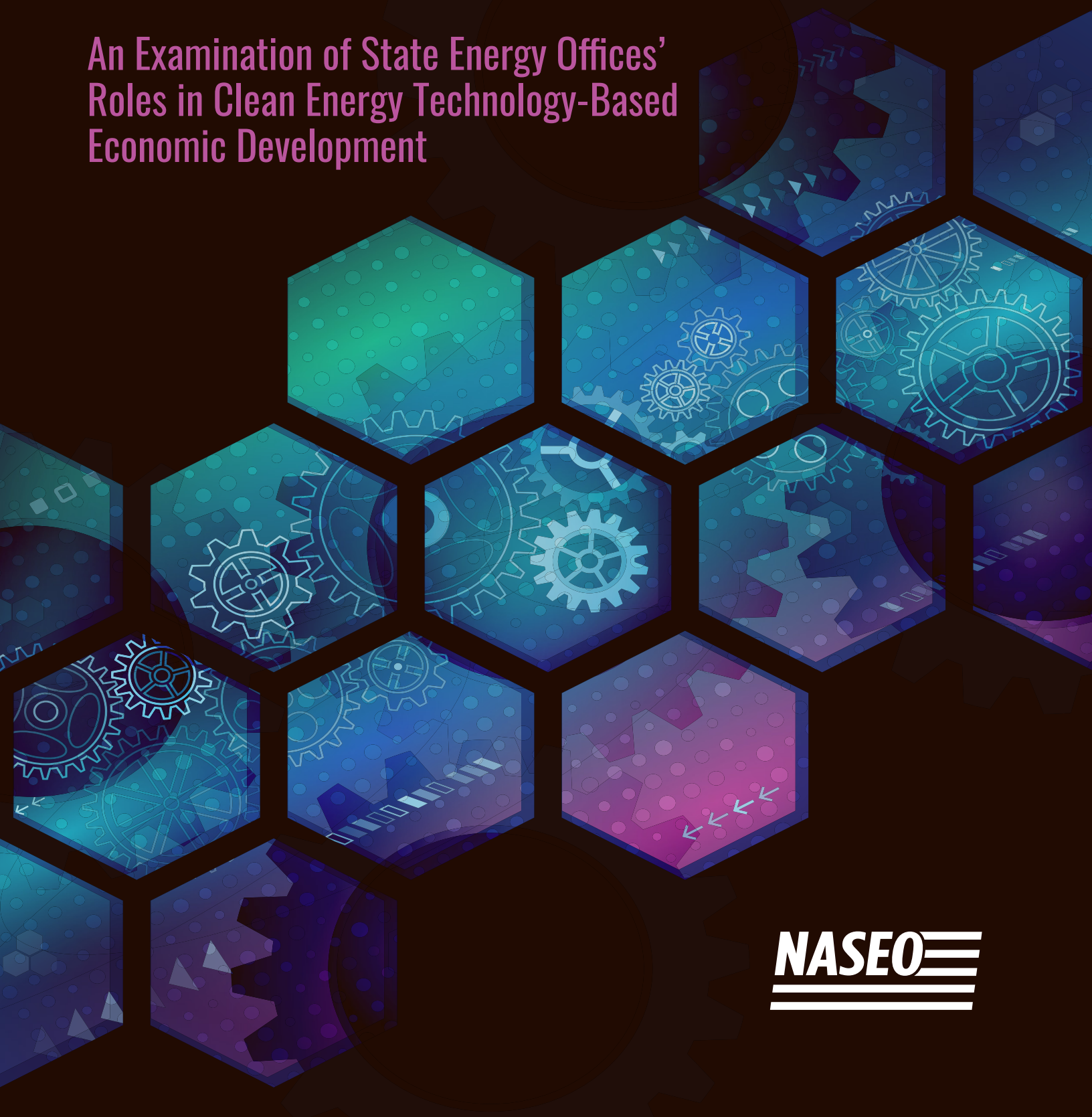
STATES AND CLEANTECH INNOVATION

An Examination of State Energy Offices' Roles in Clean Energy Technology-Based Economic Development



NASEO

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About NASEO

NASEO is the only national non-profit association for the governor-designated energy officials from each of the 56 states and territories. Formed by the states in 1986, NASEO facilitates peer learning among State Energy Officials, serves as a resource for and about State Energy Offices, and advocates the interests of the State Energy Offices to Congress and federal agencies. To learn more about NASEO, visit www.naseo.org.

