a range of innovative nuclear fission and fusion technologies.[24]

N-CET would build off of the existing momentum represented in the programs discussed above by institutionalizing federal support for this advanced technology demonstration process and by providing an umbrella for the demonstration of all types of advanced clean energy technologies, beyond just nuclear and solar energy technologies.

HOW N-CET WOULD WORK

Technology Assessment and Selection

N-CET's first step would be an assessment of the status of advanced energy technologies and a determination as to which broad technology categories would benefit from centralized demonstration sites. DOE staff would lead this process, with input from DOD on technical assessment and military energy technology needs, based on DOD experience with energy technology development, procurement, and use. The assessment process should consider the following criteria in selection of eligible technology categories:

1. Eligible technologies should generally not be considered commercially ready as a result of high perceived technology risk or similar factors;

2. Eligible technologies will require large-scale demonstration before proceeding to commercialization;

3. Accelerating permitting and siting and establishing key infrastructure (e.g., transmission connection) would accelerate demonstration and assessment of technology risks, reduce technology uncertainty, and hasten commercialization for eligible technologies; and

4. Eligible technologies will have the long-term potential to:

   A. Contribute to the diversification of sources of United States energy supply and reduce the nation's reliance on fossil energy sources, with a favorable balance of environmental effects if the entire technology system is considered; or

   B. Help strengthen and enhance US military capabilities and reduce the military's operational reliance on fossil energy sources; or

   C. Contribute to reducing, avoiding, or sequestering energy-related greenhouse gas emissions.

Under such criteria, technologies that might be suitable for selection include CSP, wave power, floating deep-water wind turbine designs, enhanced/engineered geothermal energy production methods, modular nuclear reactor designs, carbon capture and storage technologies for fossil fuel and biomass-fired power plants, and grid-connected energy storage technologies, among others. The decision of the technology assessment panel would direct N-CET as to what kinds of demonstration sites would be necessary. After an initial period of time (e.g., several years), N-CET would re-asses technology needs and consider new demonstration zones and/or alterations or closures for existing N-CET zones.

Demonstration Site Selection and Preparation

Based on the results of the technology assessment and selection, N-CET would identify potential demonstration sites on federal lands and waters. This task would fall to DOI and DOD, as the primary stewards of suitable public lands and waters, although DOE-managed sites throughout the country would also be considered. The process would ensure that the best possible sites are identified for each technology type, while minimizing costs to the government.

Of the possible sites, DOE and DOD would select the sites best suited to be a "demonstration zone" for each technology category. Some necessary qualities—size, geology, and weather, for example—would vary by technology type, but all sites would require electricity grid interconnection or suitable indigenous, on-site demand (e.g., from military or industrial facilities or other large-scale energy consumers). Therefore, sites with advantageous existing infrastructure, such as electricity substations, large on-site energy demand, and/or proximity to long-distance transmission lines would be favored.

Each demonstration zone would ideally house a number of individual "testbeds"—ready-to-use sites suitable for large-scale demonstration of a given technology design—in order for multiple designs to undergo demonstration simultaneously. If an appropriate number of testbeds cannot be accommodated in a single demonstration zone, multiple demonstration zone locations may be selected for a given technology category.

In addition to identifying suitable sites, N-CET would facilitate demonstration by pre-permitting testbeds and conducting programmatic environmental impact statement (EIS) assessments for demonstration zones. DOI would head this effort with support from DOE.[25] Similar actions are already underway on public lands. For example, as part its efforts to comply with the Energy Policy Act of 2005, which calls for greater use of public lands for energy production, BLM has completed programmatic environmental impact statements for commercial, utility-scale wind and geothermal plant siting on BLM-managed lands and is currently conducting a programmatic EIS for solar energy plants.[26]

N-CET would further lower the barriers to demonstration by supplying the appropriate basic infrastructure for the demonstration zones, according to technology type. This would include access roads or port facilities, water supply as needed for plant cooling, and basic testbed site preparation to prepare for construction activities.

In order to provide true performance evaluations, all N-CET demonstration zones would be grid-connected or serve suitable indigenous, on-site energy load centers. As needed, N-CET would build or upgrade substations and transmission grid interconnection infrastructure. N-CET would also pre-negotiate interconnection and transmission capacity allocation agreements with transmission line owners, to be finalized after specific technology designs have been selected.

By establishing plug and play testbeds at N-CET demonstration zones, the program will greatly reduce the demonstration hurdles faced by new and innovative clean energy technologies. By reducing the cost, time, and permitting burdens associated with finding and preparing sites for demonstration, N-CET will allow more designs to reach demonstration and accelerate the commercialization of promising clean energy technologies.

