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# Mind the Gap: A Design for a New Energy Technology Commercialization Foundation

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The United States is struggling to move innovative energy technologies from discovery to scale. This gap could put the climate and U.S. investments at risk. A nonprofit foundation working with the Department of Energy could help fill the gap.

## KEY TAKEAWAYS

- ITIF urges Congress to authorize an Energy Technology Commercialization Foundation (ETCF) that would work closely with the Department of Energy and support organizations and entrepreneurs to bring clean energy technologies to market.
- There is an urgent need for such a foundation, because the United States, in spite of its scientific prowess, is not making rapid enough progress toward solving the diverse and difficult decarbonization challenges it faces.
- ETCF would facilitate energy innovators' access to DOE's technical expertise and world-class facilities, encourage researchers to seek commercial applications for their discoveries, and foster public-private collaboration.
- ETCF would draw on precedents set by the diverse array of agency-related foundations that Congress has established over the past 50 years.
- Congress should provide ETCF and DOE with tools and instructions to work together and jump-start the foundation with a one-time appropriation of $30 million, which would leverage substantially larger contributions from nongovernmental donors.

## INTRODUCTION

Over the coming decades, the world economy must make a transition to low-carbon energy. This transition will require accelerated innovation to affordably reduce the carbon footprint of all major emissions sources, including hard-to-decarbonize sectors such as long-distance transportation and manufacturing, as well as electricity and light-duty vehicles, where the transition has already begun.

The United States' strong support for energy research and development (R&D) should position it well to lead the global energy transition. But the United States has difficulty moving new technologies from early discovery to scale. This gap in the nation's energy innovation system could put the climate at risk by stalling the transition. It could also open the way for China and other countries to capitalize on U.S. investments. If key technologies are made overseas, the United States will lose out on many of the commercial opportunities the transition will create, and its national security could be compromised.

A nonprofit Energy Technology Commercialization Foundation (ETCF), authorized by Congress to work closely with the U.S. Department of Energy (DOE), could help fill this gap by allowing energy innovators' access to DOE's tremendous technical expertise and world-class facilities, thereby helping them advance more quickly. It would encourage DOE-funded researchers to more aggressively seek commercial applications for their discoveries, and connect them with partners, funding, and tools to do so. These activities would be motivated by national and regional opportunities to develop globally scalable solutions to decarbonization challenges through collaborative partnerships with the private sector.

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ETCF would raise most of its funds from private-sector and philanthropic donors that see value in accelerating the commercialization of such solutions. Groups of domestic companies seeking a competitive advantage in decarbonizing common activities or supply chains, for instance, would partner through ETCF to build up service providers and next-generation vendors. Mission- and region-oriented philanthropies would give to it to advance their environmental and economic objectives.

ETCF would regrant these funds to innovative teams and organizations developing new energy technologies in a variety of settings, including businesses, incubators, universities, and government laboratories. ETCF would leverage its strong connection to DOE to connect innovators with technical resources and expertise across the country, including DOE's 17 national laboratories and extensive network in academia and the private sector. ETCF's congressional authorization would allow it to catalyze technical collaborations more effectively than other nongovernmental entities.

ETCF would complement and supplement DOE's own activities, doing what DOE is constrained by existing rules from doing or has proven unable to do with great success and speed. Its authorization would draw on precedents set by other congressionally authorized agency-related

foundations, such as the National Park Foundation (NPF), the Foundation for the National Institutes of Health (FNIH), the Foundation for Food and Agriculture Research (FFAR), and the Centers for Disease Control Foundation (CDCF). These precedents include the capacity to create public-private partnerships in ways that federal agencies cannot, and the ability to transfer money and equipment to agencies. They can also take action more quickly and flexibly than agencies can, as exemplified by CDCF's ability to raise over $78 million to respond to COVID-19 so far in 2020. ETCF would also add momentum to DOE's in-house commercialization initiatives, which are products of the same multi-decadal reform impulse that has led advocates to propose an agency-related foundation for DOE.

This report puts forward a vision and design for ETCF for Congress to consider. It draws on more than 140 interviews and 2 full-day stakeholder workshops, as well as extensive research on the diverse array of agency-related foundations Congress has authorized since 1967. (Appendix 1 describes the project's methodology. Appendix 2 sketches nine federal-agency-related foundations.)

We begin by laying out the energy-technology commercialization gap, reviewing the roles of the federal government, research institutions, philanthropy, and industry, and highlighting the inadequate bridges that link them to one another. We show that no one entity in the U.S. energy innovation system is responsible for bringing new technologies across the fabled "valley of death" between proof of concept and early adoption in the market. Government and philanthropic funding typically comes too early in the process to help would-be innovators get to market, while the private sector (with a few exceptions) prefers investments that pay off more quickly and with more certainty.

The next section begins to show how ETCF would help fill this gap by explaining how other congressionally authorized agency-related foundations work. While they are not a part of the federal government, their authorizations create unique relationships with their related agencies. Each seeks, in its own way, to create what NPF calls a "margin of excellence" in its related agency's performance. Their authorizations take a similar form but enable differing functions, depending on the agency's mission and needs. We argue that the public-private partnership model of FNIH, the challenge model of FFAR, and the distributed model of NPF (and others) provide valuable precedents for ETCF.

The last section describes our proposed design for ETCF, including its mission, unique capabilities, collaboration strategies, funding sources, and commercialization activities it would support. We propose ETCF be charged by Congress with the mission of strengthening U.S. competitiveness in a carbon-constrained world. We advance a governance structure for ETCF that would connect it effectively to DOE, the national labs, and other stakeholders, while giving it sufficient autonomy to make a real difference.

The need for an Energy Technology Commercialization Foundation is urgent. The United States, in spite of its scientific prowess, is not making rapid enough progress toward solving the diverse and difficult decarbonization challenges it faces. ETCF's creation would not solve all that ails the U.S. energy innovation system. But it would help DOE to lower the mortality rate of innovators seeking to cross the valley of death and encourage other actors in the system to take actions that would have that effect as well.

We call on Congress to authorize ETCF, provide it and DOE with the tools and incentives they need to work together harmoniously, and jump-start it with a modest one-time appropriation of $30 million, which would leverage substantially larger contributions from nongovernmental donors.

## THE CLEAN ENERGY TECHNOLOGY COMMERCIALIZATION GAP

The central role of clean energy innovation in the transition to a carbon-constrained world creates both opportunities and threats for the United States. As the world's leading investor in energy R&D, the United States has the infrastructure and talent to generate a wide array of potential climate solutions.[1] The United States' strong position at the front end of the innovation cycle gives it the inside track to capture a substantial share of the trillions of dollars that will flow into new clean energy products and services as they are commercialized and adopted globally.

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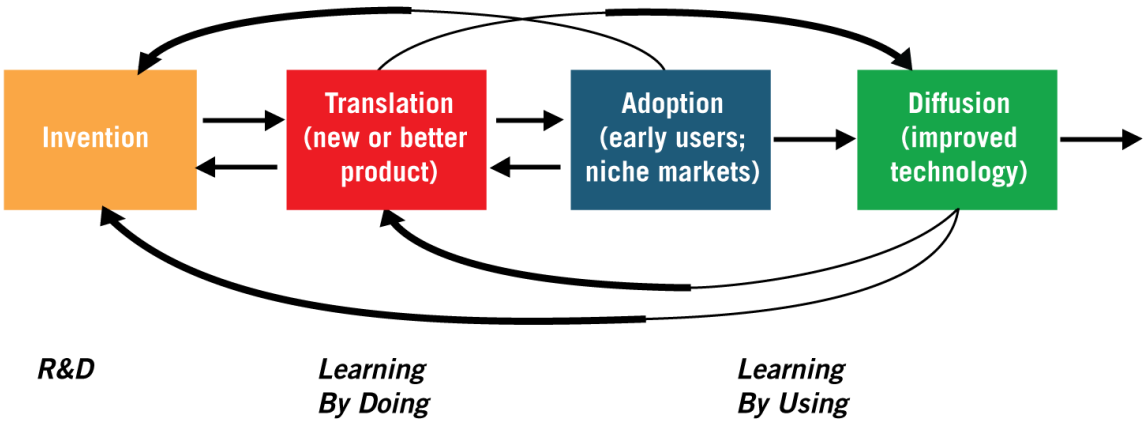
International competitors—notably China—are avidly pursuing similar opportunities, ramping up their own investments in scientific discovery and technological innovation. They are also moving aggressively to scale up innovations regardless of where the intellectual property is sourced or whether it was obtained legally.[2] Success in this global competition has implications for U.S. national security, the environment, and the economy. International relations in the 21st century, as in the 20th century, will be influenced by energy resources and related innovations.

The U.S. record in bringing clean energy technologies through the full innovation cycle, and reaping the benefits that follow, is less than stellar, especially considering the extraordinary science and technology assets at DOE's national laboratories. This section argues that none of the institutions in the U.S. energy innovation system are fully responsible for the middle phases of the cycle, such as proof of concept, demonstration and validation, commercialization, and early adoption. The gap between government-funded R&D and private-sector commercialization slows or even stops some promising solutions from achieving their full potential. They also provide an opportunity for China and other foreign competitors to capitalize on U.S. investments by bringing technologies that are stalled at home to maturity abroad.

### The Innovation Cycle and Valley of Death

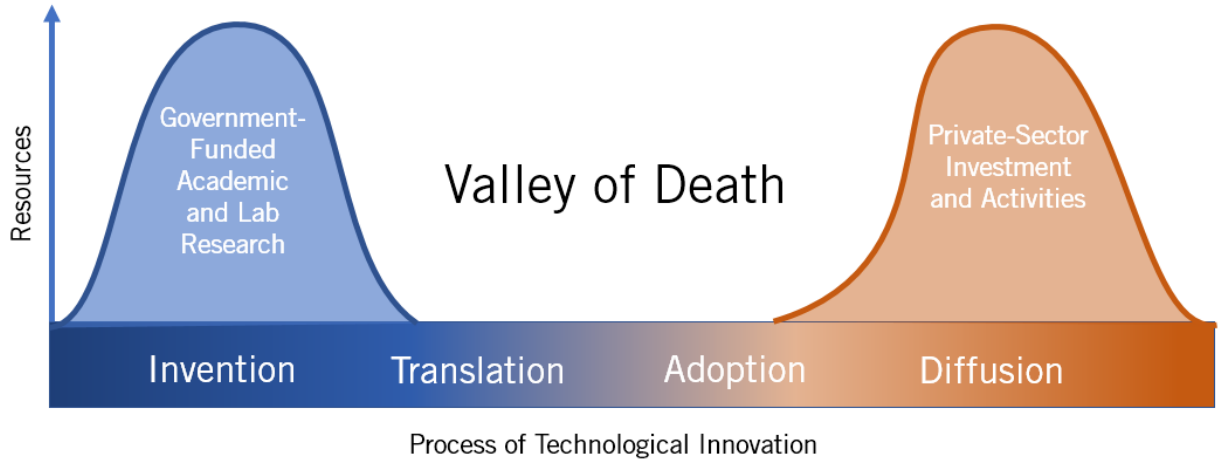
The road from basic research to the market for new products and services is often long, complicated, and beset by significant barriers. A model of the innovation process (see figure 1) set out by the President's Council of Advisors on Science and Technology describes four interrelated stages: invention, translation, adoption, and diffusion. Programs and policies across these stages shape a complicated innovation ecosystem that includes a diverse network of institutions. Few technologies move from research to market in a linear fashion. Most are aided by feedbacks from later stages to earlier ones, so that downstream learning is incorporated into design and development.[3]

**Figure 1: President's Council of Advisors on Science and Technology: Process of Technological Innovation**




When these feedback loops break down and the major players are disconnected, promising technologies fall into the valley of death (see figure 2). Neither the welfare-maximizing objective of government-funded R&D nor the profit-maximizing approach of the private sector catalyzes investment. Without investment, progress stalls.[4]

**Figure 2: The valley of death**




Risk reduction is one key to crossing the valley of death. Private investors are acutely sensitive to risk; they choose their investments in large part based on the relative risks and rewards of each. Information asymmetry plays into their decision-making as well. Investors must take into account the chance they do not fully understand the risk—the less they know, the higher the rate of return they will demand on a particular investment. Moreover, as the Energy Futures Initiative

(EFI) and IHS Markit have written, energy innovation "requires steeply escalating investments" that amplify the perceived risk.[5]

The EFI/IHS report notes that success in crossing the valley of death "requires the alignment of many players," who bring different skills, experiences, knowledge, and resources to the innovation process.[6] Private-sector players engaged in the later stages of adoption and diffusion must believe there will be demand for an innovation before they invest at a level that will take it through the valley of death. They must be able to learn enough about what early stage players at universities and national labs are doing to overcome this asymmetry.

Ideally, those involved in invention and translation would be informed and motivated by downstream needs. But, as the U.S. Economic Development Administration described, key elements of commercialization, such as "market assessment, product design, manufacturing engineering, management of intellectual property rights, marketing strategy development, raising capital, and worker training" lie well outside the skill set of most researchers.

The valley of death is two-sided, with peaks and plateaus. There are significant limits on how far federally funded research programs are able to move toward commercial application without effective collaboration from the private sector. There are also significant limits on the private sector's willingness to pull promising energy technologies into the market without first having innovations de-risked by the federal government. And there are too few players that seek to build bridges between them.

## The Limits of Federally Funded Energy R&D

DOE is funding about $8 billion in energy R&D in fiscal year 2020.[7] That is far larger than any counterpart abroad; China's equivalent funding agency, in second place, invests about half as much. However, despite this level of funding, institutional barriers, misaligned structures, and weak incentives for federally funded researchers lead to significant commercialization shortfalls and hinder the United States from leading the global clean energy transition.