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Executive Summary

State Energy Offices seeking to grow and support their energy innovation ecosystems have many robust tools at their disposal. Their work in policymaking, regulatory intervention, grant-making, program design, and stakeholder convening offers a major opportunity to connect emerging technologies and their innovators with on-the-ground realities about markets, public priorities, and regulations. In addition to offering targeted investment and support of cleantech innovation, State Energy Offices can serve as a focal point of information, communications, and coordination in their cleantech innovation ecosystems, bringing together both private and public partners and helping to bridge federal, regional, state, and local stakeholders as well.

This report draws on the principles of technology-based economic development, as well as ways states have invested in energy technology innovation and commercialization, to shed light on strategies that states can use to realize the long-term job creation, revenue generation, and environmental benefits of clean energy technologies. By developing a strong research base, mechanisms for commercializing and testing technologies, funding, and education and workforce initiatives, states can unlock opportunities and partnerships for energy technology advancement, commercialization, and large-scale deployment.

Key considerations and recommendations for state leadership and involvement in clean energy technology-based economic development, innovation, and commercialization include:

The Need for Continued Cleantech Innovation and Commercialization

- Further advancement and larger-scale deployment of clean energy technologies are necessary to meet key public policy imperatives, including but not limited to climate change, energy affordability and resiliency, and the need for economic and workforce support and growth.
- Continued advancement in clean energy technologies will involve not only the emergence and commercialization of innovative solutions but also cost reductions, performance improvements, and larger-scale deployment of existing clean energy technologies.
- Most innovations are not immediate "breakthrough" technologies, but rather incremental advances that shift how and what types of energy can be produced, delivered, and consumed. Compatibility and integration with existing energy systems will improve the chances of newer technologies being adopted successfully and rapidly.

The Case for State Involvement in Cleantech

- Private sector and federal action in innovation is critical, but alone insufficient, in advancing clean energy technologies at scale. State policy and program support creates business and policy environments that are conducive to research advances, commercialization, and market deployment.
- States benefit from cleantech investments: they can promote industrial productivity, reduce costs, and increase revenue generation opportunities, as well as leverage local talent and resources to generate wealth. They also tend to create jobs that command above-average salaries and wages, both for workers with college degrees and those with vocational or on-the-job training.[1]

"Technology-Based Economic Development" as a Guide for State Cleantech

- While states should not favor individual companies, they can help create a business and policy environment conducive to cleantech innovation by applying "technology-based economic development" principles. A strategy based in such principles

promotes the generation of new knowledge and research, links ideas and innovations to the marketplace, enhances the workforce, and addresses gaps where public funds, expertise, and technical assistance are needed.

