TECHNOLOGY-BASED ECONOMIC DEVELOPMENT: ASSESSMENT OF STATES' ROLES AND OPPORTUNITIES

KEY CONSIDERATIONS AND RECOMMENDATIONS FOR STATE INVOLVEMENT IN ENERGY TECHNOLOGY TRANSITION

Accelerating the transition and commercialization of energy technologies in every sector – renewables, efficiency, fossil, nuclear, grid and crosscutting – is important not only in meeting state and national energy and environmental goals, but also in creating new economic opportunities. For this reason, many states are engaged in energy technology transition, commercialization, and deployment policies and programs. State energy offices (SEOs), in particular, leverage state agency partners' resources; tap in-state private sector networks; and lend policy expertise and clout as the governors' energy advisors (formal and informal) to help inventors, entrepreneurs, and start-up businesses deliver energy technologies to the marketplace. Importantly, most SEOs see their role as identifying market needs, opening new markets, and attempting to link these markets with energy technology options offered by companies and researchers.

The connections and services that SEOs offer in energy technology commercialization and deployment are critical to the health and expansion of the states' and the nation's economies. SEOs work at the intersection of energy generation, energy demand, policy, regulation, and public and private investment. In many states, governors and legislators entrust SEOs to serve an energy-related economic development role by helping design policies, incentives, and programs that attract businesses, support private sector creation of in-state jobs, and promote energy cost savings. These SEO activities and efforts are distinctly targeted to help "identify market needs and open markets," often as a policy-oriented complement to, for example, both utility commissions that regulate some energy market participants and researchers attempting to push particular technologies. These SEO "market-opening" services include activities such as: working to streamline deployment costs and strategically target incentives; promote the expansion of clean energy programs in the regulated energy sector and unregulated markets (a growing opportunity area for new market entrants); expand access to capital for qualifying energy projects; and work with the private sector to implement market-based standards, targets, goals and plans.

In general, energy-related economic development succeeds when market needs are identified and technology solutions are sought (i.e., a focus on market needs first) in contrast to a technical solution searching for a problem it may solve. For SEOs, the innovation and commercialization continuum does not end at demonstration; rather, "opening markets" for new technologies requires the SEO to assess their value and feasibility and adjust policies, create programs, or remove barriers in support of their deployment. Accordingly, in some states, it is the involvement of the SEO or other state economic agency in the entire research, development, demonstration, *and deployment* (RDD&D) continuum that has helped labs and private technology developers gain visibility in the marketplace, become integrated into state and local "lead by example" energy programs and initiatives, advance innovative energy policies and goals, and make strategic partnerships to help expand their business.

In July 2015, the National Association of State Energy Officials (NASEO) in partnership with the U.S. Department of Energy (DOE) convened SEO directors and legislative, academic, and private-sector representatives for a roundtable discussion on technology-based economic development and state,

federal, university, and private energy technology commercialization programs.[1] The discussion was designed to help inform DOE's development and growth of the Office of Technology Transitions (OTT), a program established by Secretary of Energy Ernest Moniz in February 2015 to serve as a DOE-wide functional unit coordinating the commercial development of DOE's research outputs. The output from the meeting will also inform the DOE's administration of the Quadrennial Energy Review and the efforts of the DOE's Jobs Strategy Council. This white paper synthesizes key findings from the roundtable discussion and offers options and considerations for enhanced state-DOE coordination on technology-based economic development in the U.S. energy sector.

NASEO's key recommendations, explained in further detail in the following sections, include:

- Improving communications and increasing awareness among the array of stakeholders working in energy technology commercialization.
- Promoting bottom-up and state-based commercialization and investment models that are inclusive not only of technology innovation taking place within the national energy laboratories, but also outside of the labs, for example, by innovators and investors that partner with SEOs and state economic development organizations. Such investment models would ideally involve a funding or investment mechanism that combines federal, state, and private dollars, which could be coordinated by in-state teams representing a wide variety of actors working in energy technology commercialization.
- Supporting systematic and highly visible coordination on new and early-stage emerging technologies to optimize state, federal, and private investment and funding.

The launch of OTT's program offers a significant opportunity for the national labs and federal government to leverage SEOs' expertise and connections with energy technology innovators. Such coordination, NASEO believes, would holistically contribute to the creation of "innovation ecosystems" where promising entrepreneurs, businesses, and technologies have the opportunity to thrive.