About $3 billion is spent by DOE's Office of Science on energy-related basic research, which is by definition not conducted with a specific private-sector application or partner in mind. The rest goes to DOE's applied energy offices and the Advanced Research Projects Agency-Energy (ARPA-E).[8] While projects funded by these sources usually seek knowledge relevant to a practical aim, and may even yield prototypes, substantial subsequent investment is typically required before any customer would be willing to pay for the technologies under development. ARPA-E's new Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALEUP) program will seek to bring technologies that have won prior ARPA-E awards closer to full commercialization.[9]

Most federal energy R&D dollars flow to DOE's 17 national laboratories, with the remainder going primarily to universities.[10] The national labs are an extraordinary repository of multidisciplinary technical talent, and they house many unique research facilities. Despite these attributes—or perhaps because of them—the national labs generally are not oriented toward commercialization. As the 2013 *Turning the Page* report coauthored by the liberal Center for American Progress, conservative Heritage Foundation, and Information Technology and Innovation Foundation (ITIF) put it:

> Beliefs ingrained in the research community, particularly within DOE, hold that technology transfer fundamentally detracts from the research mission. This thinking persists due to a number of policy, budgeting, cultural, and institutional barriers to interacting with industry, to actively tying potential commercial goals with research, and to leveraging the labs' vast knowledge and talent base as resources for universities, industry, and other agencies.[11]

As DOE's Undersecretary for Science Paul Dabbar put it recently, "The problem is that most of our labs literally have a fence around them."[12]

DOE has made significant strides in recent years to better fulfill its commercialization mandate. It created an Office of Technology Transitions (OTT) in 2015 and implemented the statutory Technology Commercialization Fund worth about $30 million annually. Some labs, such as the National Renewable Energy Laboratory have created partnership programs that seek to accelerate innovations to the market and support technology maturation.[13] The department's Energy I-Corps program trains national lab researchers to become entrepreneurs. Its Lab-Embedded Entrepreneurship Program (including Berkeley Lab's Cyclotron Road, Argonne's Chain Reaction, and Oak Ridge's Innovation Crossroads) provides outside entrepreneurs with access to a national lab's facilities and expertise, in addition to entrepreneurship training.

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Many of these efforts have yet to be evaluated for their long-term effectiveness in addressing barriers to increased commercialization. Energy I-Corps, though, was evaluated by an independent third party, which found it to be moving the labs in the right direction. For example, 95 percent of Energy I-Corps participants reported a better understanding of their technologies' value proposition and could identify key market decision-makers after completing the program. Additionally, 80 percent reported being likely to apply the learnings from the program to similar activities.[14]

While these efforts are encouraging, there are fundamental limits on DOE's ability to drive commercialization. The President's Council of Advisors on Science and Technology put it this way:

> [T]he government historically performs much less well at translation, adoption, and diffusion [than at invention], partly because the Federal actions that influence these components of the energy technology ecosystem are diffused so widely across government, and partly because energy sector decision-making is ultimately in the hands of the private sector.[15]

Moreover, DOE does not move at the same speed as the private sector. It must comply with numerous requirements that aid with transparency and accountability but slow its responsiveness to fast-moving market conditions. A 2009 U.S. Government Accountability Office (GAO) report identifies 12 categories of legal requirements, ranging from budget preparation to funds control to grants and contracting processes that impact DOE's abilities. (Over 200 federally-created entities are exempted from several such requirements.)[16]

DOE has also been whipsawed and hamstrung by political forces beyond its control, making it more risk-averse and cumbersome than most other agencies. The Secretary of Energy Advisory Board found in a 2015 study:

> The lack of consistent and sustained expectations by the DOE for engagement with industry by the laboratories has driven inconsistent focus on industry engagement by laboratory management. Many laboratory directors noted the cyclical nature of DOE expectations regarding industry engagement and the uncertainty regarding industry engagement as part of the DOE mission.[17]

**DOE's haphazard approach to commercialization has created a patchwork of programs to support moving technologies from lab to market.**

This inconsistency, which has gone on for decades, has created a risk-averse environment within the national labs and the department. Decision-makers sometimes choose to take no action, even when mandated by Congress, because they fear the political winds might change at any time.[18] TCF, for instance, was mandated by Congress in 2005, but not set up for another 10 years.[19]

DOE's haphazard approach to commercialization has created a patchwork of programs to support moving technologies from lab to market. The experience of HelioBioSys (see box 1) demonstrates how resourceful entrepreneurs can leverage DOE to shepherd their technologies through the valley of death. It also shows that, despite the promising programs and trends noted above, the process remains largely serendipitous, a ripe opportunity for an agency-related foundation to work on.

### Box 1: HelioBioSys

HelioBioSys was founded in 2010 to develop a biotechnology for ethanol production. After completing lab-scale testing, it engaged in partnership discussions with Lawrence Berkeley National Lab (among others), participated in the DOE-sponsored Cleantech Open technology accelerator, and attended the National Renewable Energy Laboratory's (NREL) Industry Growth Forum. These activities led to two DOE research grants: a seedling grant and a Small Business Voucher (see box 7) to work with experts from Sandia National Lab and Berkeley Lab. The company shifted its strategic focus in 2018, due in part to its leaders' participation in NSF's I-Corps program, and was awarded an additional grant via the DOE's Bioprocessing Separations Consortium in 2019. It hopes to commercialize its product(s) in the coming years with the additional support of an NSF grant it received in 2020.[20]

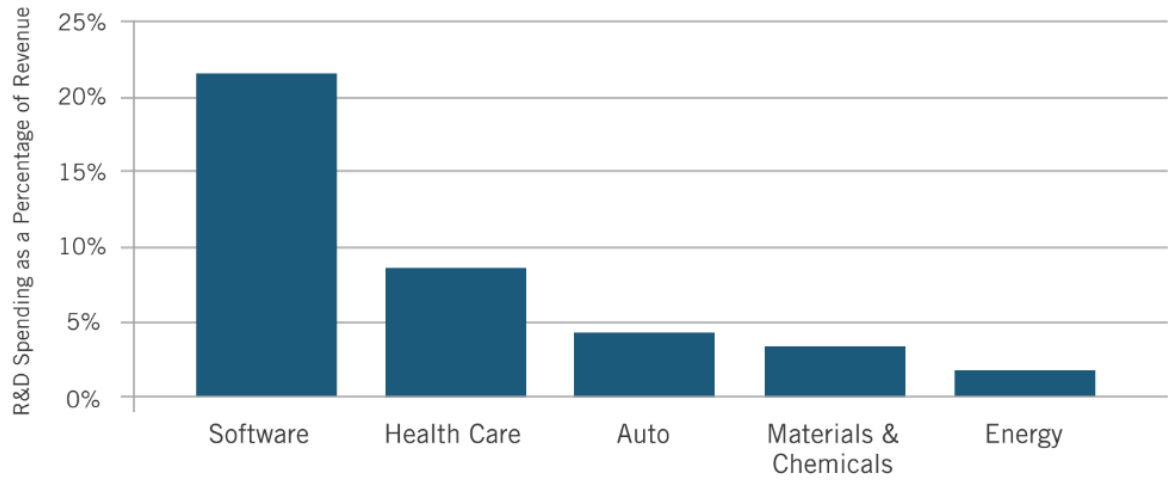
While the founders were resourceful and persistent, one founder said their success had been, "part luck, part timing, part random occurrences," and if they had had "access to a central repository of information on DOE opportunities and resources," they would have taken a more direct and faster path.[21]

## The Missing Private-Sector Model

Companies are the largest source of R&D spending in the United States, accounting for about 65 percent of the national total. The energy industry, however, lags far behind the leading industries in this indicator. A study by PricewaterhouseCoopers of the 1,000 largest corporate R&D

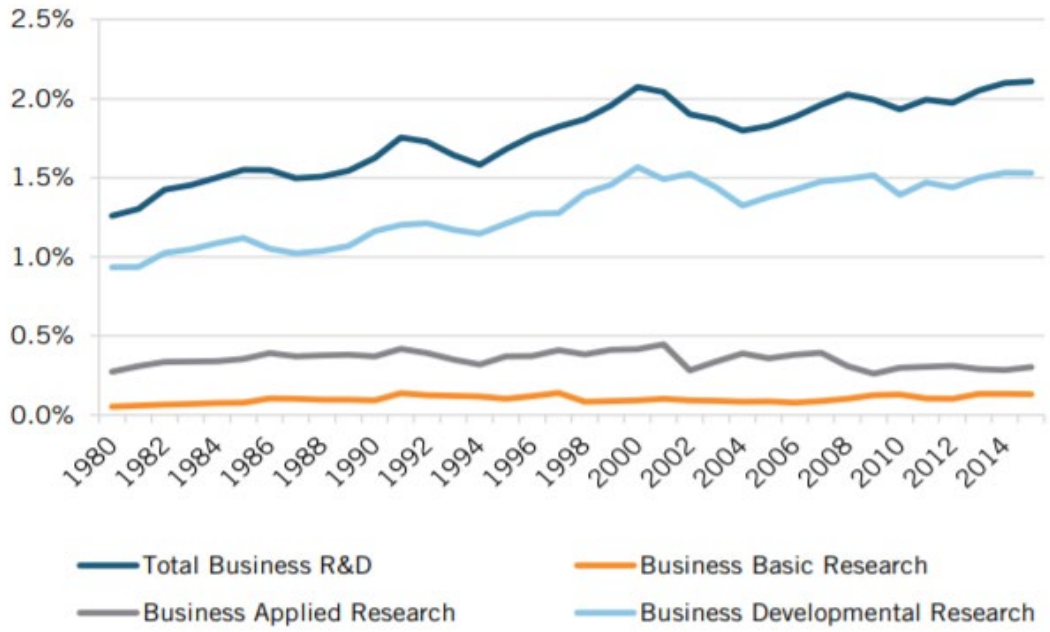
spenders (see figure 3) found energy-industry firms put only about 2 percent of their revenue into R&D, compared with roughly 20 percent for software, 10 percent for health care, and 5 percent for auto firms.[22] The energy industry has large investments that would become stranded assets if made obsolete by innovations. It is therefore (as currently structured) inherently less nimble than more R&D-intensive sectors.

**Figure 3: R&D Intensity of top 1,000 corporate R&D spenders, by industry, 2018[23]**




The majority of corporate R&D funding goes to "D" rather than "R" (see figure 4), which is devoted to improving existing technologies, rather than creating new ones. This is particularly true for the energy sector, in which products are mostly commodities, so the margin is low and motivation for innovation is weak. There is very little demand pull from government agencies such as the Department of Defense, either.

**Figure 4: U.S. Business R&D investment as a share of industry value added[24]**



To make matters worse, venture capitalists (VCs), like strategic corporate investors, rarely place their bets on emerging energy technologies (excluding energy-related software). During 2019 (the last year for which data is available), VCs put only about $1 billion into energy companies, compared with about $20 billion for health care deals and $70 billion for information technology firms. The main reason is the return on energy investments is too low, and too slow. Energy technology start-ups often have long gestation periods, absorb significant amounts of capital before receiving revenue, and, once they enter markets, have to compete with incumbents in low-margin commodity businesses. As a result, Benjamin Gaddy, Varun Sivaram, and Francis O'Sullivan, writing in a paper published by the MIT Energy Initiative, conclude that venture capital is "the wrong model for clean energy innovation."[25]

Responding to this mismatch of expectations and opportunities, a small yet influential group of investors have adopted a more patient approach. Breakthrough Energy Ventures (BEV), for instance, was set up by a group of the world's richest people when the Paris Climate Accord was being negotiated. While still seeking a return, BEV organizes its investments around solutions to major climate and energy challenges.[26] A DOE-related foundation that helps accelerate the commercialization pathways of energy start-ups would create more promising targets for socially minded VCs such as BEV, as well as more risk-taking strategic corporate investors, and connect them to these potential opportunities.

## The Philanthropic Chasm

Philanthropic giving is a quintessentially American method of pursuing social good. Individuals define for themselves what should be pursued, and put their own dollars to work. Basic research is one such pursuit. The Science Philanthropy Alliance found that in 2017, foundations, philanthropists, corporations, and charities supported at least $2.3 billion in basic science activities. These critical early-stage investments provide the seed funding for later-stage innovation. While medical research is the most common passion of science philanthropists, entities such as the Heising-Simons and Moore foundations make major philanthropic investments to support basic research related to energy and the environment.[27]

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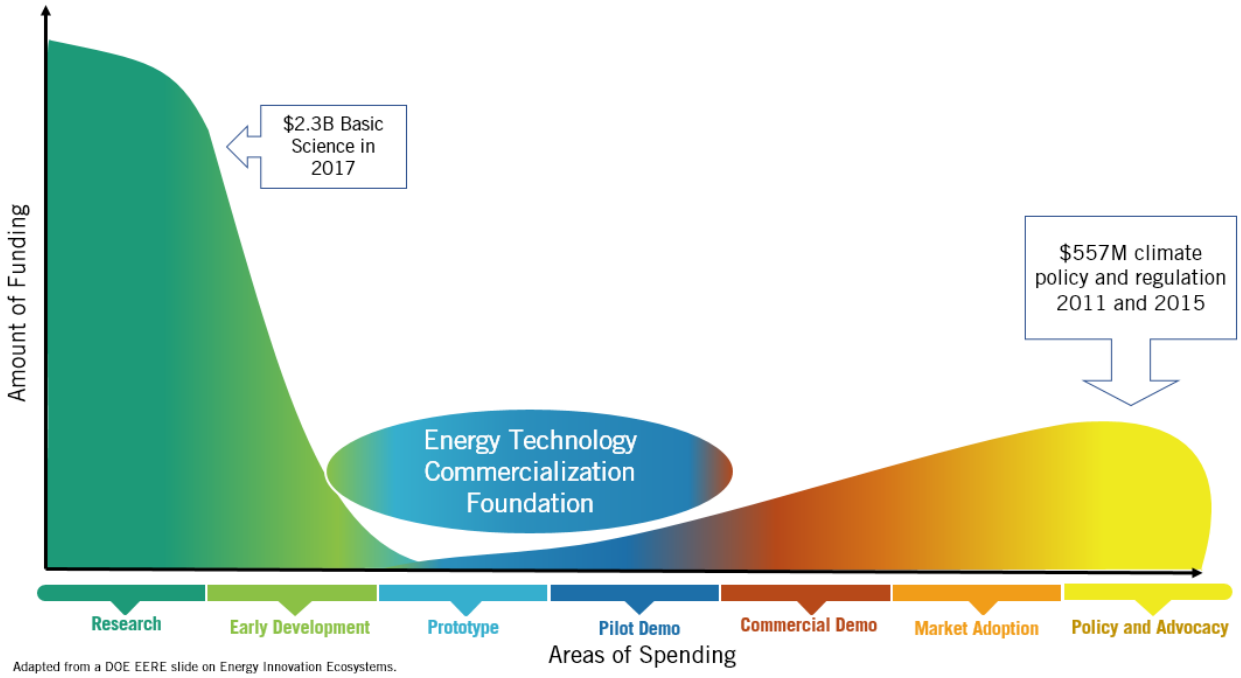
Fighting climate change is another philanthropic pursuit. The community of climate philanthropists mainly targets their funding to promote renewable energy and energy efficiency, educate the public, protect endangered ecosystems, and oppose fossil fuel use, according to a study by Matthew Nisbet of $557 million in grants made by 19 major foundations between 2011 and 2015. Less than 2 percent was devoted to promoting innovation. These activities can contribute to policies that will ultimately pull new technologies into the market, but do not directly address the valley of death.[28]

There is a chasm between the first group of philanthropists' work at the front end of the innovation cycle and the second group's at the back end. Figure 5 shows the distribution of philanthropic effort through the innovation cycle from basic research to policy and advocacy. The bimodal distribution illustrates the lack of activities bridging the valley of death. Only a handful

of philanthropists, such as the Pritzker and Schmidt foundations, use their charitable giving to help energy innovators commercialize new technologies, or to promote energy innovation as a climate solution.

