American Energy Innovation Council

SCALING INNOVATION: A PROPOSED FRAMEWORK FOR SCALING ENERGY DEMONSTRATIONS AND EARLY DEPLOYMENT

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Letter from the Principals

We are the American Energy Innovation Council, a group of CEOs, technology, and labor leaders who share a common concern over America's insufficient commitment to energy innovation. Our experience leading companies and organizations in multiple sectors informs our views on how to overcome hurdles to the wide deployment of new clean energy technologies.

The United States has long been a leader in early-stage energy technology innovation and entrepreneurship. To ensure the U.S. continues its energy leadership in the 21st century, we must focus on the commercial demonstration and mass deployment of advanced energy technologies. Solving the technology demonstration challenge and overcoming barriers to large-scale investment are key priorities for AEIC because both are essential to accelerate the clean energy transition. We believe success requires robust government support in close collaboration with the private sector.

The recent commitment from Congress to fund energy demonstration and deployment through infrastructure spending is a promising investment for our nation's energy future. In addition, new changes at the U.S. Department of Energy—specifically, efforts to revitalize the existing DOE Loan Programs Office and stand up a new Office of Clean Energy Demonstrations—thus come as a welcome development. We applaud these efforts and, in this report, offer recommendations to further strengthen the federal government's energy innovation programs. Specifically, we urge Congress and the administration to increase direct support for commercial-scale demonstration projects and create a new federal entity with the financial and project management tools necessary to work effectively with private partners to close gaps in later stages of the innovation and deployment process.

Historically, this country has accomplished incredible feats by relying on bold thinking, technological ingenuity, and a willingness to embrace change. By rediscovering that spirit of aggressive innovation, America will be well-prepared to face, and overcome, the new challenges of today. We are confident that action now can help ensure success—not only in achieving a dramatic transformation of today's energy systems but in providing the foundation for another century or more of U.S. prosperity, security, and global leadership.

DISCLAIMER:

AEIC is a consensus-based effort that relies upon principled, evidence-based deliberation and constructive compromise. As such, signatories should be understood to support the overall recommendations as a package but not necessarily every idea in isolation. In addition, it should be noted that some AEIC members joined the organization recently and were not involved in the fact finding and policy development process.

Applauding Recent Progress

On November 15, 2021, President Biden signed the Infrastructure Investment and Jobs Act (IIJA) into law, which contains several important new provisions designed to accelerate the demonstration and deployment of clean energy technologies. This bipartisan legislation delivers on many of the ideas that the American Energy Innovation Council has advocated for over the past decade including: investing serious new funding into the development and demonstration of clean energy technologies, supporting hub-based models of energy innovation, and establishing new ways to turn prototypes of advanced energy technologies into commercial-scale facilities.

In particular, section 41201 of the IIJA establishes the foundation for the recommendations we are proposing in this report by creating a new Office of Clean Energy Demonstrations (OCED) to select, fund, and manage demonstration projects by DOE. DOE announced the establishment of OCED on December 21, 2021. These exciting developments lay promising groundwork to supercharge energy demonstration in the short-term. Taken with the recommendation in this report to combine the functions of OCED and the DOE Loan Programs Office under common leadership, DOE could rapidly accelerate deployment of clean energy technologies in the long-term.

AEIC is committed to working with DOE and private sector leaders on successful implementation of the OCED while continuing to advocate for the additional reforms we believe are necessary to achieve net-zero emissions by 2050. By working together and taking bold action, we are confident America can achieve its climate goals.

Sasha Mackler
Executive Director, BPC Energy Program

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"America's energy innovation ecosystem lacks a mechanism to build, test, and refine large-scale technologies. Many technologies that need demonstration assistance are too big, expensive or risky to go forward by traditional means."

—AEIC's 2010 report, A Business Plan for America's Energy Future[1]

INTRODUCTION

The American Energy Innovation Council (AEIC) has been working since 2010 to advance policies aimed at strengthening America's innovation capabilities in clean energy technology. As decarbonization efforts gain momentum worldwide, leadership in developing and commercializing zero-carbon and negative carbon technologies is a critical strategic and competitive priority for the United States. The AEIC's Scaling Innovation Advisory Group, which includes entrepreneurs and experts from industry, finance, academia, and government, came together to focus on essential but often challenging steps in the innovation life cycle: demonstration and early deployment.

This focus is prompted by a recognition that demonstration is often the weak link in transitioning a technology from the early stages of innovation (i.e., research and development—often funded by the government) to a commercial product and mass deployment. The private sector does not fund demonstration because the market does not appropriately price the externalities of existing and new technologies; therefore, public resources must be activated. Yet despite the importance of demonstrations—to develop critical technical and operational know-how and to reduce the operational and financial risks associated with deploying a new technology—the federal government's track record of supporting early-scale-up, large-scale demonstrations, and deployment of commercial scale first-of-a-kind energy innovations is mixed at best.

How this track record might be improved through a strengthened and more focused federal role is the subject of this paper. We have two central recommendations for Congress:

1. Increase funding for the Advanced Research Projects Agency – Energy (ARPA-E) and bolster that agency's new SCALEUP program, which is focused on early technology scale-up and prepiloting (SCALEUP stands for Seeding Critical Advances for Leading Energy Technologies with Untapped Potential).
2. Create a new independent federal institution—called, for purposes of this discussion, the Energy Demonstration and Finance Corporation (EDFC)—that would have the financial tools and project management capabilities to better support large-scale energy technology demonstrations and deployment.

The AEIC has been a strong supporter of ARPA-E and views the expansion of the agency's capabilities to pilot new technology as a statutory responsibility and key to filling the early-stage demonstration gap. The SCALEUP program can help bridge the "valley of death" between research, development, and demonstration by supporting earlier scale-up and prepilot projects and thereby helping to advance technologies along the

innovation life cycle. Few other entities have the flexibility and expertise to conduct this important activity, yet it is impossible to move into large-scale demonstration without passing through these critical steps in the innovation process. Expanding ARPA-E's SCALEUP program will provide a robust pipeline of technologies that are ready, with the support of the new financing institution we propose, for large-scale commercial demonstration and deployment.

The creation of an Energy Technology Corporation would represent a monumental change in how the U.S. commercializes energy technologies. We envision a wholly owned government corporation that combines the project development and large-scale demonstration capabilities of the U.S. Department of Energy (DOE) Office of Clean Energy Demonstrations and DOE's existing Loan Programs Office; the broad range of mass deployment financing tools of the (proposed) Clean Energy Deployment Administration (CEDA) and green banks; and the governance structure of both the (proposed) Energy Technology Corporation (ETC) and the (existing) U.S. International Development Finance Corporation (DFC).