EXISTING FRAMEWORKS FOR STATE-DOE COLLABORATION

Two bipartisan, congressionally-authorized programs—the Energy Technology Commercialization Services Program (ETCSP) and the State Technologies Advancement Collaborative (STAC)—offer an important foundation and potential launch point for states and DOE to renew and coordinate their efforts on energy technology transition.[2] The focus of ETCSP, authorized in 1990, is on strengthening assistance to small and start-up businesses and applying engineering principles and techniques to energy technology product design and manufacturing. No projects have taken place under the ETCSP framework; nevertheless, it serves as a ready mechanism to facilitate collaboration among states, DOE, and start-up businesses as OTT continues to design and begins to implement technology transition projects.

STAC launched in 2002 with the signing of an intergovernmental agreement enabling states, territories, and the Federal government to collaborate on energy research, development, demonstration, and deployment (RDD&D) as part of a five-year pilot program operated by NASEO and the Association of State Energy Research and Technology Transfer Institutions (ASERTTI). Using NASEO as its operating agent, STAC created an innovative funding and competitive solicitation process supporting innovative energy research projects in energy efficiency, fossil energy, and renewable energy as a means of

[1] The agenda and a summary of this meeting are attached as Appendices 1 and 2, respectively.
[2] The authorizing language for these programs is included as Appendix 3.

accelerating the development and market adoption of clean, sustainable and efficient energy technologies. Each of STAC's three annual competitive solicitations were managed by STAC's Executive Committee (comprising DOE representatives, NASEO and ASERTTI members, and private sector representatives) and focused on priority categories pre-selected by joint Federal-State planning teams.[3]

The experience of states and private industry in the STAC pilot underscore important themes about the positive impact of coordinated planning and decision-making in an otherwise disjointed and siloed technology commercialization ecosystem. DOE invested $19.1 million in federal funds for 35 STAC projects between 2003 and 2005 while leveraging an additional $13.2 million in required state and private industry cost-share funds, highlighting the enthusiasm of states, utilities, and private industry to co-invest. The selected projects covered a wide range of research, development, demonstration, and deployment (RDD&D) efforts, were multi-state in nature, and supported technologies where common federal and state priorities in energy efficiency, fossil energy, and renewable energy existed. They also helped catalyze new research and market transitions for technologies, companies, and services that closely aligned with these common priority areas, and for projects that may not have been able to progress without the combined federal, private, and state resources.

The 35 STAC-selected projects were fairly diverse in scope, geography, and placement along the RDD&D spectrum. Many of the STAC award recipients were SEOs, research institutions, national labs, and/or private-sector partners working on advanced energy technologies. While STAC is notable for its high leverage of private and state capital, the funding model it employed was grant-based, not investment-based. This means that STAC projects received a one-time infusion of funds and had a finite amount of time (typically between one and three years) to tap into expertise from STAC leadership and membership, and were not expected to return this capital or provide equity in exchange. In fact, NASEO and ASERTTI note this in the project's final report: "while STAC was successful, it came at a time of limited private investment and was broad in nature. Going forward, recommendations for addressing these issues and improving STAC include…encourage[ing] investment from state economic development agencies and private investors." (p 23)

The poor outlook for clean energy investment in the marketplace contributed to the grant fund model of STAC; nevertheless, many of these grants were catalytic for new technologies to reach market. For instance, Advanced Energy's "Hybrid Electric School Buses" buyers' consortium project aggregated buying power education departments and schools districts in the Carolinas, California, Texas, Pennsylvania, Nevada, and several other states to move the market for school buses, which at the time was largely dominated by diesel fuel. The project led to the demonstration, unveiling, and sale of the country's first hybrid school bus by IC Corporation and Enova and supported price reductions and improved air quality for the several buyers that received buses.[4]

An additional benefit of STAC is that the administrative costs were extremely low (less than 10%), especially in relation to its size and impact. These costs were needed simply to cover project staff time and travel for operating the solicitation, overseeing the progress of the projects, and promoting STAC.

THE EVOLUTION OF THE STATE ROLE IN ENERGY TECHNOLOGY COMMERCIALIZATION

[3] Appendix 4 contains NASEO's and ASERTTI's final technical report for the STAC project.
[4] See the "STAC Demonstration Projects" section of the final technical report (pp. 18-20 for further detail on this and other STAC projects.

Since the creation of ETSCP and the pilot operation of STAC, there has been a drastic evolution in the marketplace for energy products; the availability of resources, and support for emerging energy technologies; and the ability of energy entrepreneurs to use technology, the Internet, and crowd-funding to reach investors and customers. So, too, have many SEOs' roles expanded beyond the priority-setting and cost-matching functions that STAC harnessed so successfully. The July 2015 roundtable discussion shed light on these shifts. It also offered insights on the components of the STAC pilot that should be preserved in future federal-state collaboration, and the components that may need to be modernized or re-examined, which are explained in detail below.