Other philanthropists have begun to use mission-related and program-related investments to assist early-stage start-ups to bridge the valley of death.[29] These pioneers are still a small part of the energy innovation ecosystem. A DOE-related foundation could provide a focal point to coalesce more philanthropic support around such activities.

**Figure 5: Philanthropic funding to basic science and energy and climate policy and advocacy**




## Faulty Bridges Within and Between Sectors

The fact that neither the U.S. government, philanthropy, nor industry covers the full innovation cycle in clean energy is a feature of the U.S. system, not a bug. Because downstream investors make decisions without top-down direction from the government, the system allows for diverse assessments of risk across technologies and ventures. The commercialization gap should be spanned not by replicating China's command-and-control system, but by building stronger bridges within and between the sectors. Numerous barriers impede bridge-building today.

One barrier is fragmentation within DOE itself. "Science" and "Energy" are currently managed by separate undersecretaries. This fragmentation creates ineffective and sometimes even counterproductive incentives for DOE offices, which tend to be territorial about their budgets. Applied energy offices are often unwilling to work on early-stage projects they consider to be in the territory of the Office of Science, as well as later-stage projects that may impinge on the private sector. Pressure from Congress and the Office of Management and Budget keeps program managers confined to their narrow boxes, thereby building steeper walls along the valley of death.[30]

To further complicate matters, each applied energy office, such as Energy Efficiency and Renewable Energy, Fossil Energy, and Nuclear Energy, operates differently, reflecting the office's distinct history and impeding inter-office cooperation. Because they are organized by technology, the offices focus primarily on incremental change within predetermined boundaries largely established by Congress through appropriation accounts. The 20-year saga of the recently announced desalination hub illustrates this challenge (see box 2).

Examinations of technology transfer at DOE have repeatedly found that the department lacks a strategic approach, metrics and evaluation criteria, and appropriate policies to improve its performance in commercializing new technologies. A 2015 report by the Secretary of Energy Advisory Board estimated "that universities create 5 to 8 times more start-up companies on a research-adjusted basis than the DOE national laboratories." Furthermore, GAO and the DOE Inspector General have found that DOE has sometimes shrugged off its statutory responsibilities to implement the technology transfer authorities provided to it by Congress.[31]

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The DOE labs also work under a highly prescriptive incentive and evaluation system. Sixteen are federally funded research and development centers (FFRDCs), managed and operated (M&O) by industrial, academic, or nonprofit institutions. The original FFRDC model was intended to build a partnership between DOE and the labs, but as several recent studies on the effectiveness and performance of the labs have found, DOE has become "increasingly transactional rather than strategically mission-driven."[32] DOE uses Performance Evaluation and Measurement Plans (PEMPs) to achieve specific outcomes, but they often lack specific commercialization outcomes and inadvertently discourage technology transfer.[33]

DOE's transactional approach to work conducted at the labs and the PEMPs' lackluster support for technology transfer trickle-down to discourage individual scientists from connecting with market opportunities. Furthermore, FFRDCs are prohibited from competing with the private sector. As a result, some managers in the national lab system view commercialization as risky because it might put them on a slippery slope toward violating this prohibition.

Scientists in most academic and national-lab settings are rewarded for their research prowess and success in getting papers and research grants, rather than their ability to commercialize technology. Their willingness to engage in technology transfer and entrepreneurship activities depends on the criteria applied for promotion and tenure, as well as a wide range of other factors, including social networks and organizational culture.[34]

## Box 2: DOE's Desalination Hub—20 Long Years in the Making

In September 2019, DOE selected the National Alliance for Water Innovation to set up a $100 million DOE Energy-Water Desalination Hub.[35] This important effort is the culmination of 20 years of work within DOE, and demonstrates some of the coordination challenges that plague the energy innovation process.

Reducing the cost of desalination to create clean and affordable water is a critical global challenge that will only become more important as climate change intensifies. This challenge was taken up in 2000 by researchers at DOE's Sandia National Laboratories. It drew congressional interest in FY 2002 appropriations, which directed DOE to work with the Department of Interior (DOI) to develop a technology and implementation plan. Once the immediate threat of drought seemed to abate in the early 2000s, however, Congress lost interest and R&D languished for almost a decade. It wasn't until a severe drought affected more than a third of the country from 2009 to 2012 that a more aggressive program was initiated, fueled by multiple GAO reports on the connection between energy and water.[36]

In 2012, DOE created a department-wide Water-Energy Tech Team (WETT) that was meant to "increase cohesion within DOE and strengthen outreach to other agencies and key external stakeholders."[37] WETT's work culminated in 2014 with the release of a major report, *The Water-Energy Nexus: Challenges and Opportunities*. Despite this burst of activity across the agency, it took several more years for DOE to develop the desalination hub concept and win congressional appropriations for it.

One key reason is cross-cutting technologies such as desalination do not fall within a single DOE program. Every major office plus eleven of DOE's national laboratories were involved in work on the energy-water nexus leading up to the 2014 report. Other federal agencies such as DOI and the Environmental Protection Agency have critical roles in moving new desalination technology to market as well. As the saying goes, "Everybody's problem is nobody's problem." Delay is frequently the result of such fragmentation.

Bridges between DOE—especially the national labs—and the philanthropic and industrial sectors are even more challenging to erect. Whether the cooperating parties seek to use a Cooperative Research and Development Agreement, a Strategic Partnership Project, or an Agreement for Commercializing Technology, negotiations tend to be lengthy, and the agreements unwieldy. As the Secretary of Energy's Advisory Board put it, even though these contract mechanisms are "in principle, flexible … In practice, the time required to negotiate and gain approval for a project is seen both by industry and the laboratories to greatly restrict the number of opportunities that are available."[38] This slow response time makes it virtually impossible for a start-up to partner with DOE or take advantage of facilities or expertise. While OTT has managed to bring more attention to this issue, it is not clear how it can address these challenges under the general management practices of the federal government.

Barriers to cooperation exist within private industry as well. Companies are understandably protective of technological and market knowledge that may give them an advantage. Antitrust law forbids agreements among competitors that unreasonably restrain trade. Although in 1984 Congress created an exception for joint ventures that support precompetitive R&D, and a tax

incentive for energy research consortia in 2005, cultural, organizational, and legal forces inhibit collaboration.

A DOE-related foundation, fortified with a congressional mandate and the compelling mission of strengthening the U.S. economy and global competitiveness, and fighting climate change in a carbon-constrained world, could assist ongoing bridge-building efforts—and foster new ones.

## PRECEDENTS: AGENCY-RELATED FOUNDATIONS ACROSS THE FEDERAL GOVERNMENT

The notion of a foundation that is closely associated with a government agency may seem odd, but in fact it is well established. A DOE-related foundation would be one more in a long line Congress has authorized over the past several decades. The oldest is the National Park Foundation, which works with the National Park Service (NPS) in DOI. It was originally established in 1935, and was authorized by Congress under its current name in 1967. In its 2019 "green paper" on technology transfer across the federal government, the National Institute of Standards and Technology (NIST), recommended the creation of agency-related foundations as one way to maximize the innovation outcomes from federal investments in R&D.[39]

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Agency-related foundations allow nonprofit-sector-management techniques and private funding to be applied to the pursuit of governmental objectives in collaboration with agencies and their stakeholders. This successful model has helped develop new pathways to cancer drugs, a better understanding of rare diseases, new agriculture practices, human vaccines, and expanded coastal resilience efforts. As described in box 3, several of the agency-related foundations are working along with their parent agencies in the fight against COVID-19. The nine established federal agency-related foundations that we researched for this report have many characteristics in common. (Appendix 2 provides brief descriptions of them.) These commonalities provide the basis for our design for a DOE-related foundation. However, these foundations display a surprisingly wide array of approaches and activities as well. This diversity supplies precedents upon which we have been able to draw in order to meet the particular challenges of energy technology commercialization.

## Box 3: Agency-Related Foundations—Fast and Flexible in the Face of a Pandemic

Several agency-related foundations have activated their private-sector and philanthropic partners to respond to the spread of COVID-19. These partnerships have been able to swiftly identify, prioritize, and act in communities around the country to provide medical supplies, personal protective equipment, and laboratory equipment. Most critically, they have been able to hire hundreds of staff to work with state and local governments in hard-hit communities.

CDCF, for instance, has raised more than $78 million to fight the pandemic in just a few short months. A large portion of this total was given by members of the general public in response to a crowdfunding campaign. These funds are meeting the urgent needs of first responders and health care professionals, and creating tools, capabilities, and improvements for future emergencies.[40] Other agency-related foundation activities to address immediate needs and systemic problems related to COVID-19 include the work of The Henry M. Jackson Foundation for the Advancement of Military Medicine (HJF) to provide personal protective equipment for scientists researching therapeutics, diagnostics, and vaccine development.[41] The National Association of Veterans' Research and Education Foundations' (NAVREF) also played a role as central communications node for guidance on operations from the Veterans Administration and financial assistance from NIH and DOD.[42]

Longer-term actions have been taken by FNIH and FFAR. FNIH established the Pandemic Response Fund to support NIH and its National Institute for Allergy and Infectious Diseases (NIAID), which is led by Anthony Fauci. It researches potential COVID-19 treatments and vaccines, and seeks other ways to prepare the United States for future pandemics.[43] In partnership with over a dozen private-sector companies and five government divisions, including the European Medicines Agency, FNIH and NIH also launched an Accelerating COVID-19 Therapeutic Interventions and Vaccines (ACTIV) partnership. This collaboration, coordinated by FNIH, brings government and private sector infrastructure and subject matter expertise together to "develop a collaborative framework for prioritizing vaccine and drug candidates, streamlining clinical trials, [and] coordinating regulatory processes," to respond to COVID-19 and future pandemics.[44] FFAR is helping the United States develop expertise to prevent the spread of animal-to-human pathogens in the future by funding five additional research fellowships.[45]

A DOE-related foundation would be able to act with similar speed and scope to respond to urgent needs in energy-related crisis situations, leveraging its private and philanthropic partnerships as well as the science and technology of DOE. There is no doubt such crises will arise, as evidenced by the devastating floods, storms, and fires of recent years.[46]

## Common Characteristics

Agency-related foundations are incorporated under the same general provision of tax law (Section 501(c)(3)) as other charitable foundations. They are not a part of the federal government and, therefore, are exempt from laws and regulations that constrain public agencies. However, they are set apart from other nonprofit foundations by specific federal laws that define their unique relationships with their related agencies. These laws provide direction on governance, including board composition, bylaws, incorporation, nonprofit status, and reporting requirements. They also define the agency-related foundations' relationships to federal agencies and employees, specify

permissible and prohibited activities, and determine how funds flow to and from the government.[47]

Agency-related foundations are typically able to "solicit and accept gifts, grants, and other donations, establish accounts, and invest and expend funds" in support of agency and foundation programs.[48] Furthermore, they are usually allowed to transfer funds, land, and equipment to their related agencies for specific donor-directed activities. These activities include education and training, fellowships, forums and meetings, and the development of public-private collaborations. The foundations' efforts are intended to both complement and supplement work conducted by the parent agencies.

The authorized relationship between an agency-related foundation and its agency is often codified in a memorandum of understanding (MOU) between the two organizations. Importantly, each agency must issue its own directives implementing the MOU, thereby establishing policies, requirements, and responsibilities for agency elements and contractors. Examples of such documentation can be obtained from the Centers for Disease Control and Prevention (CDC), NPS, and Fish and Wildlife Service and their agency-related foundations.[49]

Science and technology are the focus of many foundation-facilitated public-private collaborations. For federal researchers, funds from an agency-related foundation may serve as force multipliers as they pursue agency missions. From the donors' perspective, such a foundation lets them mobilize outstanding researchers to tackle problems the donors care about, even if those researchers are civil servants or employees of a government-owned contractor-operated laboratory and are therefore ineligible to compete for government funding in the same way academic scientists are. The nation, for its part, gets a better return from money it has already spent to build top-notch scientific and technological capabilities oriented toward public problems.

A 2019 Congressional Research Service report articulates several potential benefits of agency-related foundations for fostering public-private R&D collaborations:

1. Providing a flexible and efficient mechanism for establishing public-private R&D partnerships;
2. Enabling the solicitation, acceptance, and use of private donations to supplement work performed with federal R&D funds;
3. Increasing technology transfer and the commercialization of federally funded R&D;
4. Improving the ability of federal agencies to attract and retain scientific talent; and
5. Enhancing public education and awareness regarding the role and value of federal R&D.[50]

Many of the agency-related foundations we studied raise money from nongovernmental sources, including individual donors, companies, and private foundations. Most also receive a modest annual federal appropriation of between $500,000 and $1,250,000 to cover their administrative costs. Such appropriations are essential to establish and sustain the core staff and basic functions of agency-related foundations, which private sources are reluctant to fund.[51]

Strong and transparent conflict-of-interest rules are critical for both the foundations and the agencies. Close relationships between them allow for strategic collaboration, but also create risks of improper influence or use of information. The congressional authorizations for some agency-related foundations, such as CDCF and Reagan-Udall Foundation for the Food and Drug Administration (FDA), include specific provisions governing conflicts of interest. Conflict-of-interest policies are often included in foundation bylaws and agency policies as well. These rules impact how the foundation collaborates with its related agency, and how it partners with the private sector, academia, and other nonprofit organizations. Members of Congress have raised concerns in recent years about the effectiveness of these rules in light of media reports about potential conflicts at FNIH and CDCF.[52]

## Distinctive Attributes

While the statutory authorizations for agency-related foundations are broadly similar across the federal government, the foundations are as different as the agencies they serve. Each foundation's structure, size, and focus areas are tailored to the agency's needs and operations. Their annual budgets range from just a few million dollars for the FDA-related Reagan-Udall Foundation to almost $500 million for the Department of Defense-related HJF.[53] Their activities vary as well. The FDA's foundation focuses on research, for instance, while HJF concentrates on support and services for medical research centers.