To position the EDFC for success, we recommend that this new entity be established with:

- An initial congressional authorization and upfront appropriations of $60 billion for at least 10 years of operation
- An explicit focus on large-scale demonstration and early-stage mass deployment of advanced energy technologies
- An independent board of directors, nominated by the president and appointed with the advice and consent of the Senate, to govern the organization
- Special hiring authority to attract individuals with energy-sector experience who have specialized financial and technical skills, including individuals outside the professional civil service system who could be hired on a temporary basis at commercially competitive salary levels
- Authority to implement a broad set of financial tools, including contract, grant, and cooperative agreement authorities as well as the ability to provide direct loans, loan guarantees, and letters of credit, and to offer equity investments, insurance products, securitization for resale, and other means of secondary market credit enhancement

Establishing the EDFC would be a natural step in DOE's evolving approach to the energy innovation and commercialization process. In the short term, strengthening DOE's loan programs and launching a new Office of Clean Energy Demonstrations within DOE will help build financial and project management capabilities and fill important gaps in the existing innovation system. Longer term, the EDFC, as an independent agency, would better coordinate and execute these capabilities as a single entity that has a degree of additional freedom from political interference.

The ARPA-E early prepilot demonstrations and the EDFC large-scale demonstration and deployment proposals complement previous AEIC recommendations, which call for tripling the federal government's overall

investment in energy innovation, increasing ARPA-E's budget to $1 billion per year, and creating a New Energy Challenge Program[2] to demonstrate energy technology breakthroughs at commercial scale.

These recommendations are important for closing the demonstration and deployment gaps in the innovation cycle, and can help unlock major new energy advancements for our nation. Much is at stake in the race to reduce CO_2 emissions. The objectives of the energy transition should be broad and include additional priorities such as job security and quality, community development, and domestic supply chains for products and skilled labor. To successfully bring forward these objectives, the EDFC will need to ensure it approaches its work with equity in mind, incorporating a diverse leadership structure with experts from labor, environmental organizations, and the private sector as well as strong community engagement.

To provide context for these recommendations, we review AEIC's previous work on large-scale demonstration and outline the case for a meaningful federal role in closing demonstration and deployment gaps. Next, we describe existing models for effective federal engagement in these areas. We conclude with further discussion of our two central recommendations in this paper: strengthening ARPA-E and implementing the Energy Demonstration and Finance Corporation concept.

FOUNDATIONS FOR AEIC'S SCALING INNOVATION RECOMMENDATIONS

The AEIC Scaling Innovation Project is focused on addressing the challenges inherent in the demonstration and deployment of new energy technologies. The recommendations outlined in this paper reflect insights and ideas generated by a series of case studies and workshops that examined the role of demonstration projects in commercializing new clean energy technologies.

A Scaling Innovation Advisory Group, which included entrepreneurs and experts from industry, finance, academia, and government, came together to advise the AEIC on the critical but often challenging steps in the innovation life cycle: demonstration and early deployment. Between March and November 2020, AEIC held seven workshops on the need for greater federal support for demonstrations and deployment. The Advisory Group invited guest speakers from DOE, investment groups, private companies, and think tanks to highlight critical barriers to demonstration and deployment of new energy technologies. The successes and failures of several federal programs were analyzed for lessons learned. While critical characteristics and capabilities began to emerge, important conversations took place regarding political feasibility and timing.

The AEIC commissioned four experts to analyze case studies that examined the role of demonstration projects in the commercialization of new technology, particularly clean energy technology. The resulting case study reports are summarized below:

1. *A Review of Federal Efforts to Demonstrate Carbon Capture and Storage with Commercial-scale Coal-Based Power Plants (2003–2016)*, by Eric Redman, highlights the management and technical challenges inherent in demonstrating first-of-a-kind technology, especially technologies that integrate two different subsystems. The report also describes the high cost of political interference in the demonstration of new technologies.

2. *The U.S. Clean Energy Deployment Administration: A Business-Driven Approach to Leveraging Private Sector Investment in Clean Energy Innovation and Commercialization*, by Dan Reicher. Reicher's report showcases the political feasibility of the proposed Clean Energy Deployment Administration and the value it could bring to the deployment of new technology through a broad range of financing mechanisms. Additionally, Reicher argues that CEDA should be a part of the federal government so that it is backed by the full faith and credit of the government.

3. *The American Recovery & Reinvestment Act and the Rise of Utility-Scale Solar Photovoltaics: How U.S. Public Policy During the Great Recession Launched a Decade-Long Solar Boom*, by Varun Sivaram, describes the origins of the commercial-scale solar energy expansion in the United States and the DOE Loan Program Office's important role. In particular, the case study highlights the need for complementary policies and the importance of this new DOE program that filled a critical early deployment gap and had an ability to hire both technology experts and private sector project financing experts.

4. *Flying Laboratories, Prototyping, and Dem/Val: The Crucial Role of Technology Demonstration in Advancing Military Innovation and Its Relevance for the Department of Energy*, by Dorothy Robyn, discusses the role of technology demonstration in the U.S. military's innovation process, which has driven advances ranging from GPS to the internet. Robyn draws lessons from the military's approach that are relevant to DOE and to the ongoing debate over how the federal government should support large-scale energy demonstration projects. She also looks at whether the Department of Defense can play a broader role in demonstrating new energy technologies that have civilian (as well as military) applications.

AIEC's workshops, along with the case studies, and many one-on-one conversations informed the recommendations contained in this paper. In addition, the Scaling Innovation Advisory Group considered technical and political challenges to overcoming barriers to demonstration resulting in the recommendations contained here, which we acknowledge are a combination of pragmatism and ambition.

THE INNOVATION CONTINUUM: STAGES AND LIFE CYCLE

An extensive amount of literature exists on the key features and challenges associated with each of the research, development, demonstration, and deployment (RDD&D) stages of the innovation continuum, and the stages' overlapping relationships to each other. These features are not unique to energy, but as previous AEIC reports have highlighted, the path from the lab bench to wide-scale deployment of a new energy technology is arduous and can require decades of effort and hundreds of millions, or even billions, of dollars of investment. A more comprehensive approach to the full innovation life cycle—encompassing not only research and development, but also demonstration and deployment and the associated feedback loops, especially from the private sector—can help ensure that the U.S. remains home, not only to the inventors of tomorrow's critical energy technologies, but also to the companies that design, build, manufacture, deploy, and export those technologies domestically and around the world.

The research and development stages, funded largely by the public sector, are where discovery and invention happen. These stages receive relatively little private-sector investment because the probability of success is uncertain, technology risk is high, and there is usually no clear "commercial application of early-stage R&D." When the private sector does fund R&D, it often funds "development" innovations focused on improving existing technologies rather than "research" focused on new innovations.[3] Federal support for research efforts (both basic and applied) at national labs and universities is necessary to address the market failure of inadequately pricing the benefits of future technology deployment and the inability of most industries to turn the benefits of research into viable products with potential users.

The demonstration stage is made up of a range of small- and large-scale demonstrations. The small-scale demonstrations, sometimes called pilots, are where precommercial integrated systems are created as a technology proof of concept, resulting in important technology de-risking. In this period, project developers can conduct the initial tests of their technologies under highly controlled settings (*not* in real-world settings or at scale) to evaluate the technologies and sort through any emergent issues that appear, including those issues that require additional research and development. While rare, private sector engagement at this stage accelerates learnings and strengthens later partnerships and eventual market acceptance.