First, SEO resources are now being utilized and harnessed in an increasingly comprehensive and holistic way. While priority-setting and grant funding continue to be core activities for many states working in technology commercialization, some SEOs also work with a wider range of partners in technology transfer and entrepreneurship. Like in STAC, utilizing the "convening power" of SEOs is an effective way to bring concepts and partners together both within state and local government as well as in the private sector.[5] However, whereas STAC project partners were mainly SEOs, research institutions, and fairly well-established private sector partner, today SEO activities in R&D reside within a much more expansive stakeholder group. These include fledgling companies, research institutions, and laboratories (such as the DOE's national labs) that are developing technology; angel, equity, and venture capital providers; technology demonstration and production facilities; business incubators; and, importantly, technology users and deployment channels such as state and local government agencies, utilities, Energy Service Companies (ESCOs), and consumers themselves.

This array of partners is mobilized in New York, where the New York State Energy Research and Development Authority (NYSERDA) hosts a robust suite of business and technology growth activities including early-stage funding; clean energy incubation; smart grid, battery, and lighting consortia; proof-of-concept and technology testing centers; regional economic development centers; and www.cleantechNYconnect.com, an online network of New York cleantech partners.

In Texas, the State Energy Conservation Office (SECO) runs a Clean Energy Incubator Emerging Technology Program, which supports incubators and incubator corridors in the state. An important component of SECO's funding for this program is that the incubators develop a business model to sustain their incubation practice, absent continued state funds.[6] This approach underscores SECO's recognition of the need for sustained investment and resources across the entire innovation ecosystem, rather than for one-off projects or infusions of capital.

Relatedly, some SEOs also serve a "matchmaking" function in their state, helping connect new technologies and concepts to sources of investment, financing, and expertise and providing a source of technical assistance and business acumen for energy start-ups. NYSERDA boasts a wide range of activities to this end, including its "Entrepreneur-in-Residence" which matches executive-level experts with early-stage companies. Importantly, some SEOs have utilized these relationships, networks, and activities to calibrate and re-calibrate the state's energy policy environment (as needed) to reduce barriers and promote access for entrepreneurs to the marketplace. For instance, many of California's most innovative policies, standards, and programs have their roots in the California Energy

[5] See "Case Studies: The Convening Power of State Energy Offices," attached as Appendix 5.
[6] SECO's Request for Proposals for the Clean Energy Incubator Emerging Clean Technology Program is available at http://seco.cpa.state.tx.us/funding/061314/RFP-210b.pdf.

Commission's Emerging Technologies Program, including demand response, advanced lighting, and zero-net-energy buildings.[7]

Finally, the Commonwealth of Virginia has embraced a "bottom-up" investment, financing, and mentorship approach that deepens the "top-down" funding and priority-setting role that STAC mobilized. The Virginia Commonwealth Energy Fund (CEF), launched in 2011, makes convertible debt-to-equity loans to high-growth potential early stage Virginia companies capable of driving job creation, reducing energy consumption, increasing energy generation from renewable resources, and reducing greenhouse gas emissions. CEF is capitalized by State Energy Program funds from the Virginia energy office and is operated by the Center for Innovative Technology (CIT), a non-profit corporation dedicated to accelerating the rate of advanced technology innovation, production, and adoption in the state. Investment from the SEO, which is housed in the Department of Mines, Minerals and Energy (DMME) does not stop at its sponsorship of the loan fund—in fact, DMME sits as an ex officio member on CEF's Investment Advisory Board, evaluating prospective borrowers and serving as a resource and mentor to companies selected for the CEF portfolio. In sync with the broader investment community across the country, the CEF has adopted a fairly energy sector-agnostic, technology-agnostic investment approach, favoring sound business plans, promising technical approaches, and prospects for promoting clean energy over the specific type or category of technology involved.

While DMME's expertise helps the CEF Investment Advisory Board understand the feasibility and potential savings of the energy technology under consideration, a higher priority for the investment team is to use metrics such as the business plan, the market opportunity, and the growth potential to determine the bankability of the company.[8] The CEF has helped contribute to the emergence of a growing ecosystem of energy innovation in the state, including Sunnovations, a solar hot water heating manufacturer, and WireTough, a developer and manufacturer of compressed natural gas cylinders for vehicles.[9]

OPPORTUNITIES AND RECOMMENDATIONS FOR LEVERAGING THE STATES' ROLE AND EXPERTISE TO ENHANCE, STREAMLINE, AND TRANSITION R&D TO THE MARKETPLACE

In addition to the robust state-level and private-sector activity around emerging technology and technology commercialization, the July 2015 roundtable attendees indicated that there are still significant opportunities and options for modernizing and improving coordination with federal entities such as OTT, EPSA, and the national labs. They discussed three opportunity areas in particular: improved communications; innovative technology advancement and stakeholder engagement; and coordination of emerging technology activities.