Three distinctive attributes of existing agency-related foundations are especially relevant and useful to the design of a DOE-related foundation: problem-oriented R&D collaborations; prizes, challenges, and competitive grants; and distributed structure.

### Problem-Oriented R&D Collaboration: Foundation for the National Institutes of Health

FNIH was established in 1990, and has raised over $1 billion from individuals, companies, and charitable foundations over its history. While this funding is critical to individual projects at NIH, what makes FNIH stand out is its ability to create and sustain R&D collaborations that focus on national challenges identified by NIH researchers and partners in academia, industry, and philanthropy.

**Three distinctive attributes of existing agency-related foundations are especially relevant and useful to the design of a DOE-related foundation: problem-oriented R&D collaborations; prizes, challenges, and competitive grants; and distributed structure.**

FNIH projects aim to create value for multiple parties across the public, private, and nonprofit sectors through a focus on specific problems that may fly under the radar or are not a specific priority for appropriators and NIH leadership. It concentrates its collaborative efforts on precompetitive basic science, and is authorized to solicit and transfer funds and equipment from external partners to specific scientific units within NIH that donors want to support. It seeks to manage conflicts of interest and uses sophisticated assessment frameworks to evaluate its partnerships.[54]

For instance, FNIH's Biomarkers Consortium, created in 2006, seeks to "accelerate the development of new medicines, inform regulatory decision making, and improve patient care" for medical conditions such as autism and Alzheimer's. The Biotechnology Industry Organization and Pharmaceutical Research and Manufacturing Association as well as 32 companies, 15

nonprofit organizations, and 2 other federal agencies (FDA and the Centers for Medicare and Medicaid Services) participate in the consortium along with NIH.[55] Consortium partners have equal roles in project development and management, allowing costs, risks, and results to be shared and made public. Consortium projects span the entire innovation cycle from early-stage disease definition to late-stage FDA qualification. Since the consortium is run through FNIH, it has a flexible and nimble funding process. Partners can meet without the burdens of the Federal Advisory Committee Act, which can make it difficult to build trust and move quickly.

By bringing together industry, academia, federal labs, and regulators, the Biomarkers Consortium accelerates the pathway to new drugs, tools, and clinical trials, leveraging nongovernmental funding to accomplish mutually agreed upon public-sector priorities. Its successes include the establishment of over 30 projects; generation of over 50 project-team publications, which have been cited in publications over 800 times; creation of 9 tools used by industry in drug development; development of 5 FDA guidance documents and one FDA Biomarker qualification; and advancement of 12 therapies toward FDA approval.[56]

### Prizes, Challenges, and Competitive Grants: Foundation for Food and Agriculture Research

FFAR was established in 2014 to increase agricultural R&D in association with the U.S. Department of Agriculture (USDA). Congress sought to strengthen American leadership in this field by "supplementing USDA's basic and applied research activities." Congress acted on this vision by giving FFAR two large multiyear appropriations totaling $385 million, while making clear this investment should not "offset or allow for a reduction in the appropriated dollars that go to [USDA] research." For every tax dollar it has received, FFAR has been able to raise $1.25 from about 300 co-funders from philanthropy, academia, and industry. [57]

One notable innovation made by FFAR is its use of prizes and challenges, along with more traditional competitive, cost-shared grants. For example, FFAR is working with the Open Philanthropy Project to design and administer an Egg-Tech Prize, which could save the egg industry $1.5 billion to $2.5 billion annually and reduce the carbon footprint of industry operations. To ensure technologies can scale, FFAR brings industry experts into its project design and administration. In the case of the Egg-Tech Prize, FFAR's engagement with industry and its project management skills were essential to the project's success. The Open Philanthropy Project lacked these relationships and skills and stated that "[FFAR] made the [prize competition] possible."[58] Federal regulations do not allow outside organizations to develop and jointly fund programs with agencies, so FFAR plays a unique role.

In a review of the FFAR's progress to date, the Boston Consulting Group (BGC) found that FFAR's "Congressional funding allows it to bring partners to the table and serve as an independent, neutral third party." BGC's survey of FFAR stakeholders found that FFAR's congressional mandate contributes to its "gravitas" and thus its convening power. BGC also found that FFAR could increase its impact by expanding the number and scale of consortia, diversifying funding partners (including nontraditional funders), and deepening its collaboration with USDA and other federal agencies. Translational research and technology transfer were identified as particularly promising areas for FFAR. One former industry CTO observed that "translation [from] a lab or greenhouse … to scale and testing … is the space where FFAR can make an impact."[59]

## Distributed Structure: NAVREF, HJF, and NPF

While FNIH and FFAR are national efforts, at least three federal agency-related foundations have adopted distributed models that may be appropriate for a DOE-related foundation that would work with DOE's 17 national laboratories, academic researchers, and other energy innovation organizations across the country. These foundations are organized as networks that include a national hub and independent but affiliated units at the local level.

The National Association of Veteran's Research and Education Foundations (NAVREF) is a membership association of congressionally authorized state and local nonprofit research and education corporations (NPCs) that work with Veterans Administration medical centers nationwide. In 2016, there were 83 NPCs in 44 states. The NPCs fund research, improve infrastructure, and provide personnel and contracting arrangements at the centers. NAVREF seeks to share information, spread best practices, and carry out projects that serve the shared interests of its local members.[60]

In addition to providing services similar to NAVREF, HJF directly administers DOD grants and contracts. It works with 20 military health centers across the country, providing such services as consulting, renovations, leasing, and procurement assistance, along with administrative support for the conduct of research and education.

NPF, similarly, provides technical, financial, and administrative support, and serves as a strategic partner for "friend" organizations for individual parks. The "friends" are independent nonprofits that share NPF's goals of protecting and stewarding national parks. NPF's relationship with these organizations was incorporated into its congressional authorization in 1998. NPF convenes the friends on a regular basis to identify shared issues and discuss best practices. NPF also helps them raise money. For instance, in response to a string of hurricanes that devastated parts of the United States' Southeast and Caribbean territories, NPF worked with friends of affected parks to fund recovery efforts.[61] NPF's national presence gives the local affiliates a fundraising platform with a broad reach.

## Precedents

These precedents provide a menu of options a DOE-related foundation should draw upon. The collaboration strategies used by FNIH and FFAR show how key actors can be brought together from across the innovation ecosystem. The distributed structures of NAVREF, HJF, and NPF show how a national hub can provide valuable services to affiliates that are more knowledgeable about regional challenges (such as the DOE lab foundations described in box 4), and connect them to partners that can support their important work.

## Box 4: DOE Lab Foundations

Three of DOE's national laboratories, Lawrence Berkeley, Lawrence Livermore, and Los Alamos have established lab-related foundations that provide insights into how a DOE-related foundation might work.[62] These lab-related foundations would benefit from the creation of a DOE-wide counterpart.

The Berkeley Lab Foundation (BLF) has attracted over $29 million since it started fundraising in 2014, including a $5 million gift from the MJS Foundation in 2016 to support the Berkeley-Tsinghua Center on Energy and Climate Change.[63] BLF is an official fundraising organization of the University of California, which provides contracting flexibility for the university and the lab. It can also accept funds, real estate, stocks, and other assets, provide donor recognition, and pay for meetings and conferences involving food and drink (which is an unallowable cost under the university's M&O contract).[64]

Additionally, the lab benefits from a special clause in its contract that allows it to accept "gifts" as "contractor-supported research" from the university of up to $7 million annually. Funds accepted under this clause are charged a lower indirect cost rate because the university is exempted from paying general and administrative expenses and supporting Laboratory Directed Research and Development funds. Additionally, gifts received by the lab cannot come with any strings attached, such as requiring reports or specific forms of recognition.[65]

The Livermore Lab Foundation (LLF) was founded by former lab employees in 2016. LLF initially focused on STEM education programs for local communities, but has branched out into research more recently, leveraging the lab's capabilities and expertise. For example, the Lawrence Livermore National Laboratory published *Getting to Neutral: Options for Negative Carbon Emissions in California,* a report funded by LLF through a generous donation from ClimateWorks in January 2020.

The University of California Office of the President (UCOP) covers many of the administrative and operational expenses of both BLF and LLF, significantly reducing their overhead. For example, UCOP has the capacity to accept estates, stocks, and endowments on their behalf, thereby unburdening them from a complex and legally significant set of tasks. UCOP has also been willing to link BLF and LLF into its robust network of donors.[66] A national DOE-related foundation could provide similar services to other individual DOE lab foundations that do not have an M&O contractor willing to fund these activities.

## DESIGN FOR AN ENERGY TECHNOLOGY COMMERCIALIZATION FOUNDATION

If the United States is to lead the world toward a cleaner energy future and gain the economic, security, and environmental benefits of that leadership, it must fill the gaps in its system for commercializing new energy technologies by better connecting the diverse players that make up the energy innovation ecosystem. Building on the flexible, challenge-oriented, and partnership-based precedents set by the diverse and growing network of federal agency-related foundations, a new DOE-related foundation should be set up with this aim. We propose this Energy Technology Commercialization Foundation (ETCF) be charged by Congress with the mission of supporting DOE by strengthening U.S. competitiveness in a carbon-constrained world.

ETCF would pursue its mission by leveraging and streamlining access to DOE's unparalleled expertise, networks, and infrastructure. It would catalyze and strengthen collaborations among researchers and private-sector partners who are tackling cross-cutting national challenges and building regional energy innovation ecosystems. Through its special relationship with DOE, as authorized by its legislation, ETCF would prioritize high-impact commercialization activities and collaborations of mutual interest to DOE, the private sector, and philanthropic organizations, all of which would provide funding, expertise, and resources. ETCF would achieve its mission by elevating and funding organizations across the country. Its activities would supplement and complement DOE's commercialization efforts, rather than duplicate them.

## Mission and Motivation

The proposed mission—to increase U.S. competitiveness in a carbon-constrained world—is worth parsing carefully. The carbon constraint derives from the imperative to limit the rise in global average temperature to 2 degrees Celsius or less over the course of this century. Although there are many pathways that could lead to radical reductions in carbon emissions, all of them will be disruptive to major industries, ranging from electric power to transportation to agriculture, not to mention fuels, chemicals, and materials. As may already be observed in sectors such as coal mining and solar panel manufacturing, the energy transition will create winners and losers across communities, companies, and countries. A country that strengthens its competitiveness is likely to weather the coming disruption better than one that fails to make the most of emerging opportunities.

## Unique Capabilities

ETCF's relationship with DOE, made possible by a congressional authorization, would make it unique from other nonprofits and foundations. DOE's large and growing $8 billion energy R&D budget places it at the center of a larger network of energy-focused researchers, students, entrepreneurs, technology developers, and technology users than any other organization in the country—and probably the world. The physical and intellectual infrastructure provided by DOE's 17 national laboratories form the backbone of the nation's energy innovation ecosystem and those of many regional systems as well. National lab researchers collaborate with more than 450 academic institutions, subcontracting more than $500 million to universities annually. An additional $900 million of DOE funds goes directly to universities for academic research grants.[67] Donors will be attracted by the chance to bring these enormous resources to bear on problems of mutual interest.

**A country that strengthens its competitiveness is likely to weather the coming disruption better than one that fails to make the most of emerging opportunities.**

The law authorizing ETCF should follow the model set by other agency-related foundations, defining a special relationship between the foundation and the agency. In addition to setting forth ETCF's mission, Congress should give it legal and administrative tools, such as the ability to solicit funds for, and transfer them to, DOE and its labs in order to support its mission. The law should also simplify or eliminate barriers that make it difficult for private and philanthropic partners to work with DOE labs now. For instance, projects funded by ETCF and carried out by DOE labs might be subject to reduced overhead requirements, building on the precedent set by Berkeley Lab's gift clause (see box 4). Other burdensome provisions in lab partnership

agreements (i.e., indemnification, advance payments, or intellectual property) that are now in use could similarly be streamlined. The law should also establish key channels of communication and coordination. Through *ex officio* membership on ETCF's board and key committees, DOE leaders would advise it of national energy priorities and goals, and, in turn, be apprised of its activities.

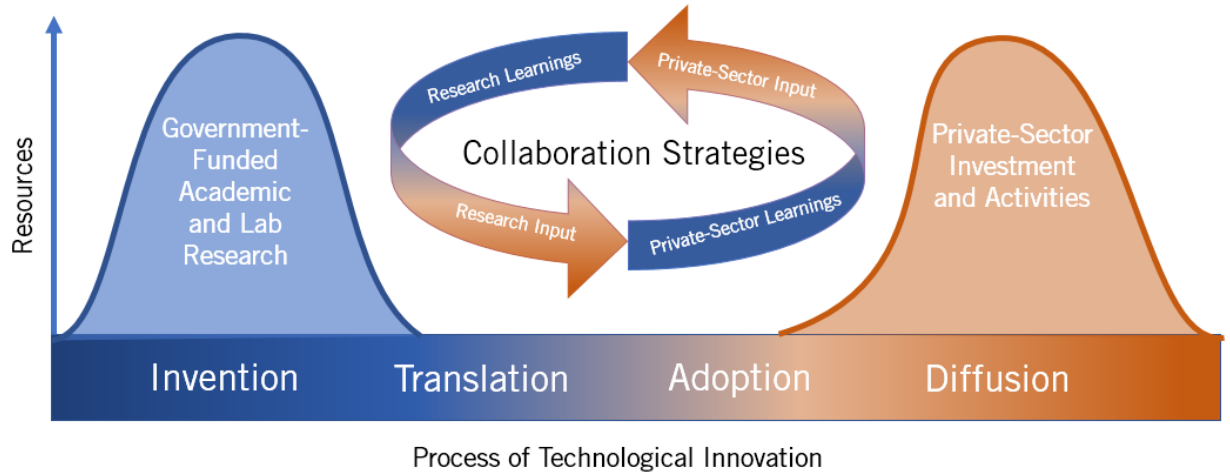
## Collaboration Strategies

At the core of our design for ETCF are two strategies aimed at catalyzing and incubating collaborations between the public, private, and philanthropic communities to accelerate the commercialization of energy technology in the United States. An ETCF would:

1. respond to cross-cutting national challenges; and
2. strengthen regional energy innovation ecosystems.