Large-scale demonstrations are fully integrated, "first-of-a-kind" projects implemented on a commercial or close-to-commercial scale under real-world conditions. At this point, the roles of the private and public sector intersect. Private entities must be intimately engaged with the design and operation of demonstration plants. The public sector, which is focused on achieving the societal benefits of new technology, must help defray the costs and risks of the private sector's engagement. The market does not often recognize those societal benefits; therefore, the private sector would not rationally choose to conduct a demonstration on its own. The primary focus at this stage is on developing *technology* capabilities and proving commercial viability. Lessons learned from large-scale demonstration projects directly inform the next stage of early deployment, which typically involves the first set of replicable "nth-of-a-kind" projects and where the focus is on improving *financing* and driving down costs through multiple iterations of the same or similar designs. Demonstration projects are particularly challenging because they generally have large and concentrated capital requirements, but they are not expected to deliver optimized cost or performance. An additional challenge is the disincentive to demonstrate new technologies due to industry's large investments in existing, long-lived energy infrastructure. A recent report from the Information Technology and Innovation Foundation summarizes the specific importance of large-scale demonstration projects:

> "The fundamental role of demonstration is to instill confidence in technology developers, users, investors, and other stakeholders that a technology will perform predictably from both a technical and economic perspective. Knowledge and data created by demonstration projects reduce the risks that stakeholders perceive themselves to be taking in follow-on projects that deploy the same technology."

—Robert Rozansky and David M. Hart. *More and Better: Building and Managing a Federal Energy Demonstration Project Portfolio*. ITIF May 2020.

Although the process of commercializing new technologies is often described in distinct stages, innovation is rarely linear, the stages are not static, and it takes many different players and partners to commercialize a new technology. Finally, there is not a clear dividing line between a large-scale demonstration project and an early deployment. In fact, these different kinds of projects require different skills, funding mechanisms, and partnerships. Aligning all these moving pieces is a major challenge.

CHALLENGES IN THE INNOVATION PROCESS

Gaining technical and operational confidence in a new technology is important, but often a challenge. In marked contrast to many consumer products, taking an energy innovation from lab- or pilot-scale to large-scale is rarely a simple, additive process. Instead, it often requires the integration of numerous and diverse components and subsystems, all of which may interact at a large scale in ways that cannot be anticipated in the laboratory or even in a pilot plant. Not infrequently, unexpected problems emerge that require further technical changes or process adjustments. A complex, tightly coupled system such as a coal plant with gasification and carbon capture, for example, or a smart grid, may also be vulnerable to breakdown if a single component or subsystem fails. In these cases, building and operating a large-scale demonstration plant allows for the learning-by-doing that is needed to successfully resolve technical issues and build confidence in the performance and operation of the technology or system at scale.

Economic confidence is likewise critical to attract the early investment needed to support new energy technology commercialization and mass deployment, particularly for projects that require large, upfront capital expenditures. First and foremost is the likelihood, over time, of new energy technologies becoming cost-competitive with existing technologies, both high and low-carbon emitters. Other external factors such as regulation, policy, political factors, and a lack of prior experience can create uncertainties in construction timelines and permitting that add to investor perceptions of risk. Regulatory barriers are particularly challenging, as existing regulatory frameworks are generally designed for incumbent technologies. Additional economic risk can arise from uncertainties about technology performance at scale: project may work perfectly at first but then prove vulnerable to operational failures that are difficult or time-consuming to resolve. Often these risks alone, combined with the potential for delayed return on investment, are enough to keep private sector financing out of demonstration and early deployment altogether.[4] Many innovative technologies also encounter major head winds when entering the market and have trouble displacing incumbent technologies, even if the incumbent technologies are inferior. Risk aversion among investors and customers, lack of familiarity, lack of clear near-term market signals, and lack of a track record of commercial success are typical and often potent barriers. Greater federal support to address various market failures can help ensure that project developers are better able to de-risk their technologies and successfully demonstrate economic viability of technologies, which may then mitigate some concerns raised by potential investors or private sector partners.

Large-scale demonstration projects present inherent technical and management challenges that government agencies do not always have the expertise to manage. And political considerations often complicate these challenges, making it difficult to adopt an incremental approach that avoids picking technology “winners.” One

overarching problem is that federal support for large-scale demonstrations has historically been inconsistent and sporadic, with extended periods of minimal funding. To the extent that resources have been available, program priorities have shifted frequently, often in response to political pressures, as described in Box 1. As projects scale, they become more prominent to the public, which makes failures more notable, and makes federal employees more risk averse, both in the selection and termination of projects.

Box 1. A Case Study in Political and Management Challenges

Eric Redman's case study of DOE efforts to demonstrate carbon-capture technologies for coal-fired power plants (titled *A Review of Federal Efforts to Demonstrate Carbon Capture and Storage with Commercial-Scale Coal-Based Power Plants (2003–2016)*, highlights the political and bureaucratic challenges of effectively managing large-scale demonstration projects. The Clean Coal Power Initiative (CCPI) and the FutureGen project were high-profile DOE demonstration programs from a decade ago. All the projects were designed to demonstrate carbon capture and sequestration (CCS) at large coal-based power plants. Only one of the projects funded under the two programs could be considered successful. Others suffered from cost and scheduling problems that are typical of first-of-a-kind demonstrations—and DOE policies and management practices proved inadequate to overcome those challenges. More flexible financial incentives and more time could have significantly improved the probability of success. Instead, support from successive administrations and from Congress was inconsistent, and policy objectives had a tendency to shift, as illustrated with the FutureGen project described immediately below. Finally, policy incentives were not based on clear public policy. Instead, they were cobbled together to support multiple challenges including carbon emissions, low employment during the Great Recession of 2008, and a struggling coal industry.

DOE's signature project, FutureGen, was proposed in 2003 to demonstrate an integrated gasification combined cycle power plant with carbon capture and sequestration and hydrogen production. The process of selecting a demonstration site became politically contentious, especially between Texas and Illinois, as potential host states saw the project as a major public works opportunity. Rumors were that Texas was to be selected, but when the final decision was announced, and it was Illinois, suspicions of political interference arose when the Bush administration pulled its funding. While the Bush administration maintains that it was responding to escalating cost estimates, onlookers were not convinced. FutureGen was later revived by the Obama administration with a simpler design. Nonetheless, the project suffered numerous delays and problems, and was eventually terminated in 2015, after an expenditure of over $200 million in DOE funding.[5]

A further problem is that many large publicly supported projects present inherent technical and management challenges that government energy offices do not always have the expertise to manage. A notable exception is the DOE's Loan Programs Office (LPO), which helped lay the foundation for recent rapid growth in U.S. solar energy capacity by financing the first five utility-scale photovoltaic (PV) projects larger than 100 megawatts.

Part of this success was due to LPO's ability to quickly amass considerable technical and financial expertise to conduct rigorous due diligence of proposed projects. Once private investors had initial experience with LPO-backed solar projects, they were more comfortable funding these projects independently, without the need for federal loans or loan guarantees. Without this expertise, it is difficult for the government to deal with project developers that have the tendency to underestimate costs and overpromise performance. Once underway, projects can be difficult to terminate, even when they are unlikely to succeed.

In light of these challenges, the government approach for managing and financing demonstration projects must be systematic, patient, risk-tolerant, and risk-sensitive, and structured in a manner that brings in private sector participation.