(1) Improved Communications:

Many of the informational gaps and barriers that gave rise to programs like STAC and ETCSP and Congressional authorization of OTT have persisted for decades. There are many actors in the RDD&D field (DOE, national laboratories, universities, states, clean energy centers, incubators,

[7] Edwin Hornquist, "California's Emerging Technologies Accomplishments – the View from Here," presentation at NASEO 2015 Annual Meeting, http://annualmeeting.naseo.org/Data/Sites/7/media/presentations/Hornquist.pdf.
[8] Interviews with Marco Rubin, GAP Funds Advisor, Center for Innovative Technology, September 24, 2015 and with Matthew Carlson, CEO, Sunnovations, September 28, 2015.
[9] A list of the five CEF-supported companies and their descriptions is available at http://www.cit.org/service-lines/portfolio/?T=3.

start-ups, and investors), and no one single actor has full information regarding the marketplace. The lack of systematic and consistent communications at a multi-state, regional, or national level among these core partners (e.g., SEOs, DOE labs, universities, and others) leads to missed opportunities for state commercialization policy innovation that could be informed by greater engagement with DOE's applied research and commercialization efforts; increased synergy between state policy and investment, and DOE applied research and commercialization efforts; and enhanced peer-to-peer (state, federal, private) learning about best practices approaches to supporting the transition of technologies from research to the market.

To address this communications barrier, NASEO recommends the following activities:

1. *SEO-DOE Commercialization Investment Task Force:* NASEO proposes to expand its current State Energy Financing Committee to include a Commercialization Investment Task Force. This Task Force would convene DOE, interested SEOs, labs, and public and private experts from the venture capital and investment communities, and members of the National Association of Development Organizations (NADO) for quarterly calls to foster discussion and understanding of technology commercialization and investment, highlight opportunities for multi-state activities, and provide updates on lab activities.
2. *National Technology Transfer Directory:* NASEO proposes to work with members of the Task Force and ASERTTI and NADO members to create and maintain a directory of contacts and key professionals working in energy technology transfer. Once established, the directory would be maintained by NASEO and its partners on an ongoing basis without DOE support.
3. *Regional Forums:* NASEO proposes to partner with State Energy Offices, national laboratories, DOE R&D program offices, NADO, state economic development directors, and state and private technology transfer organizations to hold regional technology commercialization forums. The purpose of the forums would be to introduce the capabilities of the national energy labs and R&D program offices to the states, and to introduce the energy-related economic development capabilities of the states to the national labs and R&D program managers. Both sets of stakeholders have a longstanding, limited understanding of their respective assets and capabilities, which has stunted coordination. The forum participants would be tasked with detailing state-identified market needs and national lab-identified technology opportunities. NASEO would facilitate ongoing regional communication around these priorities and, as requested, coordinate groups to match market needs with technology opportunities. These forums would also provide an opportunity to convene the Commercialization Energy Investment Task Force, draw upon local (in-region) investment experts to inform DOE's and the labs' technology transition work, and cultivate relationships among SEOs, labs, companies (particularly small businesses), incubators, DOE R&D program offices, and investment and economic development stakeholders.

***(2) Innovative State Technology Advancement and Stakeholder Engagement*:**
Some leading SEOs' operational experience across the RDD&D spectrum offers important insights in advancing technologies from demonstration to market adoption. The breadth and depth of services and resources in transitioning technologies that SEOs can bring to the table is substantial and includes targeted policy, demonstration projects, purchasing support, financing and risk reduction, business training and incubation, sustained market transformation programs, and partnership matchmaking and formation. As with STAC, money/funding is a piece of the puzzle in that it typically draws partners together and brings focus. However, effective programs also leverage SEO expertise, networks, clout, and their ability to elevate key technologies open

new markets through the state's comprehensive energy plan developed for the governor and legislature.