Competitive Application Process

After establishing an operational demonstration zone, N-CET would oversee a competitive application process to select the designs that would be granted use of the testbeds. Applicants could be any private firms, public-private partnerships, or consortia whose technology fits the qualities outlined above for technology assessment. The design must have long-term potential to reach a market-competitive price and/or should meet military procurement requirements. Applicant designs must be sufficiently advanced

to conduct a grid-connected, large-scale pilot or full-scale demonstration. Applicants must also prove their ability to meet their share of the project-specific financing, discussed further below.

Financing

N-CET could be housed within DOE, but with a separate congressional authorization and high level of autonomy so that it can most freely function as a productive collaboration between DOE, DOD, and DOI. N-CET's budget would provide funding for technology assessment, site selection, pre-permitting, programmatic EISs, construction of basic common infrastructure, applicant selection, and program administration.

Securing project-specific financing to cover the cost of demonstration project construction and installation, operation, testing, validation, and monitoring would be the responsibility of the project applicant. While applicants may draw on existing federal programs designed to finance or reduce risk for innovative energy technology demonstrations, at least 35 percent of project financing costs should be provided by private sector participants in the project.[27] This cost share requirement will ensure private sector involvement, a necessary step to reduce technology risk and spur commercialization.

While N-CET is a novel concept that will reduce key barriers to financing the demonstration and commercialization of nascent clean energy technologies, it remains one piece of the larger puzzle of securing financing for these early-stage energy technologies. This proposal will need to be considered along with other financing mechanisms to address the wide range of financing challenges that face innovative clean energy companies along the entire technology innovation lifecycle.[28]

Department of Defense Participation

As the nation's single largest energy consumer, the DOD has strong motivation to optimize its energy use. As discussed earlier, the military has an acute need for non-fossil fuel alternatives and to enhance the resiliency of electricity grids at military facilities at home and abroad. As a result, DOD is motivated to explore new options and is already accelerating the demonstration of biofuels for Air Force aircraft and Navy vessels and opening military lands for clean energy generation.[29]

N-CET will provide DOD further opportunities to engage in dual-use energy technology demonstrations to meet civilian and military energy needs. As part of the N-CET technology assessment and selection process, DOD will be able to highlight and recommend technologies it deems necessary and beneficial. DOD may also opt to make its own lands available for demonstration zones.

In addition, the military is likely to be a willing and effective partner in clean energy innovation efforts. The CNA Military Advisory Board finds that "in the course of addressing its most serious energy

challenges, the Department of Defense can contribute to national solutions as a technological innovator, early adopter, and testbed."[30] Because of its unique structure, leadership culture, and experience with technology innovation, DOD "can be a powerful catalyst of energy innovation," especially when collaborating with other agencies.[31] N-CET will provide an invaluable opportunity for DOD to act on these advantages in collaboration with DOE, serving as a guide and testbed in the country's search for effective advanced energy technologies.

DEFINING SUCCESS FOR N-CET

The success or failure of the N-CET program should be judged based on its ability to accelerate the general *rate* of commercialization of advanced energy technologies. Policymakers should fully expect that some specific designs will prove unsatisfactory once built and monitored at the N-CET demonstration zones. Technology innovation is an inherently uncertain process, and some technologies *will* fail to reach commercialization. Such designs may return to the bench for reengineering or may be scrapped altogether, but even "unsuccessful" demonstrations often provide the fertile lessons critical to future technology success. As Thomas Watson, IBM's pioneering former president stated, "If you want to succeed, double your failure rate." This is what N-CET aims to do, providing more entrepreneurial, creative American firms the opportunity to prove the viability of their designs and ultimately contribute to a more secure, healthier, and diversified energy system. N-CET should therefore be evaluated based on the program's ability to accelerate the rate of commercialization for technology classes assisted by the program, and individual unsuccessful demonstration projects should not be considered a failure of the N-CET program as a whole.