Policymakers in Congress and the executive branch increasingly acknowledge the need for continued federal support of all stages in the innovation life cycle, particularly to better accelerate the pace of the energy transition and position American companies to successfully compete in the emerging international clean energy marketplace. Consequently, there is a renewed focus on this topic in the current Congress.[6] Over the years, the federal government has implemented programs to pilot and demonstrate new technologies. Unfortunately, from synfuels and biofuels to carbon-capture technologies, the government has not yet successfully developed a consistent and successful model. As a Breakthrough Energy report from 2019 states, "the track record for DOE-funded demonstration projects is mixed," especially with respect to commercial-scale demonstration projects.[7] The AEIC's Scaling Innovation Advisory Group case studies from summer 2020 provide further analysis in support of this conclusion.[8] The Energy Act of 2020, which passed in December 2020 as part of the 2021 Consolidated Appropriations Act, authorized significant funding for DOE with a priority on demonstration and early deployment efforts in several areas, including energy efficiency, advanced nuclear technology, renewable energy, energy storage, carbon capture, carbon removal, and grid modernization. To implement these programs, President Biden recently proposed an Office of Clean Energy Demonstrations as part of the administration's fiscal year 2022 budget request (discussed below).[9] How DOE intends to implement this office remains a key question.

ELEMENTS OF A NEW APPROACH

Many proposals have been put forward to better address the challenges identified above and strengthen federal support for demonstrating and deploying new energy technologies at scale more broadly. Several of these proposals target financing mechanisms and project management capabilities—two key hurdles at this stage of the innovation life cycle. Some proposals also attempt to address well-known shortcomings in the current federal approach with respect to program consistency, budget stability, and political independence.

In 2008, for example, Senators Jeff Bingaman (D-NM) and Lisa Murkowski (R-AK) introduced legislation to create a Clean Energy Deployment Administration (CEDA) to provide a broad array of financing mechanisms to advance innovative early clean energy technology deployments.[10] In 2011, John Deutch, in a report for the Brookings Institution's Hamilton Project, proposed a quasi-public new entity, the Energy Technology Corporation (ETC), that would finance and develop demonstration projects in collaboration with industry.[11] Many groups have advocated for the creation of a national green bank or climate bank to advance the

mass deployment of clean energy technologies and climate-resilient infrastructure. And ITIF has proposed creating an Office of Major Demonstrations within DOE to manage demonstration projects in collaboration with industry.[12] With respect to addressing the challenges in the energy space, the proposals take different approaches to navigating these issues.

Most recently, attention has focused on creating programs and institutions with varying degrees of independence from political pressures. There is precedent for this. Congress has created numerous entities with new flexibilities and governance, accountability, and transparency requirements. These include traditional executive departments with unique capabilities, like special hiring authorities, quasi-governmental independent nonprofits, and wholly owned government corporations.[13] The most recently created entity of this type is the International Development Finance Corporation (DFC), which finances projects in developing countries (Box 2). Senator Chris Coons (D-DE) has called for a similar entity, an Industrial Finance Corporation of the United States (IFCUS), a wholly owned government corporation focused on financing high-tech manufacturing.[14] These quasi-governmental entities can have legal characteristics of both the government and the private sector. A 2011 Congressional Research Service report, *The Quasi Government: Hybrid Organizations with Both Government and Private Sector Legal Characteristics*, describes the factors that have motivated recent interest in such entities, including "the desire to avoid creating another federal bureaucracy," tightening "controls on the federal budget that encourage agencies to develop new sources of revenues," and stakeholder interest in exempting agencies and programs "from central management laws, especially statutory ceilings on personnel and compensation."[15]

Addressing these factors by exempting new institutions from specific federal requirements or by separating the entities from direct public oversight provides varying levels of independence. Yet in most cases, these institutions are never truly free from congressional or executive branch influence. Likewise, political appointees of a president also can influence budget requests, program development, and agency policy. Additionally, oversight can be obtained through the creation of a board where members are selected by a secretary, the Senate, or the president. This and other protections create trade-offs around funding certainty, political viability, and accountability.

Box 2. International Development Finance Corporation (DFC)

While not focused on energy technologies, the U.S. International Development Finance Corporation (DFC) offers a useful model for financing innovation with private sector participation. The DFC is a relatively new, wholly owned government corporation under the guidance of the State Department. It finances and facilitates financing for private development projects in lower- and middle-income countries. The DFC was authorized in the bipartisan Better Utilization of Investment Leading to Development of 2018 (or BUILD Act), which merged the Overseas Private Investment Corporation (OPIC)[16] and the Development Credit Authority (DCA). Operations began in December 2019.[17]

The DFC has a lending authority of $60 billion, under a one-time authorization for seven years, to provide loans, loan guarantees, insurance, equity investments, and other special mechanisms.

These products are backed by the full faith and credit of the U.S. government and can be used for development projects undertaken by U.S. businesses in lower-income countries. In April 2021, the DFC announced it would target climate mitigation, adaptation, and other solutions, in addition to other State Department priorities.[18] The DFC's regular operations are largely self-financed through fees and interest collected on DFC loans.

The DFC's unique authorities are balanced with additional oversight requirements, and its leadership structure is notable for its mix of public and private sector representatives. The Office of the Executive includes the CEO, COO, Deputy Chief of Staff, in addition to the Senior Advisor to the CEO. There are about a dozen other executive staff members. The board of directors includes the DFC CEO, the Secretary of State, the Administrator of USAID, the Secretary of Commerce, the Deputy Secretary of the Treasury, and board members from the private sector. All board positions are presidentially appointed and subject to Senate confirmation. For increased accountability, Congress required the DFC board to establish an independent accountability mechanism and annually report to Congress on the corporation's statutory mandates. While exempted from the Federal Advisory Committee Act, there is also a Development Advisory Council, which includes leaders from the international community as well as the private sector.

Strong connections to the private sector necessitate clear conflict-of-interest rules. The DFC adheres to regulations and guidance of the Office of Government Ethics and has created internal policies to avoid and address potential conflicts of interest. Additionally, the DFC management team and board of directors submit public financial disclosure reports like other government officials.[19]

The remainder of this paper provides summary descriptions of various proposals to strengthen government support for energy innovation before turning to a more detailed discussion of our recommendations. Some of these proposals involve existing governmental and quasi-governmental organizations; others would require the creation of new entities. We divide this discussion into two sections: one focused on proposals that address demonstration gaps, the second focused on proposals that address deployment, with a focus on governance, funding, political viability, and independence from the federal government.

MODELS FOR SUPPORTING CLEAN ENERGY TECHNOLOGY DEMONSTRATIONS

ARPA-E SCALEUP

The Advanced Research Projects Agency for Energy (ARPA-E) is an independent agency within DOE that takes an innovative approach to funding transformative, early-stage energy research. ARPA-E offers a streamlined, competitive grant process to innovative energy technology developers seeking to advance their concepts.

ARPA-E's special hiring authority enables it to select program managers with expertise, enthusiasm, and novel approaches to supporting projects. These managers are only able to stay with ARPA-E for three years, meaning they move more quickly on projects and have a greater risk tolerance relative to other programs at DOE. This

has led to tremendous technical gains from ARPA-E and its grantees, with a reverberating impact on DOE culture. Additionally, while ARPA-E—like DOE as a whole—relies on annual appropriations, it has more budget flexibility than DOE's applied energy offices.