To enhance understanding of state's roles and help SEOs learn from leaders in this arena, NASEO recommends the following activities:

1. *Establish a State-DOE Collaborative Program to Leverage Commercialization Investment and Activities:* NASEO recommends that DOE examine existing sources of authority for state-federal collaboration on energy innovation (e.g. ETSCP and STAC) to establish a renewed collaborative framework and co-funding mechanism that coordinates federal, state, and private commercialization resources more effectively. Such a framework would help DOE R&D programs and national energy labs better leverage existing state resources, help SEOs better understand the opportunities for collaborating and increasing state buy-in of OTT's programs, and provide a feedback loop from states' market opening and policy activities to DOE's R&D program.
2. *RDD&D "Menu of Options"*: NASEO proposes to create a "menu of options" educational report for states' consideration, documenting in further detail key components of state RDD&D programs, including the variety of investment and technical assistance approaches deployed, available avenues to partner with DOE and the national labs, such as OTT, the Jobs Strategy Council, and the Office of Science; and the "major actors" in the RDD&D spectrum, including an identification of their key functions, as well as tangible examples and public-private partnership models from states that have or are embarking on RDD&D programs. These examples will be elaborated using program-specific case studies to help less active SEOs understand how to undertake similar activities.
3. *State Energy Innovations Pilot:* NASEO proposes to conduct a pilot in up to three states to create and coordinate "Energy Innovation Teams." These teams would convene the SEO and SEO-identified partner economic development organizations, accelerators and incubators, investors, and researchers to create a roadmap for technology transitions. The teams would be technology-agnostic to an extent, but their discussions would be centered around strategies to innovate in support of a common theme or goal identified by the SEO (as an example, smart grid in North Carolina or offshore wind in Texas). The roadmap would describe agreed-upon processes that various stakeholders could use to research, develop, demonstrate, and deploy and invest in clean energy technologies. A desired outcome of this roadmapping exercise would be to facilitate connections, promote in-state communication, and encourage stakeholders to use the process delineated in the roadmap to guide their activities along the RDD&D continuum.

3) Coordination of Emerging Technology Activities:

There is a significant need for peer-to-peer and private, state, and federal level coordination of emerging technology activities, which would benefit the marketplace by ensuring that both R&D and technology commercialization funds reach non-duplicative, innovative, and promising projects. SEOs, particularly those located in states that do not house a national energy laboratory (such as Minnesota), often do not have access to information about federal applied research, R&D, emerging technology, and technology transition activities. This was a specific issue raised during the roundtable by state research institution participants and others citing, as an example, emerging building energy technology programs operated by Washington, California, Iowa, New York, Florida, Minnesota, the U.S. Department of Defense, DOE, General Services Administration, utilities across the country, and others that are generally not connected and

could benefit substantially from awareness and collaboration. There are also many examples of emerging technology program "silos" across state, private, and federal entities in the smart grid, storage, and distributed generation areas. The opportunity to avoid duplication, share program results and data, and inform ongoing federal R&D efforts is great. Participants and follow-up discussions produced several practical activities to address this missed opportunity:

1. *Identification of State, Federal, and Private Emerging Energy Technology Programs:* NASEO proposes to partner with DOE and states to create a report identifying emerging technology programs in several key areas, such as buildings, distributed generation, intelligent grid, energy-water nexus. The report would inform existing DOE support for emerging technology activities and suggest means to better leverage resources across federal agencies, states, and private emerging technology activities. This report would be developed in partnership with the Commercialization and Investment Task Force members and will be based off of interviews and small group meetings with federal agencies, state-based organizations and private energy groups that are supporting or engaged in emerging technology programs and initiatives in a few key sectors (e.g., buildings, grid). Its purpose would be to raise awareness of efforts and explore channels for communication and coordination.
2. *National Forum*: NASEO proposes to use its engagement of stakeholders for the emerging technologies report to convene federal, state, and private emerging energy technology programs in key clean energy and grid-related areas. Meeting costs would be significantly offset by registration fees and sponsorships, provided DOE and/or other federal agency commitments to elevate and participate in the forum.

CONCLUSION

The roundtable discussion confirmed that some SEOs typically possess an expert understanding of the technical, financial, and policy resources to support energy technology advancement and commercialization in their states. They are close not only to existing or potential RDD&D partners, but also to customers and markets. These factors make them ideal partners for DOE's commercialization and technology transition efforts, because they understand how national, state, and local policy changes impact markets. Establishing a more systematic communications link, information-sharing channels, and a modernized framework for coordination for SEO, OTT, and various DOE RDD&D activities could better leverage the resources and expertise that each stakeholder brings to the table. Equally important, it would provide an independent feedback loop to DOE program managers to not only guide commercialization efforts and ensure a greater market impact, but also inform future RDD&D investments.