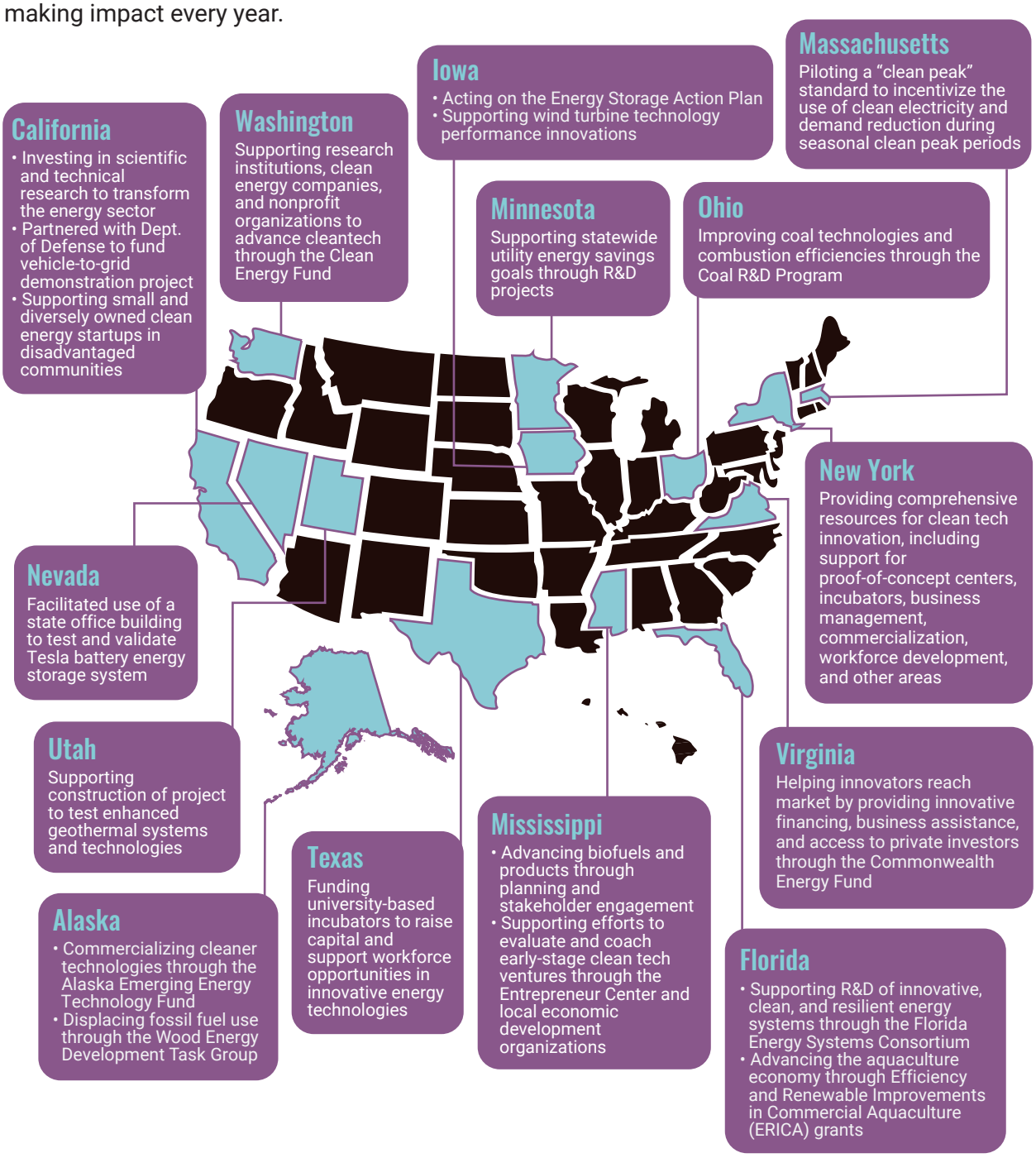
- States should root state cleantech goals, policies, and programs in market realities, building on existing core industrial, technological, and workforce advantages and priorities. Market studies, assessments, stakeholder engagement, planning, and partnerships may help State Energy Offices understand the state of clean energy technologies, market needs and wants, and the technical, labor, and financial resources needed to achieve their goals.
- Some states have focused their innovation and commercialization efforts on a specific industry sector or single stage of the technology development process, whereas others have established comprehensive frameworks that align policies, programs, and resources across their states' entire innovation ecosystem. These experiences may inform other states' efforts and are applicable to diverse priorities, budgets, and staff sizes.

Strategic Partnerships to Deepen Impact

- Women, minorities, and people from disadvantaged communities are less likely to be represented in the high-tech workforce,[2] including in cleantech, and especially at the executive level. Addressing these disparities requires innovation not in technology, but in business and program design. State Energy Offices should partner with mission-driven investment and economic development organizations to address unequal access to capital and bias in investment, recruitment, and advancement decisions, among other factors contributing to racial and gender disparities.
- Where shared priorities exist, states should promote alignment and coordination with federal and private sector research, development, and demonstration (RD&D) activities and investments. Greater engagement offers opportunities to speed the transfer of new technologies to market and inform research investments across various decision-making entities.
- As the backbone of the U.S. energy economy, energy workers are crucial to any plans to commercialize, deploy, or improve innovative technologies. State Energy Offices can use a variety of tactics to build a skilled and diverse workforce capable of meeting states' innovation, economic development, and environmental goals. These strategies include the encouragement of students and researchers to enter into STEM fields, programs to provide training and workforce development for existing professionals, and strategies to ensure an equitable and just transition away from fossil fuels. States are likely to find strong partners in energy education organizations, the private sector, and agencies focused on career and economic development.