Beyond R&D, ARPA-E also has the capability to support pilot demonstration projects. Notably, the new SCALEUP program can help bridge the valley of death between research, development, and demonstration by supporting scale-up or prepilot projects and helping to advance technologies along the innovation life cycle. The SCALEUP program is focused on supporting high-risk, high-reward scaling efforts to help test the integration and operation of early-stage technologies. Awards range between $1 million and $10 million, with a 50% cost share to help drive down costs, demonstrate performance, and provide essential information to investors and other partners for the next steps in the commercialization process. ARPA-E's independence and special authorities allow its SCALEUP program to be flexible and adaptive to the needs of project developers. Thus far, the new program appears to be popular and oversubscribed, but results are not yet in. Furthermore, it is currently limited to previous ARPA-E grantees because the program itself is still under development.

DOE OFFICE OF CLEAN ENERGY DEMONSTRATIONS

A $ 400 million new Office of Clean Energy Demonstrations (OCED) within DOE was included in President Biden's fiscal year 2022 budget request. This office was established on December 21, 2021, and focuses on bringing innovative cross-cutting technologies to the market and coordinating activities across the agency. The OCED is similar to an idea put forward by the Energy Futures Initiative and expanded upon by ITIF for a new office within DOE to manage large-scale demonstrations of a variety of unproven technologies. Called the Office of Major Demonstrations (OMD), this new office within the Department of Energy would manage a portfolio of large-scale energy demonstration projects of unproven technologies across various areas that would otherwise be managed by DOE's applied offices. ITIF notes that while the staff in the applied energy offices are technical experts and highly capable of managing a technology-specific R&D portfolio, this does not necessarily translate into proficiency for the management of large-scale demonstration projects. The OMD would have flexible hiring authority, like ARPA-E, so that it could employ individuals with backgrounds in commercial project management and project finance, who would then coordinate with staff in the applied energy offices, as well as with stakeholders outside of government. These individuals would have both the authority and financial expertise to continue or terminate large-scale demonstrations depending on the project's success.

In addition to close collaboration with the DOE applied energy offices, OMD would complement the Loan Programs Office, which is focused on early deployment after a technology has been demonstrated. OMD's funding would come from the standard annual congressional appropriations process. Awardees would enter into tailored cost-sharing agreements that would take into consideration the unique features of each project to better support project developers.[20] OMD would require some reorganization within DOE as a whole, but because it does not require the establishment of a new agency and a large upfront investment, proponents of this idea believe it to be more politically feasible than other proposals with similar intent to demonstrate new technology through more independent authorities.[21] The Infrastructure Investment and Jobs Act (H.R.3684), which passed into law on November 21, 2021, creates and funds the OCED at $21.5 billion.[22]

Yet the OCED does not ensure a smooth handoff between large-scale demonstration and early deployment. Nor does it have flexible financing authorities to overcome the financial hurdles at the end of the innovation process. Additionally, as a new office within DOE, it is beholden to typical political influence, long budget cycles, and potentially stifling oversight from OMB.

PROPOSED ENERGY TECHNOLOGY CORPORATION (ETC)

Originally proposed by John Deutch in the Brookings Institution's Hamilton Project in 2011, the Energy Technology Corporation would be a quasi-public independent corporation focused on large-scale demonstration of new and unproven energy technologies. It would not be an agency or instrument of the federal government and it would not be managed by the government. The ETC concept is modeled on the government-funded Synthetic Fuels Corporation from 1980.[23] Its objective would be to conduct large-scale demonstrations and provide technical and economic performance information from those demonstrations to the private sector. A similar model was described by AEIC co-chair Norman Augustine in 2020 at a National Academy of Sciences webinar on *Enhancing Federal Clean Energy Innovation*. In that discussion, Augustine proposed "the creation of a nonprofit bridge organization to facilitate the private sector in conducting large-scale demonstrations," akin to In-Q-Tel.[24] This organization would be mostly funded by the government and would focus on large-scale demonstrations. Most importantly, it would be managed independently of the government and operate under commercial laws and regulations.[25]

To provide flexible financing, the ETC would deploy a variety of finance mechanisms including guaranteed purchases, loan guarantees, production tax credits, and cost-shared reimbursements. The ETC would receive a one-time appropriation on the order of $60 billion, with each project estimated to receive funding on the order of $3 billion. Funds recovered from loans would be made available for reinvestment. Depending on performance, further funding might be extended.[26]

As a public corporation, the ETC would not be constrained by the general management practices of the federal government, including federal hiring practices and acquisition regulations. This would allow the ETC to operate under standard commercial practices and more easily obtain the technical and financial expertise to conduct strong project management. ETC would also have full responsibility to select and manage its own projects. Additionally, since the ETC's priorities and direct decisions would not be influenced by Congress or the executive branch, it would offer at least partial insulation from political interference.

The trade-off for this independence–substantial upfront funding and extensive financing authorities– is that the ETC would not have access to the full faith and credit of the U.S. government. The ETC would be governed by an independent board of eight directors, nominated by the president and confirmed by the Senate. Currently, an independent organization such as the ETC has not been discussed seriously by Congress, and appears less politically feasible. Finally, while the ETC in concept would be laser-focused on closing financing gaps for large-scale demonstrations, it would not have access to all the funding mechanisms that might be needed to deploy new technology.

MODELS FOR SUPPORTING CLEAN ENERGY TECHNOLOGY DEPLOYMENT

LOAN PROGRAMS OFFICE

DOE's Loan Programs Office (LPO) has played an important role in supporting the deployment of energy technologies at commercial scale. LPO's Tribal Energy Loan Guarantee Program, Advanced Technology Vehicles Manufacturing Loan Program, and the Title XVII Innovative Energy Loan Guarantee Program were originally authorized in the Energy Policy Act of 2005. These programs provide financial support to projects that have difficulty obtaining private investment because of concerns around technological risk, cost of capital, and market uncertainties. These financing mechanisms were provided through special authorities from Congress and are not typical for a federal agency.