These strategies build on distinctive attributes of existing agency-related foundations such as FNIH and FFAR that are particularly relevant to the energy industry and ETCF's transformative mission. The objective of the collaborations is to create partnerships that allow for the free flow of information across the valley of death, aligning the different players of the innovation process and reducing risk (see figure 6).

**Figure 6: ETCF collaboration strategies helping to bridge the valley of death**




### 1. Responding to Cross-Cutting National Challenges

The overarching challenge of transforming our nation's energy system comprises many subsidiary challenges. Each major source of carbon emissions, for instance, will require the commercialization of a specific set of new technologies, many of which must be further tailored to meet regional and application-specific demands and reach customers that may not be familiar with these innovations. The federal government, including DOE, is well suited to respond to some of these challenges, notably those aligned with its existing structure. It can and should be able to drive down emissions from light-duty vehicles, for example, having done so effectively in the past.

However, many aspects of the energy transition cut across the jurisdictions of federal agencies, including DOE units, or fall partly within the remit of state or local governments. For instance, as described in box 5, decarbonizing the marine-transportation sector will involve several federal agencies, multiple units within DOE, and many state and local governments, along with a diverse array of private-sector interests. Agriculture, mining, construction, and manufacturing are just a few of the other sectors that pose cross-cutting challenges. In addition, there may be cross-cutting opportunities to develop tools and platform technologies needed by multiple industries.

DOE's organizational structure, siloed funding, management practices, and risk-averse culture constrain its ability to tackle cross-cutting challenges, and especially to do so as quickly as the energy transition requires. Funding flexibility is limited by budgetary rules and the stipulations of congressional appropriators. DOE's management and culture are shaped by its multi-faceted history, including its role as steward of the nuclear weapons complex.[68]

ETCF would help DOE and energy innovation organizations respond more rapidly and effectively to cross-cutting challenges by convening private and philanthropic partners, developing strategies, and catalyzing collaborations focused on commercialization. These efforts would be driven by private-sector opportunities, and informed by DOE's depth of knowledge and expertise. They would draw on entrepreneurs and scientists who are developing pre-commercial technologies at national labs, universities, and incubators, and inspire more of these innovators to take action on the challenges at hand. Partnerships put in motion by ETCF would focus on maturing technologies to the point they are ready to be licensed or acquired, including facilitating pre-pilot and pilot demonstrations. Its staff would focus on identifying and convening the right partners around these challenges with a small amount of seed capital, and then advising the partners as they develop and fund collaborations that serve their mutual interests.

**ETCF would help DOE and energy innovation organizations respond more rapidly and effectively to cross-cutting challenges by convening private and philanthropic partners, developing strategies, and catalyzing collaborations focused on commercialization.**

In executing this collaboration strategy, ETCF would deepen existing DOE capabilities. For example, DOE has long experience working on precompetitive technologies with industrial consortia. Once they are up and running, these consortia can be very productive—although initial implementation tends to be slowed by red tape and tensions among competitors. ETCF would have the flexibility to move more quickly, building the reputation and expertise needed to launch effective consortia. Similarly, DOE has begun offering prizes in recent years to broaden the pool of innovators focused on specific challenges. ETCF can aid DOE in identifying priority challenges, designing prize competitions that enable a diverse group of innovators to propose solutions, and then raising funds to help launch competitions.

While it is possible DOE's culture would hamper its ability to work effectively with ETCF, a relationship built on mutual respect and effective partnership would reduce the prospect of agency staff perceiving ETCF as an "outsider." ETCF must earn this respect by hiring a superior staff of experts with both technical and commercial knowledge as well as experience in building collaborations. Done right, grand-challenge collaborations sparked by ETCF would bring new

science and innovation from industry and other stakeholders to DOE and fuse it with contributions from federal scientists into scalable solutions.

### Box 5: Decarbonizing Marine Transportation—A National Challenge

Marine transportation is a major source of greenhouse gas emissions, responsible for about one gigaton of carbon dioxide equivalent annually. It is a sector with few zero-carbon ready-to-be-applied solutions on the shelf. Therefore, even though the International Maritime Organization has set ambitious reduction targets, it is likely emissions will continue to rise unless significant progress is made in a wide range of technological domains, including fuel cells, batteries, hybrid propulsion, vessel charging stations, microgrids, and port automation.[69]

Responsibility for marine transportation cuts across several federal agencies, including the National Oceanic and Atmospheric Administration, the U.S. Navy, the Coast Guard, and the Department of Transportation, along with DOE. Within DOE, several offices—including Fossil Energy; Electricity and Reliability; and Energy Efficiency and Renewable Energy (EERE)—contain relevant R&D programs. (In EERE alone, there are at least five relevant programs.) Furthermore, states and localities along both seaboards and the Gulf Coast, including major ports such as in Seattle, Los Angeles, New York, and Houston have some regulatory and administrative responsibility for marine transportation.

As part of a comprehensive response to climate change, the federal government should develop and fund a coordinated, cross-agency initiative to develop maritime technology solutions that can surmount complex regulatory and market barriers. The initiative should engage with the private sector to drive an agenda that will keep the United States competitive as the marine transportation industry goes through a disruptive transition. Knitting together the ecosystem of stakeholders in this sector should not take 20 years, as it did with the desalination hub.

This national challenge is ripe for action by ETCF. Working with DOE and other federal, state, and local agencies, industry leaders, academic centers, and concerned philanthropists, ETCF could be a catalyst for a problem-oriented research, development, and demonstration (RD&D) initiative. Its focus would be on identifying technological challenges nongovernmental funders are primed to invest in, which would in turn leverage government support and action on behalf of the partnership. For example, adapting existing terrestrial technology to marine conditions would require rigorous testing and evaluation, which could be conducted at DOE labs such as Pacific Northwest National Laboratory's Marine Sciences Laboratory.

Over the last several years, "blue economy" clusters that bring diverse stakeholders together to pursue ocean-oriented opportunities have appeared in seven regions around the United States.[70] At least three such clusters house targeted accelerator programs for start-ups interested in addressing marine technology challenges: Washington Maritime Blue, AltaSea in California, and Sea Ahead in Massachusetts.[71] The national effort could build on and interconnect these local initiatives, and bring a whole new set of innovators into the sector, while reducing duplication and accelerating the diffusion of new technology.

FNIH and FFAR serve as precedents for ETCF in these respects. FNIH demonstrates that an agency-related foundation can bring together industrial competitors to define solutions to national challenges and mobilize multi-sectoral science and technology responses to pursue

them. FFAR shows that such a foundation can run competitions and administer prizes that advance its partner agency's goals.

### 2. Strengthening Regional Energy Innovation Ecosystems

Regional diversity is one of the outstanding attributes of the U.S. energy innovation system. Agglomerated networks of specialized firms and personnel, drawing on an "industrial commons" of physical and institutional infrastructure, create distinctive technological strengths in specific regions. Houston's oil and gas complex is probably the nation's largest energy innovation cluster, but many others, ranging from green buildings in Seattle to building-control systems in Minneapolis to smart-grid electronics in North Carolina's Research Triangle, contribute to their regional economies while also generating solutions of value to respond to the climate challenge nationally and globally. Regions are increasingly building economic development strategies around clean energy innovation clusters they perceive to be growth opportunities as the global transition moves forward—as we see in the case of the Los Angeles Cleantech Incubator described in box 6.[72]

Federal institutions and programs often play important roles in regional energy innovation ecosystems. Federal labs draw talent as well as dollars to the regions in which they are located. They may also be sources of demand for and collaboration with nearby research universities and high-tech businesses. Federal spending, which accounted for 22 percent of all R&D and 42 percent of basic research nationally in 2017, is important to almost all regions—but it is not distributed evenly. DOE R&D funding, for instance, varies by a factor of almost 20 across the states when measured on a per capita basis, with North Dakota and Oregon leading and Mississippi trailing, according to recent research published by EFI.[73]

**ETCF would help foster multi-sectoral energy innovation networks that build regional strengths and contribute to economic development through the commercialization of new low-carbon technologies.**

Innovation clusters have sprung up around some DOE labs, such as the Colorado "cleantech" cluster associated with NREL, which was documented by the EFI team, and the growing electric vehicle components cluster near Oak Ridge National Laboratory in Tennessee. Programs at these labs and others feed such clusters by providing facilities and expertise, supporting industrial partnerships, and nurturing entrepreneurial start-ups. Numerous advocates, including former Energy Secretary Ernest Moniz (now a principal at EFI), have called for strengthening and systematizing the federal role in regional energy innovation ecosystems.[74]

These calls have gained only limited traction. DOE's primary responsibilities, especially in science and national security, are national and global, inevitably relegating regional issues to a lower priority. As a result, notwithstanding some impressive programs, DOE as a whole has lacked the focus, leadership, and bandwidth to execute a full-fledged regional energy innovation strategy.

ETCF would help foster multi-sectoral energy innovation networks that build regional strengths and contribute to economic development through the commercialization of new low-carbon technologies. ETCF, as an unbiased convener, would strengthen strategic and cluster planning, assist with assessing opportunities, and connect regional partners to one another. It would strengthen existing organizations by helping them tap experts from DOE's national network, as

needed, to fill regional gaps. (New partnerships and interesting technical challenges are appealing to national labs and other research institutions.) To entice these groups to work together, a small amount of catalytic funding would be needed. But once the participants understand the mutually beneficial nature of the partnership, ETCF's job would be to advise and reduce transaction costs of collaboration.

### Box 6: Los Angeles Cleantech Incubator—Leading Regional Energy Innovation[75]

The Los Angeles Cleantech Incubator (LACI) is the center of regional work to build a robust innovation ecosystem that supports technology commercialization. LACI's mission is "to create an inclusive green economy by unlocking innovation, transforming markets, and enhancing community." In 2017, the California Energy Commission awarded LACI a 6-year Regional Energy Innovation Cluster grant of $5 million to serve as the central coordinating body for Los Angeles's cleantech cluster.[76]

The founding members of LACI's board include the City of Los Angeles and its municipal utility, the Los Angeles Department of Water & Power. These special relationships allow LACI to understand both the policy drivers of the city and technical challenges facing the utility, giving it an unparalleled understanding of the market for new technology.

A region famously dependent on automobiles, Los Angeles faces a particularly tough battle to reduce carbon emissions from the transportation sector. That is why LACI created a multiyear Transportation Electrification Partnership with local, regional, and state stakeholders in 2018. The partnership seeks to "accelerate progress towards transportation electrification and zero emissions goods movement in the Greater Los Angeles region in advance of the 2028 Olympic and Paralympic Games."[77]

While this partnership links important local stakeholders, it is not well networked to federal resources nor to other parts of the country that may offer lessons on reducing carbon emissions from the transportation sector. Access to information coming out of electric vehicle pilot programs in New York or port decarbonization initiatives in Washington State, for example, may help them accelerate Los Angeles's progress. The rest of the country might also learn from LACI's work to get electric-vehicle technologies into disadvantaged communities, or its tools that aid investors exploring early-stage opportunities.

Commercialization, by definition, is the phase of the innovation process when economic results from R&D investments begin to be realized. Regional strategies can link local demand from both the private sector and government customers to emerging solutions in conjunction with state and local policy incentives. Additionally, regional networks of customers, innovators, and government officials can help create the feedback loops needed to inform both R&D and policy.

ETCF would play a particularly valuable role in regions that are behind the curve in the new energy innovation ecosystem. Its convening activities would help regional innovation organizations tap into DOE's networks, find relevant expertise, and connect to early customers for innovative technologies. ETCF may also be able to provide bridge funding when state and local programs are in flux, partnering with community foundations across the country. These foundations—numbering more than 800 at last count—are growing rapidly. Many have expressed strong interest in both environmental issues and economic development, but generally lack the

technical capabilities needed to solve these challenges.[78] ETCF, leveraging DOE's capabilities, could fill this technical gap. Furthermore, it could help connect local communities to national funders that may share common goals, as the University of California does for LBF and LLF. Bringing underserved communities into the energy innovation economy would be a key objective of the regional collaboration strategy.

By virtue of its national purview, ETCF would be well-positioned to disseminate lessons learned across regions, thereby accelerating commercialization through common best practices. It may also be able to create a national platform that provides support services for diverse regional initiatives. In such efforts, ETCF should draw on the precedents set by established agency-related foundations, such as NAVREF, HJF, and NPF, that have adopted distributed models.

## Commercialization Activities

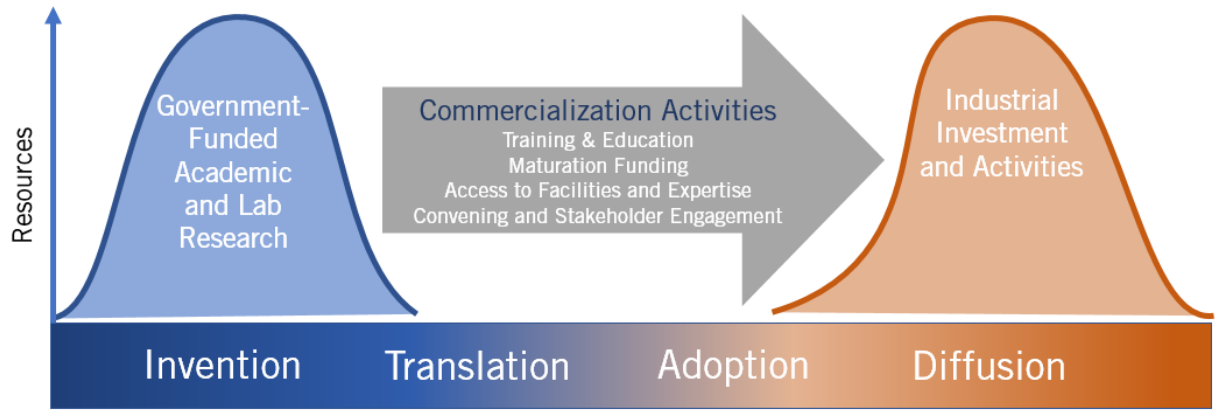
Within the context of the two collaborative strategies, ETCF would regrant most of its funds, and direct its staff, advisors, and other resources to four commercialization activities (see figure 7).

Most recipients of funding and resources, including DOE offices and labs, would:

1. streamline access to facilities and expertise;
2. educate and train researchers to become entrepreneurs;
3. carry out R&D to turn prototypes or other early-stage technologies into marketable products; and
4. convene energy innovation stakeholders.

ETCF may sometimes convene stakeholders itself, as well as fund other organizations to do so.