SEEDING NEW CENTERS OF CLEAN ENERGY INNOVATION AND INDUSTRY

N-CET's demonstration zones have the potential to seed vibrant clean energy industry clusters. Industry clusters are geographic areas in which companies of a particular field congregate, developing mutually beneficial horizontal and vertical networks. Through the concentration of knowledge and infrastructure, such clusters often greatly accelerate innovation and spark economic development and growth.[32]

Such clusters are highly sought after because they are "good for business"—both for industry participants and local residents and governments. Silicon Valley, a famous example of industry clustering, experienced an upward spiral of semiconductor and information technology companies, with much of the early growth and innovation in the region supported by DOD and other federal contracts and research

funding, ultimately making Silicon Valley a prosperous region and the world's leading cluster of high technology companies. N-CET's demonstration zones, as centers where creative entrepreneurs from diverse firms will gather to test their designs, inherently contain the potential "seed crystals" from which new industry clusters will grow.

→ CONCLUSION ←

American entrepreneurs working on clean and affordable advanced energy technologies are sorely in need of more opportunities to demonstrate that their designs are commercially viable, a process that is usually long, costly, and constrained by red tape. These challenges combine to increase risks and reduce the rate of commercialization for advanced energy alternatives. Today, too many promising advanced energy designs therefore fall victim to the Commercialization Valley of Death between research and commercial demonstration, and the pace of commercialization for new, large-scale clean energy technologies remains too slow to meet national needs.

The nation's public lands and waters thus have a new role to play in meeting America's 21st century advanced energy needs. The establishment of a National Clean Energy Testbeds program would help address the bottleneck that currently exists in the clean energy innovation pipeline, supporting entrepreneurs and advanced technology ventures and enhancing competition and innovation in the energy sector. By allowing more advanced energy technologies to reach commercialization, our public lands would contribute to pressing national energy, economic, and environmental imperatives.

→ NOTES AND CITATIONS ←

[1] Jesse Jenkins is Director of Energy and Climate Policy at the Breakthrough Institute. Sara Mansur contributed as a Policy Associate with the Energy and Climate Program at the Breakthrough Institute. Alexandra Tweedie contributed to this report as an M.S. degree candidate in Environmental Studies (Policy) at the University of Colorado-Boulder and a 2010 Breakthrough Generation Fellow. Paul Scharfenberger contributed as an M.B.A./M.S. degree candidate in Environmental Studies at the University of Colorado-Boulder.

[2] Christopher Guith, "Testimony of Christopher Guith, Vice President for Policy Institute for 21st Century Energy, US Chamber of Commerce" before the US Senate Committee on Energy and Natural Resources, May 3, 2011. Available at: http://energy.senate.gov/public/_files/GuithTestimony05032011.pdf

[3] Jesse Jenkins and Sara Mansur, "Bridging the Clean Energy Valleys of Death," Breakthrough Institute, November 2011. Available at: http://thebreakthrough.org/

[4] "From Innovation to Infrastructure: Financing First Commercial Clean Energy Projects," California Clean Energy Fund (CalCEF), June 2010, at pages 5–33.

[5] Steven Hayward *et al.,* "Post-Partisan Power," Breakthrough Institute, American Enterprise Institute and Brookings Institution, October 2011.

[6] Jesse Jenkins and Sara Mansur, 2011, *op. cit.* note 3.

[7] CalCEF, 2010, *op. cit.* note 4, at page 8.

[8] Clean tech venture capital investment in the third and fourth quarters of 2010 totaled $3.56 billion worldwide, spread across 360 deals, for an average value of $9.89 million per deal. Iris Kuo, "Record $7.8 billion year for cleantech venture capital in 2010, but two quarters of decline," *GreenBeat / VentureBeat.com,* January 7, 2011. Available at: http://venturebeat.com/2011/01/07/record-7-8-billion-year-for-cleantech-venture-capital-in-2010-with-declines-in-second-half/

[9] Jesse Jenkins and Sara Mansur, 2011, *op. cit.* note 3.

[10] Christopher Guith, 2011, *op. cit.* note 2.

[11] CalCEF, 2010, *op. cit.* note 4, at page 3.

[12] It should also be noted that streamlining the demonstration phase for emerging clean energy technologies is only one piece of the puzzle; multiple policy strategies deployed in parallel will be necessary to fully bridge the "Commercialization Valley of Death,," including programs to directly finance worthy large-scale demonstration projects.

For more, see a companion brief to this document: Jesse Jenkins and Sara Mansur, "A Clean Energy Deployment Administration: Unlocking Advanced Energy Innovation and Commercialization," Breakthrough Institute, November 2011. Available at: http://thebreakthrough.org/

[13] Jesse Jenkins *et al.,* "Where Good Technologies Come From: Case Studies in American Innovation," Breakthrough Institute, December 2010.

[14] S. M. Stacy, "Proving the Principle: A History of the Idaho National Engineering and Environmental Laboratory, 1949-1999," US Department of Energy, Idaho Operations Office, 2000, at pages 259-268.