As noted earlier in this paper and detailed in a 2020 BPC case study, *The American Recovery & Reinvestment Act and the Rise of Utility-Scale Solar Photovoltaics: How U.S. Public Policy During the Great Recession Launched a Decade-Long Solar Boom*, by Varun Sivaram, LPO helped finance and demonstrate the first five utility-scale photovoltaic (PV) projects larger than 100 megawatts—an important step in the rapid expansion of this critical clean energy resource in 2011. In the PV case, a new provision of American Recovery and Reinvestment Act of 2009 allowed the Title XVII loan guarantee authority to be used for large-scale demonstrations of a "commercially proven technology"; LPO paid for the subsidy costs of these loan guarantees, which otherwise constituted a barrier to potential applicants. Part of its success was due to LPO's ability to quickly amass considerable technical and financial expertise to conduct rigorous due diligence of proposed projects. Once private investors had initial experience with LPO-backed solar projects, they were more comfortable funding these projects independently without the need for federal loans or loan guarantees. It was also important that several state (Renewable Portfolio Standards) and federal policies (tax credits) were aligned to help support follow-on deployment of this technology.[27]

However, structural barriers on the front and back end of the loan process, together with a lack of support from the Trump administration, have discouraged industry from using the Title XVII program in recent years. Although interest rates for Title XVII are based on Treasury rates, applicants face other costs that discourage participation. These other costs include application fees, third-party advisor fees, credit subsidy costs, and project equity. When a project closes on financing, applicants are responsible for paying the credit subsidy cost (the net present value of the estimated long-term cost to the government of a loan), which can be the largest expense associated with the application process. For other government lending programs, Congress has appropriated funds to lessen or eliminate this cost burden for potential borrowers.[28]

At present, LPO has roughly $40 billion in remaining loan authority, which could be a powerful tool in advancing large-scale demonstration projects. A study from the Energy Futures Initiative found that this remaining loan authority could leverage as much as $100 billion in further investments.[29] There have been many attempts to refine LPO by Congress. Bills have been introduced to reduce application and third-party fees, provide more funding for subsidy costs, and change the definition of eligible technologies, among many other amendments. The Energy Act of 2020 was successful in changing some eligibility criteria, and allows the payment of fees at the point of loan closure. These incremental changes will strengthen LPO and help the office support additional technologies.

PROPOSED CLEAN ENERGY DEPLOYMENT ADMINISTRATION (CEDA)

The idea of establishing a stable, long-term, well-funded, and business-driven entity within the federal government to leverage greater private sector investment in clean energy technologies has been circulating for over a decade. In fact, several bipartisan bills were introduced during the 111th Congress in 2009, including the 21st Century Energy Technology Deployment Act (S.949), the American Clean Energy Leadership Act (S.1462), and a similar House bill that would have created a new independent agency called the "Clean Energy Deployment Administration," or CEDA. More recently, in the 116th Congress, Rep. Diana DeGette (D-CO) introduced the Clean Energy Innovation and Deployment Act of 2020, which also included the creation of CEDA.

A detailed discussion and description of CEDA can be found in BPC's case study, *The U.S. Clean Energy Deployment Administration: A Business-Driven Approach to Leveraging Private Sector Investment in Clean Energy Innovation and Commercialization*, by Dan Reicher.[30] As described in the case study, CEDA would have special authorities to access a diverse set of financing tools, and could offer both direct support for large-scale projects—using instruments such as loans, loan guarantees, letters of credit, and insurance products—and indirect support, through securitization and other means of credit enhancement. Related bills have also proposed to transfer the authorities of LPO to CEDA, which would be backed by the full faith and credit of the U.S. government. Congress would make an initial appropriation on the order of $10 billion, but CEDA would be self-sustaining thereafter, based on its ability to collect—and reinvest—revenues through fees and insurance. This feature is unlike that of the current LPO or other offices within DOE.

CEDA would have a "dotted line" relationship with DOE, but like the Federal Energy Regulatory Commission (FERC), it would operate independently, under the direction of an administrator and a nine-member board of directors selected by the president, with the Secretary of Energy serving as an ex-officio member. The CEDA administrator would chair the board of directors. CEDA's investment decisions would be guided by a new Energy Technology Advisory Council that would include five members selected by the Secretary of Energy and three members selected by the CEDA board of directors. Among other duties, the Advisory Council would develop a methodology for assessing technologies and would help CEDA identify promising new innovations. Additionally, CEDA would have special hiring authorities. These authorities would not be the same as if CEDA were a private sector corporation, but they would provide considerably more flexibility than is afforded to a typical DOE program office.

In 2009, the CEDA concept was included in the Waxman-Markey bill, which was adopted by the full House and successfully voted out of the Senate Energy and Natural Resources Committee in the same year. Despite bipartisan support, however, the bill was never enacted into law. As noted above, legislation to establish CEDA was introduced again in 2020 by Rep. DeGette, a senior member of the House Committee on Energy and Commerce, as part of a broader clean energy bill.

CEDA would use a portfolio investment approach to mitigate risk and diversify investments across an array of technologies. This portfolio approach, a range of financing tools, and the ability to collect fees from its investments would provide CEDA with broad flexibility to finance "breakthrough" technologies that have "generally not been considered a commercially ready technology as a result of high perceived technology risk or other similar factors."[31] Notably, the self-financing feature of CEDA has prompted concerns from some

stakeholders that a new agency might lack incentives to pursue riskier projects, leaving a key piece of the innovation puzzle unresolved. Additionally, concerns remain about the potential for political influence since the Secretary of Energy would have a role in selecting CEDA board members.

PROPOSED FEDERAL GREEN BANK, CLIMATE BANK, AND ACCELERATOR

Green banks, or climate banks, are institutions currently employed at the subnational level to help provide low-cost capital for clean energy and climate mitigation projects. Green banks are meant to complement existing financial institutions by leveraging private capital that may not have been otherwise directed to clean energy or climate mitigation projects. Subnational green banks also provide a public service by providing knowledge and financing of clean energy projects in local markets that might otherwise be perceived as technically and financially risky by traditional private lenders. Today, 20 green banks are established in the United States, including by 14 states (California, Colorado, Connecticut, Delaware, Florida, Hawaii, Maryland, Michigan, Nevada, New Jersey, New York, North Carolina, Ohio, and Rhode Island), the District of Columbia, and five cities and counties. According to the Coalition for Green Capital, between 2011 and 2020, U.S. green banks used $1.9 billion to leverage private co-investments of $5.1 billion to invest a total of $7 billion.[32] Green banks also exist at the national level in the countries of Australia, Japan, Malaysia, Switzerland, and the United Kingdom.

Proposals[33] to establish a national green bank in the United States were included in several bills introduced in Congress between 2014 and 2017; a successor bill, the National Climate Bank Act, was introduced in 2019. The National Green Bank and National Climate bank proposals are quite similar, with minor differences regarding financing capabilities, leadership, and initial funding, among other details. In the 117th Congress, Senator Dick Durbin (D-IL) introduced America's Clean Future Fund Act (S. 685) to establish a Climate Change Finance Corporation as an independent agency of the government that would act like a national green bank. Another version of the green bank concept, called the Clean Energy and Sustainability Accelerator (the Accelerator), was included in the Climate Leadership and Environmental Action for our Nation's Future Act or the CLEAN Future Act of 2021 (H.R. 1512) recently introduced by the House Committee on Energy and Commerce. The legislation calls for an initial capitalization of $100 billion for the Accelerator to mobilize public and private investment at scale to deploy climate-friendly energy technologies. The framework released by Senate Democrats for the FY2022 reconciliation package also calls for the creation of the Accelerator to fund the mass deployment of solar and climate-friendly technologies in low-income communities.[34]

The Accelerator in the House bill would be a nonprofit corporation (as opposed to an agency or instrument of the federal government), and it would have a broad portfolio of tools to help scale and rapidly deploy mature technologies and maximize emissions reductions in the United States. The Accelerator would be able to provide senior, mezzanine, and subordinated debt; credit enhancements, including loan loss reserves and loan guarantees; aggregation and warehousing; equity capital; and any other financial product approved by its board of directors. These government-funded debt products would leverage significant private capital, but because the corporation would be outside the federal government, they would not be backed by the full faith and credit of the U.S. government—a potentially significant disadvantage in terms of access to low-cost capital and other advantages of federal investment.