**Figure 7: ETCF commercialization activities**




### 1. Access to Facilities and Expertise

Energy innovators, especially those developing hardware technologies, often lack access to facilities and expertise that could help them speed through the valley of death. Without such

access, they may be unable to conduct work, including pre-pilot and pilot demonstration projects, that validates their technologies in laboratory and operational environments. DOE's Small Business Voucher pilot (see box 7) and Lab-Embedded Entrepreneurship Program, along with the diverse array of testbeds the department supports, have shown that the national labs and DOE-funded universities house many resources that are valuable for this purpose. Yet, all too frequently, innovators that would benefit from these resources are unaware of or unable to locate them. For their part, DOE units and researchers all too frequently lack strong incentives to provide access to these resources.[79]

In collaboration with DOE and building on DOE's current efforts, ETCF would create a one-stop shop to access facilities and expertise in the national lab system and beyond. It would support programs and partnerships that work with organizations, such as incubators and accelerators, that serve innovators. ETCF, building on DOE's Lab Partnering Service and the Small Business Voucher pilot program's central application portal (described in box 7), would work to expand stakeholders' understanding about how the labs work, what their capabilities are, and how to access each of them.[80] It would take advantage of its flexibility in procurement (compared with the federal structure) to use innovative new technologies to develop, maintain, and update the one-stop shop.

ETCF would also collaborate with state, regional, and local entities that support energy innovation. Organizations such as the California Energy Commission and the New York State Energy Research and Development Authority are natural partners for the DOE labs. These relationships could finance access for companies that are collaborating in regional innovation partnerships or national grand challenges. ETCF's congressional authorization would allow it to overcome contractual barriers that impede these relationships, especially with state governments. It would include both specific language to overcome difficult provisions DOE's national laboratories must adhere to (e.g., advanced payment and indemnification), which state and local governments generally will not accept. ETCF would be able to offer streamlined contracting because the process and mechanisms would be codified in DOE's directives and other policies.

## Box 7: DOE's Small Business Voucher Pilot Program

The Small Business Voucher (SBV) pilot was launched in 2015 by DOE's Office of Energy Efficiency and Renewable Energy. Its original goals were to:

1) increase small business access to DOE national lab capabilities;
2) broaden the labs' awareness of small business needs and technologies;
3) encourage the labs to develop outreach strategies to showcase their capabilities; and
4) make lab business practices more compatible with private-sector timelines.

The pilot involved 14 labs working with 114 small businesses at a cost of approximately $22 million over three years. About two-thirds of the awards, which ranged from $50,000 to $300,000 each, were for cooperative R&D, with the rest for technical assistance.

A third-party evaluation of the pilot found that 81 percent of awardees advanced at least 1 level on the technology readiness level scale compared with 43 percent of nonparticipants.[81] Almost half of all awardees received follow-on funding, and 18 percent achieved sales of their SBV-related technology. Ninety-one percent of awardees rated positively how quickly they were able to sign contracts with a national lab—a key goal of the pilot. The evaluation also found the pilot's central application portal was a key to its success, consolidating descriptions of lab resources and capabilities, simplifying the application process, and linking to the labs' standardized contracting mechanisms.

Although the SBV pilot evaluators found evidence of success, they also identified areas for improvement. Awardees found that funding was often insufficient for them to take their projects to pilot scale. Additionally, the program's complex process of external merit review, internal lab reviewers, and program review and approval was cumbersome. Awardees also reported the labs frequently moved too slowly to suit the needs of technology-based small businesses.[82] ETCF might aim to assist DOE to improve the program, specifically providing flexible funding for cross-cutting technologies, and reducing contracting and process issues inherent to federal management practices.

### 2. Entrepreneurship Training and Education

Researchers at national labs and universities are rewarded primarily for their ability to publish novel results in the technical literature. Most federal energy R&D funding supports such work, which is, as a result, rarely well-informed by the market or of immediate interest to the private sector. Nonetheless, an impressive and growing cadre of federally funded researchers, including many graduate students and post-docs, would like to connect their work with practical outcomes. Unfortunately, their training and the institutional settings in which they work do not usually provide them with the skills and knowledge to make that happen.

DOE has created some programs, notably Energy I-Corps, that have proven to be effective in overcoming these barriers.[83] While successful, this program is limited by the federal budget process, which constrains DOE offices to stay within their technology silos. Each silo represents a narrow set of technologies. They are created by legal restrictions imposed by congressional appropriators, which reduce a lab's ability to fund innovative technologies that do not fall cleanly within a single silo.[84] Energy I-Corps also suffers from uncertain institutional support from the

labs, inconsistent management support, and a shortage of commercialization funding. Underlying these weaknesses are the labs' dependence on overhead budgets for technology transfer and commercialization efforts, which are vulnerable to cuts.

ETCF could step into this gap to work with Energy I-Corps and similar energy technology commercialization programs to help fund activities that are not covered by regular appropriations. Furthermore, ETCF would be able to create a full commercialization pathway for technologies, promoting and connecting innovators with complementary technical expertise in the middle stages of the innovation process and eventually with customers. It would also fund education and training service providers who engage private sector partners, perform market research, and subsidize entrepreneurial leave at labs and universities. It would spread innovative programming ideas and best practices through the training ecosystem.

### 3. Maturation Funding from Prototype to Marketable Products

Funding, along with facilities and training, is a third barrier to successful energy technology commercialization. Public programs aimed at the middle phases of the innovation process are a patchwork at best, as the story of HelioBioSys demonstrates (see box 1), and such government funding comes with burdensome reporting requirements. Private venture capital is poorly matched to an industry in which competition with incumbents is fierce—and it often takes years to get to positive revenue, especially when the venture is developing hardware, rather than software.[85] Although more-patient sources of capital—such as Breakthrough Energy Ventures, which seek to combine private-sector savvy with public-spirited objectives—have been entering the sector, given the scale of the challenge, there are too few of them.

ETCF, working with the emerging community of energy innovation donors and investors, would help increase the use of low-cost financing mechanisms for technology maturation. Although groundbreaking organizations such as Prime Coalition ("a public charity that partners with philanthropists to invest charitable capital in extraordinary companies that combat climate change"[86]) —have taken major steps forward on this front, private foundations have been slow to recognize their own potential role as funders of innovation. Impact investing and related tools are unfamiliar to many foundations and their financial advisors. Yet if private foundations contributed just 1 percent of their annual grant-making to climate-related impact investing, the total would be larger than traditional venture capital globally.[87] ETCF's role could include elevating organizations such as Prime and providing them with an opportunity to spread their knowledge and model.

ETCF would also connect and fund organizations that help to catalyze partnerships between early-stage entrepreneurs and private companies. It would convene partners across the innovation ecosystem around cross-cutting challenges, and provide a small amount of catalytic funding. The partners would follow up by supporting R&D necessary to commercialize products and services. ETCF would also ensure such partnerships are informed by cutting-edge science by facilitating access to DOE expertise.

ETCF's work to connect technology developers with potential funders would go beyond what DOE is permitted to do. The goal should be to turn what has been a serendipitous process into something more systematic, providing the right support to promising technology projects at the right time. The process would not be uniform across regions, sectors, or technologies, but when done right and at the direction of the organizations closest to the problems, it would greatly

accelerate commercialization. ETCF would have to establish its credibility and demonstrate its value in order to attract investors to participate in its activities. It would not syndicate deals, but rather create challenges and partnerships for which deals are a natural next step. Deals could be made with collaboration partners or funded by investment organizations such as the Clean Energy Deployment Administration—a proposal that addresses financing challenges for technology demonstration.[88] These activities would be particularly powerful in combination with other ETCF programs that provide access to facilities, expertise, and entrepreneurship training.

### 4. Convening Power and Stakeholder Engagement

ETCF's collaborative strategies will be successful only if they have significant input from key stakeholders. These stakeholders include DOE and other federal agencies and units; large and small firms across industry sectors; academic and training institutions; economic development organizations; and state and local governments, among others. Many stakeholders must also serve as partners in execution of the commercialization activities if the strategies are to succeed. The stakeholders may need to be pulled together to create communities, wherein such communities do not now exist—and they may need to engage in dialogue over a period of time in order to align their interests sufficiently for workable strategies to be devised.

**ETCF, working with the emerging community of energy innovation donors and investors, would help increase the use of low-cost financing mechanisms for technology maturation.**

ETCF would seek to overcome these barriers by serving as a neutral convener at the national and regional levels. It would tap into DOE's unparalleled network of researchers and partners across the country to do so. ETCF may also create platforms for engagement and matchmaking that highlight technology trends, market drivers, commercialization successes, and customer demands. Such showcases and roadshows could also bring greater visibility to DOE programs and the researchers DOE supports without the tight constraints imposed by federal regulations. ETCF convenings would also help DOE to get feedback on its R&D roadmaps and investment strategies, particularly from industry, which is sometimes deterred from providing input due to the Federal Advisory Committee Act. Connecting the different parts of the ecosystem, especially early-stage entrepreneurs, around specific technology challenges, and helping to harmonize activities at the regional level, would be a central focus of the convenings.

## Supporting Activities

Strong communication and evaluation plans would support the commercialization activities and feed into the collaboration strategies.

### 1. Communication

Poor communication is a major source of failure in energy innovation. Even when R&D yields promising results, innovators may be unable to take the next step because follow-on investors lack sufficient information about the opportunity. Credibility is a key element in this communication process, along with substantive knowledge. Even when investors are strongly motivated, they may lack the capacity to conduct due diligence on science-based technology companies. Technical information provided by ETCF and its grantees would help reduce information asymmetry, thereby increasing the potential for investment.

ETCF-supported innovation organizations would benefit from a marketing team that is ready to communicate their strengths to investors and partners. The communications activities should be coordinated with DOE, and specifically with OTT, but not constrained by its federal regulations. ETCF would collaborate with DOE to make potential private and philanthropic partners more aware of and knowledgeable about DOE-funded R&D, and help them assess technology risk by connecting them to technical experts. The drumbeat of commercialization activities of ETCF's grantees should eventually become the backbone of ETCF, snowballing into technology showcase events and follow-on curated deal flow opportunities between partners after ETCF is out of the picture. ETCF's national and regional partners could lay the foundation for a more-transparent, better-connected, and more-efficient market for clean energy technology commercialization.

### 2. Evaluation

The overarching goal of ETCF would be to increase and accelerate the commercialization of energy technologies to achieve the national goals of environmental sustainability and economic prosperity. Such commercialization outcomes take a very long time to achieve, include multiple players, are not linear, and are often difficult to attribute to one specific action. Nonetheless, measurable goals that indicate whether these outcomes are likely to be achieved can and should be developed, and ETCF held to them.

**ETCF's national and regional partners could lay the foundation for a more-transparent, better-connected, and more-efficient market for clean energy technology commercialization.**

ETCF would work with experts on research evaluation to develop qualitative and quantitative metrics for the organization as a whole as well as its main activities and strategies. Evaluation should be incorporated into all ETCF projects and grants from the beginning, conducted internally on a regular basis as well as periodically by third parties, and provide feedback that informs program development. Pegging long-term goals to greenhouse gas reductions should be a priority, although with care given the difficulties of attribution. Many precedents for such program-specific accountability exist, including the DOE Small Business Voucher Pilot Program evaluation process.[89]

## Funding

ETCF would receive funding from donors with a range of interests that align with the DOE's mission, and regrant those funds to innovation organizations.

### 1. Fundraising

One of ETCF's key fundraising strategies should follow the FNIH model, seeking support from groups of private companies that share an interest in a cross-cutting national challenge or a regional energy innovation ecosystem. The value proposition to these companies revolves around getting a jump on competitors by gaining regular engagement with federal agencies, streamlining access to new ideas and opportunities, and accelerating the translation of these ideas into marketable products and services. Corporate donors may indirectly improve their own technological capabilities, build supply chains, or spot emerging companies that may become promising targets for acquisition and scale-up.

The value proposition to philanthropic organizations also centers on ETCF's two collaborative strategies, but their payoff is, of course, different. These organizations have grown to understand

that accelerated innovation at the national and regional levels is essential to head off the worst consequences of climate change. Charitable giving for this purpose is starting to materialize, and ETCF would provide a high-leverage outlet for it by virtue of its unique relationship to the national labs and other assets in the DOE-supported innovation ecosystem.

In addition to growing the existing pot of climate funding for energy innovation, ETCF would emphasize matching charitable organizations with challenge areas and regions of the country they have identified as priorities. This matching process would help bring more funds to specific innovation activities. Funders that want to have an impact on the marine, agriculture, or mining sectors, for example, would be drawn in to close the funding gaps that impact new technology development in these sectors.

**Federal support for ETCF should be modest and tightly focused.**

Federal support for ETCF should be modest and tightly focused. Congress should make a one-time appropriation of $30 million to jump-start its activities and establish its credibility. This investment would allow ETCF to attract a high-quality staff. Following the model of FFAR, all ETCF expenditures made from this appropriation would have to be cost-shared in order to leverage funds from private and philanthropic partners. In addition, an ongoing annual appropriation of $3 million from DOE would allow ETCF to avoid a constant scramble to fund core staff and certain operating expenses, which neither corporate nor philanthropic donors are usually willing to support. The annual appropriation we propose is somewhat higher than those for other federal agency-related foundations because ETCF would need not only a core staff for development and program work, but also consultants in diverse technology areas across its very broad scope. We envision ETCF's activities growing over time, and its budget becoming similar to those of other agency-related foundations.

ETCF's congressional authorization would give it a mandate not only to solicit and accept donations of money and equipment on behalf of its mission, but also to transfer or loan such resources to DOE offices and labs, as well as to academic and other institutions. The rules and requirements relevant to an ETCF-DOE relationship must be set forth in internal DOE orders, directives, and guidelines, as with other agency-related foundations.

### 2. Distribution

While ETCF would convene stakeholders and conduct a few other activities to build collaborative partnerships itself, it would primarily be a regranting organization.[90] Its recipients would likely include incubators, accelerators, national labs, universities, and other organizations working to commercialize energy technologies. There is no reason for ETCF to try to implement programs in communities that already have organizations with strong ties to local partners, such as university centers, incubators, and clean energy economic development agencies. ETCF support would bring these organizations new resources—notably access to DOE assets—to help innovators commercialize technology more quickly and effectively.

Finally, to encourage innovation and overcome the tendency of organizations to silo funding, ETCF should have an open, rolling solicitation. In a timely manner, ETCF could review responses to such an open call for their ability to strengthen U.S. competitiveness and reduce carbon emissions.

## Governance

ETCF's governance structure must establish a clear mission, ensure the foundation is responsive to the public interest, and delineate a complementary and nonoverlapping relationship with DOE.