[15] *Ibid.*

[16] *Ibid.*

[17] "NREL's Wind R&D Success Stories," Department of Energy, Office of Energy Efficiency and Renewable Energy, January 2010.

[18] "Orkney…the home of wave and tidal energy," European Marine Energy Center (2007).

[19] "EMEC Expansion – Berths Available," European Marine Energy Center, August 2010. Available at: http://www.emec.org.uk/view.asp?newsID=228

[20] "US Departments of Energy and Interior Announce Site for Solar Energy Demonstration Projects in the Nevada Desert," US Department of Interior, August 2010. Available at: http://www.doi.gov/news/pressreleases/US-Departments-of-Energy-and-Interior-Announce-Site-for-Solar-Energy-Demonstration-Projects-in-the-Nevada-Desert.cfm

[21] According the Memorandum of Understanding between DOE and DOI for the project, "The solar projects to be sited in the demonstration area are intended to facilitate increased commercialization of the technologies demonstrated by providing technical and financial validation necessary to attract conventional financing." See "Memorandum of Understanding Between the United States Department of Energy and the United States Department of the Interior for the Demonstration of Advanced Solar Power Technology on Public Lands," US Department of Energy and Department of Interior, July 2010, at page 2. Available at: http://www1.eere.energy.gov/solar/pdfs/solar_demonstration_mou.pdf

[22] "DOE and DOI Propose Solar Energy Zones in Six Western States," US Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), January 5, 2011. Available at: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=16618

[23] Dan Yurman, "Hyperion to Build Small Modular Reactor at Savannah River," *TheEnergyCollective.com*, September, 10 2010. Available at: http://theenergycollective.com/dan-yurman/43216/hyperion-build-small-modular-reactor-savannah-river

[24] "The SRS Energy Park," Savannah River Site Community Reuse Organization, 2011, accessed August 23, 2011. Available at: http://www.srscro.org/energy-park/

[25] This is consistent with the Solar Demonstration Zone, which is housed under DOE's Office of Energy Efficiency and Renewable Energy. See "DOE and DOI Pick Solar Demonstration Site in the Nevada Desert," EERE Network News, July 2010. Available at: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=16155

[26] "Wind Energy Development Programmatic EIS Information Center," Argonne National Laboratory, accessed August 23, 2011. Available at: http://windeis.anl.gov/

"Geothermal Resources Leasing Programmatic EIS," US Department of the Interior, Bureau of Land Management, accessed August 23, 2011. Available at: http://www.blm.gov/wo/st/en/prog/energy/geothermal/geothermal_nationwide.html

"Solar Development Programmatic EIS Information Center," Argonne National Laboratory, accessed August 23, 2011. Available at: http://solareis.anl.gov/

[27] Examples of such programs include FutureGen for carbon capture and sequestration technologies, various DOE grant programs, and the DOE Loan Guarantee Programs.

[28] See a companion brief to this document: Jesse Jenkins and Sara Mansur, "A Clean Energy Deployment Administration: Unlocking Advanced Energy Innovation and Commercialization," Breakthrough Institute, November 2011. Available at: http://thebreakthrough.org/

[29] Ian Graham, "Air Force Scientists Test, Develop Bio Jet Fuels," American Forces Press Service, March 2010. Available at: http://www.defense.gov/news/newsarticle.aspx?id=58528

William Jamieson, "Navy Demonstration Highlights Bio-Fuels Capability," American Forces Press Service, October 2010. Available at: http://www.defense.gov/news/newsarticle.aspx?id=61398

"Department of Defense Announces Billions of Dollars in Opportunities for Renewable Energy and Energy Efficiency Companies," *WSRG Alert*, Wilson Sonsini Goodrich and Rosati, August 17, 2011. Available at: http://www.wsgr.com/WSGR/Display.aspx?SectionName=publications/PDFSearch/wsgralert-dod-renewable-energy.htm

[30] CNA Military Advisory Board, "Powering America's Defense: Energy and the Risks to National Security," CNA Analysis and Solutions, 2009, at page 43.

[31] CNA Military Advisory Board, Powering America's Economy: Energy Innovation at the Crossroads of National Security Challenges, CNA Analysis and Solutions, 2010, at page viii.

[32] Mark Muro and Bruce Katz, "The New 'Cluster Moment': How Regional Innovation Clusters Can Foster the Next Economy," Brookings Institution Metropolitan Policy Program, 2010.

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