The Accelerator would focus on aiding the mass deployment of low- and zero-emission technologies; help ensure that frontline, climate-impacted communities would benefit from the clean energy transition; support the transition of workers impacted by a transition to a low-carbon economy; and support the creation of green banks by states, tribal governments, and communities. Regarding the last responsibility, the Accelerator would have a "start-up division," which would be responsible for providing technical assistance and start-up funding for states, tribes, and communities to establish their own green banks.

The proposed governance structure for the Accelerator includes a board of directors with seven members, three of whom would be appointed by the president and approved by the Senate, as well as four members elected by these appointees. DOE's inspector general and the federal government's comptroller general would have oversight and audit responsibilities, respectively. The Accelerator's CEO would be appointed by the board and would be responsible for hiring employees and establishing two divisions of the Accelerator, as well as day-to-day operations.

The green (or climate) bank concept differs from CEDA in that the financing entity takes the form of a private, nonprofit corporation, outside any existing government agency such as DOE. Like CEDA, a federal bank would receive an initial appropriation from Congress and would be designed to be self-sustaining thereafter, using returns on previous investments to finance new investments. As with CEDA, this approach has the advantage that it forces the financing entity to be responsive to real-world market conditions. On the other hand (and for the same reason), this self-financing feature could create disincentives to support less-proven, high-risk technologies and projects.

RECOMMENDATIONS

To strengthen federal support for the large-scale demonstration and early deployment of new energy technologies, we offer two recommendations. The first involves building on the capabilities of the existing SCALEUP program at ARPA-E and can be readily implemented in the near term. The SCALEUP program will help address the dearth of support for prepilot demonstration efforts (before large-scale demonstration). With some minor changes and expanded funding, it can be strengthened to overcome a key gap in the energy innovation life cycle.

Our second recommendation is to establish a new wholly owned government corporation with a strong relationship to DOE that is specifically focused on large-scale demonstration and early deployment. The entity we propose, called the Energy Demonstration and Finance Corporation (EDFC) for purposes of this discussion, would combine a range of financing tools and independent grant-making authority with the management capabilities of the private sector to take on large, complex, unproven technology demonstration projects and the scale-up of commercially proven energy technologies. By merging several features of the various models summarized in the previous section, this new organization can be a powerful force for accelerating the demonstration and deployment of technologies needed to achieve ambitious decarbonization goals within the next several decades. Taken together, these recommendations can help bridge existing gaps in federal support for commercializing clean energy technologies. Additional details for both recommendations are discussed below.

Recommendation No. 1: Expand funding for the ARPA-E SCALEUP program[35] and implement the program as a rolling funding opportunity. Additionally, the SCALEUP program should be open to applicants regardless of whether they have received ARPA-E funding previously.

ARPA-E's SCALEUP program targets technologies that require scale-up or prepilot support to make further progress toward commercialization. In its first iteration, it provided successful applicants with the opportunity to further illustrate the market viability of their technology or project. To date, eligibility has been limited to ARPA-E grantees that have successfully addressed proof-of-concept R&D challenges.

Despite being fairly new, the SCALEUP program is popular with technology developers; with some minor adjustments, we believe it could have even greater impact. To improve the program and expand access to SCALEUP funding for technology developers, we recommend:

- Increasing overall ARPA-E funding to $1 billion per year, including increased funding for the SCALEUP program specifically
- Opening the SCALEUP program to applicants that have not previously received ARPA-E funding
- Directing ARPA-E to grow the SCALEUP program to at least one-third and never more than 50% of the Agency's overall budget. ARPA-E already has the authority to direct up to 50% of its funding to demonstration projects, so no legislative change is needed. The SCALEUP program should be seen as tightly coupled to an overall increase in ARPA-E's budget, and should be carefully designed so that it does not cannibalize the Agency's highly effective ongoing programs.

Recommendation No. 2: Establish a new wholly owned government corporation equipped to support large-scale demonstration and early deployment of the new technologies needed for decarbonization.

Our concept for a new Energy Demonstration and Finance Corporation (EDFC) draws on the design principles embodied in other proposed energy demonstration and deployment finance institutions. Specifically, it combines the project development capabilities of a new DOE Office of Major Demonstrations, the broad range of mass deployment financing tools of a Clean Energy Deployment Administration (CEDA) and green banks, and the governance structure of both the Energy Technology Corporation (ETC) and the International Development Finance Corporation (DFC). We envision two core areas of EDFC responsibility: 1) cooperative agreements, grants, and technical support for demonstration projects; and 2) financing tools for large-scale, higher-risk early project deployments.

We emphasize the critically important role of the existing DOE Loan Program Office (LPO) and its value in the federal innovation system. LPO should be supported in the near term, and as described in recent

BPC case study recommendations,[36] can be further improved to drive impact. LPO should continue to evolve as the clean energy industry matures, and additional financing mechanisms should be evaluated as potential for tools for LPO in the future, such as insurance products, securitization for resale, and other means of secondary market credit enhancement. In the long run, LPO's authorities and capabilities should be incorporated into the EDFC, delivering a more coordinated and effective federal demonstration framework.

Likewise, we see considerable value in the creation of the new Office of Clean Energy Demonstrations (OCED). Such an entity would go a long way toward creating a systematic and institutionalized federal approach to large-scale energy demonstration projects. This will help ensure that DOE's immense expertise is leveraged while also ensuring appropriate project management and centralization of activities.

We further suggest placing both the LPO and OCED in a new EDFC as a way to maximize overall effectiveness, just as the merger of the Overseas Private Investment Corporation (OPIC)[37] and the Development Credit Authority (DCA) is expected to result in a stronger DFC. The EDFC should incorporate external private sector technical, financial, regulatory, and project development and management capabilities to better support the private sector in developing projects for which there is little to no experience.

Combining large-scale demonstration and early deployment support in one organization allows for the sharing of expertise, increased cooperation, as well as a smoother handoff from one stage of innovation to the next. Yet there is concern that these activities and outlooks are inherently different in their risk tolerance and underwriting; therefore, great care will need to be taken to ensure one part does not cannibalize the other. Our recommendations for mitigating this concern through key design parameters are summarized below.

Type of institution: We recommend the EDFC be established as a wholly owned government corporation modeled after the existing DFC, which has a politically tested organizational design and a "dotted-line" relationship to USAID. Similar to the DFC, the EDFC would have a dotted-line relationship to DOE.

Mission focus: The EDFC would focus on large-scale demonstration and early deployment of advanced energy technologies. Specifically, this would include managing and financing first-of-a-kind and early nth-of-a-kind technology deployments. The EDFC would take a hands-on managerial role in project development and financing, leveraging strong private-sector participation in all its activities, including a strong understanding of the regulatory process.

Organizational structure: The EDFC would be governed by an independent board of directors nominated by the president and with the advice and consent of the Senate, as proposed with the ETC and implemented by the DFC. The board of directors would include individuals from both the public and private sectors. The EDFC CEO would have executive authority over the management of the enterprise and maintain his or her position subject to the confidence of the board. All members of the board would be appointed for rotating three-year terms, with the potential to be reappointed for one additional term.