### Congressional Authorization

A congressional authorization that gives ETCF the mission of strengthening U.S. competitiveness in a carbon-constrained world would provide a credible claim to national leadership to pursue that mission. As with other agency-related foundations, ETCF's authorization must provide minimum requirements for the composition of its governing board, including membership for the senior leadership of DOE, and conflict of interest and ethics policies. The authorization should also outline the main strategies, activities, and programs of the foundation. Importantly, the authorization would create appropriate processes for streamlining contracting and administrative requirements that hamper DOE's technology commercialization efforts today. ETCF should be required to submit an annual activity and financial report to Congress, consistent with the authorizations of other agency-related foundations, as well as a strategic plan to guide its initial activities, which would be updated after the first two years and then every five years after that.

**Importantly, the authorization would create appropriate processes for streamlining contracting and administrative requirements that hamper DOE's technology commercialization efforts today.**

### Governing Board, Advisory Committees, Staff, and Strategic Plan

Although ETCF would be a self-governing private nonprofit organization, its governing board would need to meet requirements set by Congress to receive the benefits of its congressional authorization. The board would be required to include representatives of key institutions in the national energy innovation ecosystem, as well as a diversity of regions. The Secretary and Under Secretary of Energy, as well as two career Senior Executive Service employees of DOE should serve as nonvoting *ex officio* members of the board. Other board members may come from academia, the energy industry, technology commercialization organizations, DOE laboratories, state or local governments, philanthropy, and the financial sector. The initial board members could be selected by the Secretary of Energy from a list of candidates provided by the National Academies of Science, Engineering, and Medicine and the Secretary of Energy Advisory Board. The board chair and vice-chair should always represent different institutional types, and the positions should rotate among types. The board's steering committee, which would participate in proposal selections, should also be broadly representative of its membership.

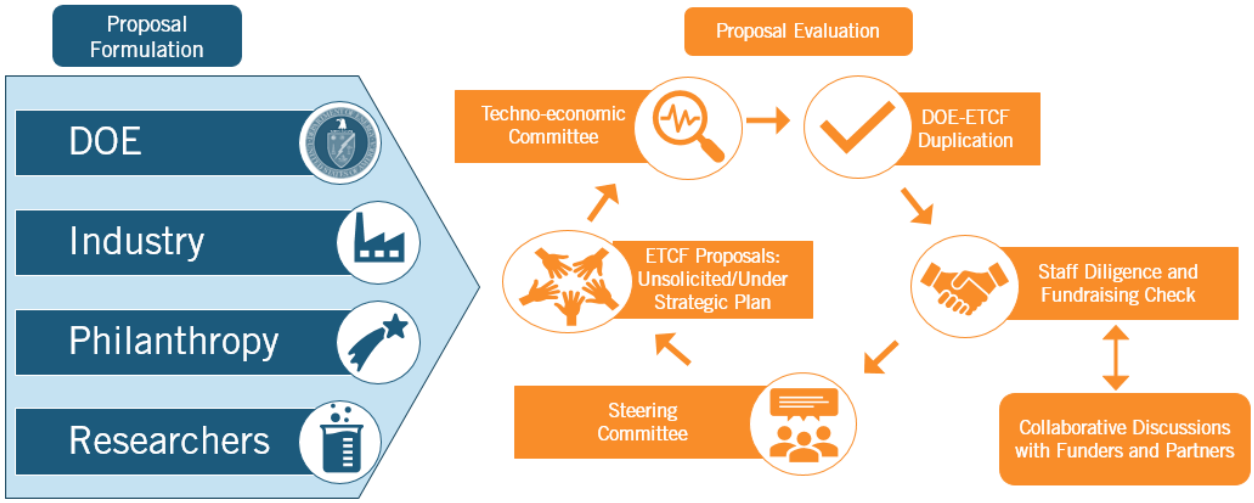
For ETCF to be successful, its staff would need to have exceptional technical and business expertise as well as a strong understanding of DOE and the philanthropic sector. The staff would have to command respect and trust across the energy innovation ecosystem. To enlist such a staff, the foundation would need to pay competitive salaries. It should be open to bringing on staff members who would serve as visiting fellows or experts in residence for limited periods to manage specific technical challenges.

The staff and board would be assisted by ad hoc techno-economic advisory committees that would assist in partnership development and grantee selection in support of ETCF's national and regional collaboration strategies. ETCF would also need investment advisory committees to provide input on the potential value of ETCF-supported commercialization opportunities. These

advisory committees would not fall under the Federal Advisory Committee Act, which requires specific procedures for establishing and managing committees, public notification of meetings, and reporting, among many other requirements.[91]

ETCF's initial congressionally-mandated strategic plan should focus on its first two or three cross-cutting national challenges and regional innovation ecosystem strategies. Proposals within the framework of these collaboration strategies may originate within DOE or from outside organizations, including DOE national labs. Proposals would go through a rigorous evaluation process, including checks to ensure non-duplication with DOE and adequacy of funding, as well as technical and commercial credibility. Funding decisions would be made by the board's steering committee (see figure 8).

**Figure 8: ETCF funding decision-making process**




## Relationship to DOE, National Labs, and Lab Foundations

The experience of other agency-related foundations shows that collaborative partnerships between ETCF on the one hand, and DOE and its national laboratories on the other, will be vital to its success. ETCF would not be an agency of the federal government, but it would be a quasi-governmental organization, with specific functions and responsibilities. DOE would be required to collaborate and coordinate with ETCF, but it would not have decision-making authority over ETCF.

**The experience of other agency-related foundations shows that collaborative partnerships between ETCF on the one hand, and DOE and its national laboratories on the other, will be vital to its success.**

Beyond the relationships established by board membership, internal DOE guidance, directives, and orders pertaining to ETCF would be required to make the relationship effective. These official documents should be developed in partnership with ETCF and take into consideration concerns of all stakeholders, including the national laboratories. They should cover a wide range of topics, including how proposals generated by DOE units would be transmitted to ETCF, as well as the creation of standardized contract mechanisms and streamlined processes to be used to support work at the national laboratories. ETCF would not be exempted from policies that protect

U.S. competitiveness, national security, and DOE's scientific integrity.[92] However, the congressional authorization should streamline the application of these policies and ensure DOE site offices prioritize contracts related to ETCF.

All guidance documents should be binding on all DOE units, including the National Nuclear Security Administration, ARPA-E, and other semiautonomous agencies within DOE. All DOE national laboratories, sites, and facilities should be allowed and encouraged to work with ETCF. ETCF should also partner with individual DOE laboratory foundations, wherever they may exist (see Box 4). Any standardized contract created for ETCF to work with DOE should also be available to individual lab foundations. ETCF's relationship with these foundations should be codified by Congress through a provision in the authorization that clearly outlines ETCF's responsibilities to work collaboratively with them, similar to that contained in the National Park Foundation's public law with regard to its local "friends" groups.[93]

## CONCLUSION

Building on precedents such as the Foundation for the National Institutes of Health, the Foundation for Food and Agricultural Research, and the National Park Foundation, Congress should pass legislation authorizing an Energy Technology Commercialization Foundation with the mission of supporting the U.S. Department of Energy by strengthening U.S. competitiveness in a carbon-constrained world. The authorizing language should include a one-time $30 million appropriation to attract additional capital, and an annual appropriation of $3 million to cover a portion of ETCF's administrative expenses. ETCF should pursue collaborative strategies with its partners in DOE, other federal agencies, the private sector, academia, and philanthropy that respond to cross-cutting national challenges and strengthen regional energy innovation ecosystems. ETCF should aid innovators to gain access to the rich resources of DOE and its national laboratories, and support initiatives for training and funding that would otherwise be unavailable to them.

The creation of a DOE-related foundation has been endorsed by a wide array of business, academic, and research organizations. For instance, the American Energy Innovation Council, a group of 12 current and former CEOs and investors such as Microsoft's Bill Gates and venture capital legend John Doerr, wrote that it could "attract significant private capital." In addition, the 2019 technology transfer green paper by NIST suggested all federal agencies acquire the ability to establish nonprofit foundations "to accelerate technology maturation, transfer, and commercialization." NIST also noted that "congressionally established foundations have benefited from appropriated agency funding to partially support their operations." Senators Chris Coons (D-DE) and Lindsey Graham (R-SC), along with Representatives Ben Ray Lujan (D-NM) and Joe Wilson (R-SC), have championed the concept of a DOE-related foundation by sponsoring legislation.[94]

Once ETCF is authorized and receives initial operational funding, DOE, with the support of the White House, should quickly take the internal steps required to build a collaborative relationship with it. These orders and guidelines would unlock a multitude of opportunities for DOE programs and national laboratories to participate in ETCF's national and regional strategies. DOE leadership should also champion the foundation externally, bringing both visibility to its mission and unique capabilities in the business and philanthropic communities.

The United States has much to contribute to the innovations that will power the energy transition—and much to gain from them as well. ETCF would be a valuable mechanism for both enhancing the contributions the nation makes to this critical global effort and ensuring it receives a reasonable share of the economic gains from it.

## Appendix 1: Project Methodology

To develop the concept of the Energy Technology Commercialization Foundation, ITIF examined the existing agency-related foundations authorized by Congress, conducted over 140 interviews (Phase I) and held two workshops (Phase II). Below is the methodology and summary of the project. The result is an agency-related foundation with functions, governance structures, and relevant policies that could apply to the specific DOE energy commercialization challenges identified by its stakeholders.

### Phase I: Pre-workshop Research, July 2019 to October 2019

ITIF surveyed and assessed the organization and operation of existing agency-related foundations and developed a preliminary set of options for a Department of Energy Foundation (DOEF) to be discussed at the workshop. We tried to answer the following questions as a part of the interview process:

1. What attributes of the organization and operation of existing agency-related foundations could be adopted by a DOEF? Which ones are the most important for energy innovation?
2. What unique aspects of DOE's mission and structure (such as the role of contractors) require a DOEF to be different from existing agency-related foundations?
3. Which problem(s) would a DOEF help solve? Why can't existing DOE capabilities and entities (i.e., hubs, Energy Frontier Research Centers) solve these problems?
4. Should the federal government appropriate funds to a DOEF? What nonfederal entities would contribute resources to a DOEF, and why?
5. Would a DOEF only be focused on commercialization of technologies developed by DOE national labs? If so, should there be a centralized (one foundation) or decentralized (one foundation per laboratory) model for coordination? If not, what else should be included in its scope? How might a DOEF improve on DOE's existing mechanisms to encourage commercialization of federally funded R&D?

#### Existing Agency-Related Foundations

Our research examined nine congressionally authorized agency-related foundations with a focus on funding, organizational structure, and functions. A description of each foundation can be found in appendix 2.

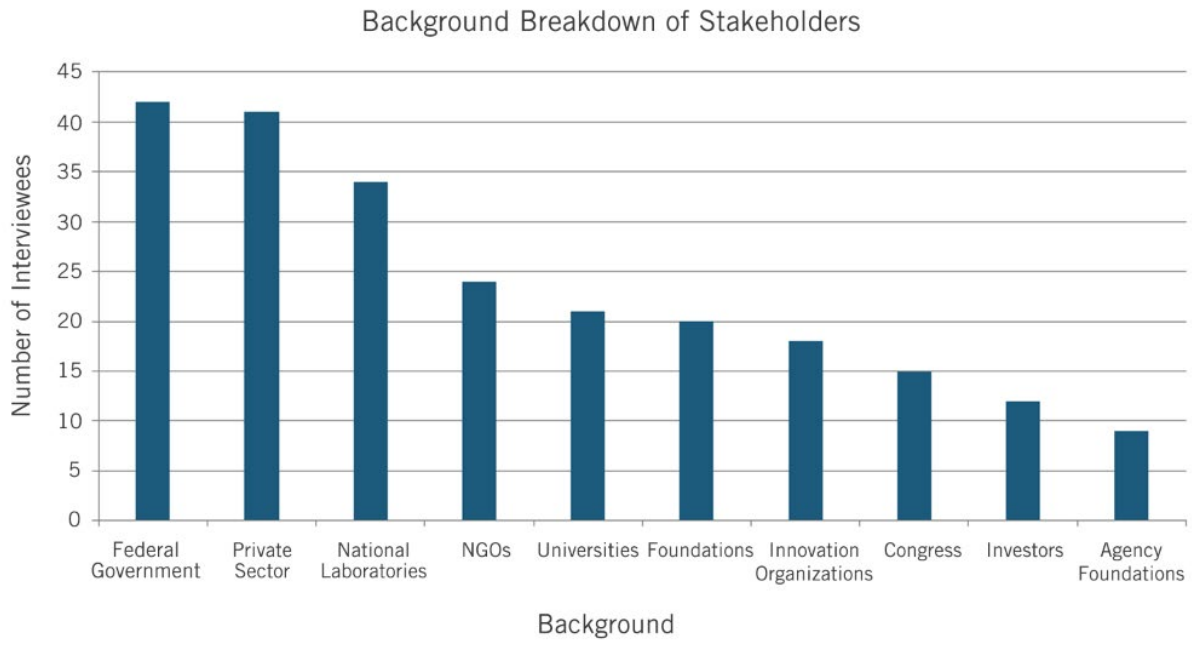
1. Foundation for the National Institutes of Health
2. Foundation for Food and Agriculture Research
3. National Association of Veterans' Research and Education Foundations
4. National Park Foundation
5. Centers for Disease Control Foundation

6. Henry M. Jackson Foundation for the Advancement of Military Medicine
7. Reagan-Udall Foundation for the FDA
8. National Forest Foundation
9. National Fish and Wildlife Foundation

**Interviews**

We interviewed 140 individuals, representing stakeholders such as private-sector companies, investors, universities, national laboratories, incubators, foundations, and non-governmental organizations (NGOs) in this phase. The chart breaks down the backgrounds of those interviewed. Some stakeholders fall into more than one category.

**Figure 9: Background breakdown of stakeholders**




Conversations with stakeholders varied significantly. Most interviewees had never heard of a foundation such as DOEF and were not familiar with how it might function. We explored how a DOEF could increase stakeholder engagement and collaboration with DOE and the national laboratories, as well as how it could accelerate new energy technologies through the innovation cycle (i.e., early-stage and late-stage Valleys of Death). Additionally, some stakeholders discussed if and how a DOEF might help DOE meet its national security and environmental cleanup missions, along with its energy mission, while other stakeholders examined how the mission of a DOEF might be broadened to other sectors with strong linkages to energy (i.e., agriculture and water conservation). Furthermore, the conversations covered how existing agency-related foundations function and whether those functions could be adapted for a DOEF.