The EDFC's management structure would be modeled on that of the DFC.[38] It would include: 1) a chief executive officer appointed by the president and confirmed by the Senate; 2) a chief investment officer appointed by the CEO and subject to approval by the board of directors; and 3) a chief project officer appointed by the CEO and subject to approval by the board of directors. The CEO would have authority to appoint and remove other officers as needed. To avoid and resolve any conflicts of interest, the EDFC would adhere to the regulations and guidance of the Office of Government Ethics, just as the DFC does.

The EDFC would also tap into DOE's applied energy programs and technical expertise of the DOE national laboratories. Appropriate conflict of interest rules and intellectual property policies as well as selection criteria would be made transparent if national labs or their management and operating (M&O) contractors receive funds as a part of specific projects.

Hiring authority and compensation: Special hiring authority should be provided to attract individuals with energy sector and regulatory experience and financial and technical skills, including individuals outside the professional civil service system who could be hired on a temporary and time-limited basis at commercially competitive salary levels. Time-limited appointments could help ensure that employees execute on projects during their tenure, and that the agency is rotating new ideas into the organization. This has been demonstrated to be a critical part of ARPA-E's success as a cutting-edge technology agency.[39]

Further, the EDFC should use success-based incentive pay as well as compensation tied to specific goals of the EDFC. In some cases, this may be timely project completion, and in other cases, it might be focused on achieving milestones related to new, higher-risk project demonstration.

Type of financial support provided: The financial tools available to the EDFC would include contract, grant, and cooperative agreement authorities as well as direct loans, loan guarantees, letters of credit to provide security for a project's feedstock and/or offtake agreement in the event of default, equity investments, insurance products, securitization for resale, and other means of secondary market credit enhancement.[40] Further, the EDFC could work with private investors and other federal, state, and local government agencies to develop procurement supports and feedstock/offtake agreements, with the ability to blend tools to meet specific project needs. As technologies move to early deployment, the support provided by the EDFC would shift from grants and cooperative agreements toward an increased reliance on loans, loan guarantees, and equity investments designed to support and attract substantial private financing. Intellectual property developed through grants and cooperative agreements would follow typical federal public law.

Government funding required: We propose that the EDFC be authorized at a total of $60 billion over 10 years, or $6 billion per year, roughly one quarter of the $25 billion per year the AEIC has recommended for overall federal energy innovation spending.[41] This initial congressional authorization and appropriations should allow for at least 10 years of operation before reauthorization would be needed. All funds would be appropriated at one time, so the EDFC would not have to go back to Congress for annual appropriations.

In this authorization, we recommend $50 billion of contract/grant/cooperative agreement authority to be used on demonstration projects to be executed over the 10-year authorization. The remaining $10 billion should be an authorization of appropriations to pay the subsidy costs of loan, loan guarantees, and other project financing tools such as equity and insurance to be used for early deployment. The EDFC, like CEDA, would be "authorized to hold fees collected for financial services rendered and could reuse those fees for further investments," creating a revolving fund.[42] In 2009, the American Recovery and Reinvestment Act authorized and appropriated $6 billion to pay the subsidy costs of the Section 1705 guaranteed loans; costs which were a known barrier to the success of the program when required to be paid by the borrower.[43] The EDFC's $10 billion will cover the same costs and other financing tools. As discussed above, we recommend moving the remaining loan guarantee authority and appropriated credit subsidy and team from DOE's LPO into this new agency to centralize loan-making authority.[44] The existing authority would be in addition to the new authorities and appropriations provided to the EDFC. The applied programs would not lose any funding. Funding appropriated for the EDFC would be in addition to traditional appropriations. The EDFC would be backed by the full faith and credit of the government.

Projects/technologies covered: The EDFC would fund and manage a portfolio of large-scale unproven clean energy demonstration projects and the financing of early deployments with a focus on zero-carbon electricity generation, clean transportation and fuels, industrial decarbonization, and negative emission technologies, along with generation and infrastructure technologies needed to enable a net-zero economy by midcentury. The selection of clean energy projects and technologies would be based on the project's ability to reduce carbon emissions while also meeting the other priorities of the energy transition, including job security and quality, community development, and the creation of domestic supply chains for products and skilled labor. Financing projects could also include manufacturing facilities, if LPO's Advanced Technology Vehicles Manufacturing (ATVM) program is transferred to the EDFC. Additionally, projects with end-user demand built in would be prioritized, and project management activities would ensure active private sector participation.

Projects would be selected based on transparent merit review criteria, and strict conflict of interest rules would be enforced to ensure project integrity and avoid fraud and abuse. Additionally, the EDFC would create an appropriate and regular evaluation system to measure project success. It would incorporate those metrics into project management and employee compensation considerations.

CONCLUSION

The AEIC has long been an advocate for a stronger, more ambitious, and more strategic national energy innovation agenda. In our 2010 report, we said:

> America's energy innovation ecosystem lacks a mechanism to build, test, and refine large-scale technologies. Many technologies that need demonstration assistance are too big, expensive, or risky to go forward by traditional means. A single nuclear plant, or a coal plant that captures and stores carbon, can cost several billion dollars. Large-scale projects carrying significant technology risk, when combined with public resources, create high visibility and intense scrutiny—which in turn add the chance of political interference. Simply put, the United States does not have the capacity to rapidly demonstrate large-scale, capital-intensive energy technologies. The nation needs to fix these institutional challenges, or it will not develop the large-scale energy options that our system so urgently needs.[45]

The stakes, moreover, are only growing higher. For the United States to meet aggressive midcentury decarbonization commitments, some combination of innovative technologies must be commercially deployed at massive scale within a generation. The recommendations made in this report, which are the result of extensive consultation with highly regarded and experienced experts, are not ones we make lightly. There is growing recognition in the federal government, across both the executive and legislative branches, of the need to demonstrate new energy technologies. Yet no proposal advanced to-date adequately supports the complex innovation process and the inherent public-private nature of demonstration and deployment. It is abundantly clear that success will be more likely if the tools, public capabilities, and financial resources to meet the climate challenge head-on are expanded. We believe these recommendations provide a strong foundation for moving forward with a successful new strategy. There is no time to lose.

ENDNOTES

1. The 2010 American Energy Innovation Council report, "A Business Plan for America's Energy Future," recommended the creation of a New Energy Challenge Program that would create a new independent corporation outside of the federal government to build large-scale pilot projects. This paper is the evolution of the original recommendation and responds to the political realities, funding requirements, and new government programs, such as ARPA-E's SCALEUP program. Available at: https://bipartisanpolicy.org/download/?file=/wp-content/uploads/2012/04/AEIC_The_Business_Plan_2010.pdf.
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AEIC WHO WE ARE

The American Energy Innovation Council, originally formed in 2010, is a group of 13 corporate leaders who share a common interest in increasing U.S. commitment to energy innovation.

AEIC MISSION STATEMENT

The mission of the American Energy Innovation Council is to foster strong economic growth, create jobs in new industries, and reestablish America's energy technology leadership through robust public and private investments in the development of world-changing energy technologies. The AEIC is a project of the Bipartisan Policy Center.

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