## Phase II: Stakeholder Workshops, October 2019 to January 2020

ITIF developed and conducted two workshops based on topics identified in Phase I. Each workshop was approximately a day long and involved 15–20 participants from a diverse set of stakeholder organizations. The participants were provided a read-ahead outlining the agenda and main topics for discussion.

Based on the information gathered in the research phase, we developed three model frameworks with functions that were presented at the first DOEF workshop in Washington, D.C., on November 12, 2019. The emphasis of the workshops was not to obtain consensus on a DOEF's organization and operation, but on gathering feedback on various options.

**Individual National Lab Foundations**
Each individual DOE laboratory would be able to establish its own foundation. These foundations would be lab- and regionally-focused. They would serve as flexible funding organizations to strengthen individual lab capabilities and connections to local communities.

**National Association of DOE Lab Foundations (Individual Foundations and a Coordinating Organization)**
Each individual DOE laboratory would be able to establish its own foundation, and a National Association of DOE Lab Foundations would be established to support their activities. The National Foundation would provide coordinating and administrative services to the network, and serve as a one-stop shop for funders and private-sector companies that want to work with more than one laboratory. It would also fund lab-commercialization programs to mature federally funded energy technology.

**Energy Technology Commercialization Foundation**
ETCF's mission would be to accelerate commercialization of energy technology in the United States. It would provide support to government and university labs for technology maturation, work with investors to reduce their risks, and leverage federal resources for more flexible and timelier private-sector engagement with federally funded researchers.

**Summary of Workshop I**
The full-day, invitation-only workshop was attended by more than 20 experts representing diverse experiences and perspectives, including the private sector, investors, universities, federal laboratories, NGOs, and Congress. Its primary purpose was to explore alternative structures and functions for a potential DOEF, and how such a foundation could improve and accelerate the commercialization of federally funded energy R&D.

The workshop succeeded in more-sharply defining the challenges a new organization might address. The group shared perspectives on the value of the DOE lab system, which incubates a wide variety of technologies, including but not limited to energy. We also explored how the energy innovation ecosystem could benefit from better coordination on cross-cutting grand challenges, which might be developed by a DOEF. Convening stakeholders and bringing more awareness to the capabilities of the DOE labs to help solve energy problems were additional functions discussed. Participants learned about some existing commercialization models at universities and the labs, including the DOE Lab-Embedded Entrepreneurship Programs, and their limits. We also heard from existing agency-related foundations, and explored how these organizations' activities might be adapted for a DOEF.

Based on the informal rating process conducted at the end of the workshop, 12 participants preferred framework #3 (the Energy Technology Commercialization Foundation), while 7 preferred a version of framework #2 (the National Association of National Lab Foundations).

**Between Workshops**
After the first workshop, ITIF conducted more interviews and additional research specific to the ETCF model and developed functions and a governance structure focused on how to

commercialize more technology through national cross-cutting challenges and regional ecosystems. It then reviewed this new model with key lab, innovation-organization, and private-sector stakeholders.

**Summary of Workshop II**

The second full-day, invitation-only workshop on a DOEF was conducted on January 31, 2020, in Oakland, California. In attendance were more than 20 experts representing diverse experiences and perspectives, including the private sector, investors, universities, federal laboratories, energy incubators, and foundations. The purpose of the workshop was to gather input on the refined vision of the DOEF, which we are provisionally calling the Energy Technology Commercialization Foundation (ETCF). The proposed mission of ETCF would be to strengthen U.S. competitiveness in a carbon-constrained world. Its goal would be to accelerate the commercialization of early-stage energy technology in the United States.

During the workshop, we discussed four collaboration strategies, and how they could have the desired effect of improving and accelerating the commercialization of clean energy technologies. We also discussed ETCF's governance structure, as well as potential donors to it and organizations that would receive grants from it.

We derived four main takeaways from the workshop discussion and informal survey. First, of the four strategies described, the Accessing Facilities and Expertise strategy earned the most support. A consensus emerged that this strategy would be the most beneficial to the stakeholders represented by workshop participants, and would help bridge the early-stage valley of death. Second, while the early-stage valley of death is important, the foundation should have a broader remit to tackle all barriers to commercialization. For example, ETCF could stimulate pre-pilot and pilot-scale demonstrations, and even facilitate testing of emerging clean energy technologies at the DOE National Laboratories. Third, ETCF should incorporate more private-sector pull into its collaboration strategies. It should strengthen and increase opportunities for the private sector to provide input into energy technology research agendas. Finally, workshop participants valued the National Cross-Cutting Challenges and Regional Ecosystem collaboration strategies, as long as those strategies involved closing the commercialization gap. Participants suggested the foundation could fund programs that would help provide access to DOE facilities within a challenge area, or work toward pilot or demonstration projects that strengthen a regional ecosystem.

The workshop provided critical direction on the scope of the foundation, as well as how it might implement and prioritize its strategies. Limiting the mission of the foundation to energy (as opposed to the full scope of DOE's mission) persisted as a concern for some participants, but in general, most were satisfied with it. Additionally, the workshop surfaced several ideas on how ETCF should be governed. ETCF would need to develop a strategic plan to prioritize its collaboration strategies, and select organizations to fund. It was also recommended that the foundation establish a rigorous set of criteria to ensure it achieves its goals and has a way to measure its success. The idea that ETCF itself provide commercialization services, in addition to being a convener, coordinator, and funder of other organizations, was also discussed.

Finally, the day ended with a discussion of next steps. To move beyond the forthcoming ITIF report and roll-out event in the springtime in Washington, D.C., participants discussed the

opportunity to collaborate on a marine transportation decarbonization initiative to demonstrate the new technology as a first project of the foundation.

### Post-Workshop Refinement

After the workshop, ITIF refined the ETCF model and started vetting the concept with key stakeholders and congressional sponsors of the IMPACT bill. The draft report was sent to all stakeholders interviewed for review before the final report was published in May 2020.

## Appendix 2: Agency-Related Foundations Examined for this Report

### Centers for Disease Control Foundation (CDCF)

CDCF helps CDC do more, faster, by forging effective partnerships between CDC and others to fight threats to health and safety. The foundation began operations in 1995 to improve the health and safety of all people by substantially enhancing the impact of CDC. It is an independent 501(c)3, and the sole entity created by Congress to mobilize philanthropic and private-sector resources to support CDC. By aligning diverse interests and resources, and leveraging all parties' strengths, its focused collaborations with private and philanthropic partners help create greater impact than any one entity can alone. CDCF helps CDC launch new programs, expand existing programs that show promise, and establish pilot projects to determine whether certain health programs should be scaled up—none of which would be possible without external support that complements government investments.

### Foundation for Food and Agriculture Research (FFAR)

FFAR builds unique partnerships to support innovative science addressing today's food and agriculture challenges. The foundation was established in 2014. It envisions a world in which ever-innovating and collaborative science provides every person access to affordable, nutritious food grown on thriving farms. It engages stakeholders across academia, the public sector, and private companies to identify pressing research ideas. It issues requests for applications, conducts prizes, and funds individual scientists and consortia. While an independent 501(c)3, FFAR complements and advances USDA's mission and builds programs that are of mutual interest to USDA and the agricultural community at large.

### Foundation for the National Institutes of Health (FNIH)

FNIH creates and leads alliances and public-private partnerships that advance breakthrough biomedical discoveries, thereby improving the quality of people's lives. The foundation began its work in 1996 to facilitate groundbreaking research at NIH and worldwide. FNIH organizes and administers research programs; supports education and training of new researchers; organizes educational events and symposia; and administers a series of funds supporting a wide range of health challenges. As an independent 501(c)3, it raises private funds and creates public-private partnerships to support NIH's mission of making important discoveries that improve health and save lives.

### Henry M. Jackson Foundation for the Advancement of Military Medicine (HJF)

HJF is a 501(c)(3) organization dedicated to advancing military medicine. It serves military, medical, academic, and government clients by administering, managing, and supporting preeminent scientific programs that benefit members of the armed forces and civilians alike. Since its founding in 1983, HJF has served as a vital link between the military medical community and its federal and private partners. HJF's support and administrative capabilities

allow military medical researchers and clinicians to maintain their scientific focus and accomplish their research goals. HJF has grown to a global organization supporting more than 700 national and international research grants, contracts, and cooperative agreements.

**National Association of Veterans' Research and Education Foundations (NAVREF)**
Formed in 1992, NAVREF is the 501(c)(3) nonprofit membership organization of research and education foundations affiliated with Department of Veterans Affairs (VA) medical centers, but is not authorized by Congress. These nonprofits, also known as the VA-affiliated nonprofit research and education corporations (NPCs), are authorized by Congress to provide flexible funding mechanisms for the conduct of research and education at VA facilities nationwide. NAVREF helps bring more high-quality clinical trials to veterans faster; provides operational best practices to NPCs; conducts educational and research topic specific convenings; advocates on behalf of NPCs with Congress; and runs an affinity program to reduce costs of products and services for its members.

**National Fish and Wildlife Foundation (NFWF)**
The National Fish and Wildlife Foundation (NFWF) is dedicated to sustaining, restoring, and enhancing the nation's fish, wildlife, plants, and habitats for current and future generations. NFWF builds partnerships between leading U.S. corporations and the federal agencies, nonprofits, and individuals who drive conservation efforts across the United States. It leverages public funds to raise private dollars and award those funds to projects that will do the most good across a wide range of landscapes. Since its founding by Congress in 1984, NFWF has supported more than 17,250 projects and enhanced wildlife populations and natural habitats in all 50 states and U.S. territories. With its partners, it protects and restores imperiled species, promotes healthy oceans and estuaries, improves working landscapes for wildlife, advances sustainable fisheries, and conserves water for wildlife and people.

**National Forest Foundation (NFF)**
The mission of the National Forest Foundation (NFF) is to engage Americans in promoting the health and public enjoyment of our National Forests. NFF works with the U.S. Forest Service and partners to leverage the best thinking, conservation capacity, and community action to measurably improve the health of National Forests and Grasslands. Chartered by Congress as a 501(c)3 in 1990, NFF engages Americans in community-based and national programs that promote the health and public enjoyment of the 193-million-acre National Forest System, and administers private gifts of funds and land for the benefit of the National Forests. The foundation conducts on-the-ground conservation activities through grant programs that align with specific strategic initiatives across five regions of the country.

**National Park Foundation (NPF)**
As the official nonprofit partner of the National Park Service, NPF generates private support and builds strategic partnerships to protect and enhance America's national parks for present and future generations. Its mission is to directly support the National Park Service. Chartered by Congress in 1967, NPF grew out of a legacy of park protection that began over a century ago, when ordinary citizens took action to establish and protect our national parks. NPF focuses on promoting programs and projects that protect precious landscapes, wilderness, historical sites, and places of cultural significance. It works to keep trails clear, partners with collaborators on kids' outdoors programs, and raises and allocates funds to keep national parks safe.

**Reagan-Udall Foundation for the FDA**

The Reagan-Udall Foundation is a private 501(c)3 created to support the mission of the U.S. FDA to help equip its staff with the highest caliber regulatory science and technology in order to enhance the safety and effectiveness of FDA-regulated products. The central focus of the foundation is to assist in the creation of new, applied scientific knowledge, tools, standards, and approaches the FDA needs to evaluate products more effectively, predictably, and efficiently—and thereby enhance the agency's ability to protect and promote the health of the American public. The Reagan-Udall Foundation serves as a crucial conduit between the FDA and the public, providing a means for the FDA to interact directly with stakeholders, including industry and consumers. The foundation does not participate in regulatory decision-making or offer advice to the FDA on policy matters.

## Acknowledgments

The authors wish to thank the following individuals for providing input to this report: Adam Cohen, Addison Stark, Amar Bhat, Andrew Green, Arthur "Chip" Cotton, Arun Majumdar, Ben Solomon, Brad Townsend, Bridget Krieger, Carol Dahl, Chad Evans, Chris Tomassi, Christopher (Chris) Keane, Clay Nesler, Cole Simons, Courtney Silverthorn, Cyndi Atherton, D. Drew Bond, Damian Kunko, Dan Byers, Dan Holladay, Dan Killoren, David Danielson, David Parekh, David Smernoff, Deborah "Debbie" Altenburg, Dona Crawford, Doug Rand, Doug Vine, Duane Dimos, Elizabeth (Betsy) Cantwell, Erin Burns, Farah Benahmed, Franz Wuerfmannsdobler, Gabriel Kra, Geoff Holmes, Greg Friberg, Greg Rosen, Greg Suski, Gretchen Jordan, Hanan Saab, Hawk Tran, Helen Tovar, Ilan Gur, Ivy Clift, J. Michael McQuade, James Dumont, Jennifer Anastasoff, Jennifer States, Jessica Balsam, Joe Menetski, Johanna Wolfson, John Balbach, John Deutch, Jonathan (Jon) Elkind, Jonathan Pershing, Joshua Berger, Judy Li, Julie Reynes, Julie Seger, Justin Baca, Kathleen (Kathy) Veit, Kei Koizumi, Kevin Klock, Kyle Simpson, Lara Pierpoint, Lawrence (Larry) Plumb, Leland Cogliani, Lindsay Steves, Lindsey Walter, Maggie Cutts, Marc Kastner, Marielle Ednalino, Mark Vanderhelm, Mary Beth Campbell, Meg Hardon, Michael (Mike) Carter, Moses Lee, Nick Loris, Nicole Systrom, Pamela (Pam) Lewis, Paul Gay, Paul Zielinski, Paula Gant, Phil Weilerstein, Pulakesh Mukherjee, Ralph Izzo, Ramsay Huntley, Ray Johnson, Rengarajan (Ramesh) Ramesh, Rob Schneider, Robin Millican, Ruth Cox, Ryan Macpherson, Ryan Mulvenon, Sally Allen, Sally Rockey, Sam Gabbita, Sarah Jane (SJ) Maxted, Sarah Kearney, Shawn Garvey, Shayle Kann, Steve Capanna, Steve Porter, Sydney Bopp, TJ Glauthier, Toby Smith, Tom Arnold, Tom Dower, Tom Erb, Tom Kalil, Vanessa Chan, Vic Shao, Wendy Torrance, and William (Will) Shafroth. Any errors of omissions are the authors' alone.

The ITIF DOE Foundation Project is funded by the Energy Innovation Fund at the National Philanthropic Trust, and the Bernard and Anne Spitzer Charitable Trust.

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