State Innovation Actions Discussed in this Report

Across diverse priorities, markets, and budgets, states have made significant contributions to their cleantech ecosystems. This report highlights some of the states taking action on energy innovation - representing but a fraction of State Energy Office RD&D investments and programs making impact every year.



Introduction

In a matter of decades, the U.S. market for clean energy has experienced rapid growth and evolution. Once considered "alternative," energy efficiency, renewable energy, and advanced transportation technologies today represent established and growing markets. They also employ millions of workers, thanks to a combination of market and policy drivers at the national, state, and local levels, along with private-sector technology and investment innovations.

Yet, pressing environmental, social, and economic imperatives place a spotlight on the need for continued, aggressive, and more equitable growth in the advancement of clean energy technologies.* Climate change; energy affordability, cost, and access; and the unprecedented short-, medium-, and long-term economic and jobs recovery efforts that will be needed in the wake of the COVID-19 public health crisis: these are but a few of the challenges that cleantech innovation and adoption can play a role in addressing. Meaningful technological innovation† will require extensive, sustained, and coordinated policy, program, and financial support from both the public and the private sectors, at various levels of government, finance, academia, and industry.

As one of the largest funders and performers of energy research and technology transfer in the world, the U.S. federal government (primarily through the U.S. Department of Energy (DOE) and its national laboratories) is often the focal point of recommendations, analyses, and strategies to accelerate clean energy technology advancement. Similarly, private sector business and financial investment in energy and climate technology is frequently cited as a crucial motivator of cleantech innovation and commercialization.

State governments, through State Energy Offices‡, can also be substantial drivers of and partners in the development of a vibrant cleantech sector. Thanks to multi-million dollar, comprehensive programs in New York and California, as well as more targeted activities in Texas, Washington, Minnesota, and many other states, State Energy Offices collectively account for hundreds of millions of dollars in technology innovation and commercialization every year. They also advance strategies that shape end-markets for clean energy technologies.

Within an evolving network of technology, business, financial, academic, scientific, and workforce stakeholders commonly known as the cleantech innovation "ecosystem," State Energy Offices play a variety of roles. Whether advancing scientific and technical capabilities ("technology push") or creating signals for innovators and investors that there are or will be profitable markets for clean energy technology innovations ("market pull"), states can provide sustained, long-term financial and policy support for emerging technologies in a way that one-off research and development (R&D) investments cannot.

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* This report defines "clean energy technologies" or "cleantech" as machinery, infrastructure, and process improvements that promote greenhouse gas reduction or removal, including but not limited to the following technology areas: energy efficiency; renewable energy; alternative fueled vehicles; advanced vehicle technologies; carbon capture, utilization, and storage; low-carbon fuels;, nuclear; and measures to minimize the environmental impact of fluids, such as hydrofluorocarbon refrigerants, that are not associated with fossil fuel use but still have high global warming potential.

† While this report focuses on technology, it also highlights some ways that states have advanced other types of innovation, including in business models, education, workforce development, and program design.

‡ State and Territory Energy Offices and the District of Columbia's Department of Energy and Environment, hereby referred to as "State Energy Offices," advance practical energy policies, inform regulatory processes, and support energy technology research, demonstration, and deployment. In partnership with the private sector, State Energy Offices accelerate energy-related economic development and support state climate goals through energy solutions that address their citizens' needs and enhance physical and cyber energy security. The State Energy Offices' work is generally under the direction of governors or state legislatures, and is funded by both state and federal appropriations, such as the U.S. State Energy Program.

In many states, efforts to support clean energy technology advancement align with the concept of technology-based economic development. This framework identifies key elements of a technology-based economy, including a strong research base, mechanisms for knowledge transfer, an entrepreneurial culture, availability of capital, and a skilled workforce.[3] By applying a lens of technology-based economic development to their work, states can understand policies, regulations, incentives, partnership-building, and program investments as tools to realize key benefits, such as economic and revenue growth, job creation, and increased entrepreneurial activity.

States, communities, and the United States as a whole stand to benefit from such efforts. A strong innovation and commercialization system at the state and local level supports the creation and modernization of industries to enhance economic growth, productivity, income, and employment, and it helps to attract talent, business, and investment capital.

Energy innovations can support energy affordability, security, reliability, and resilience necessary to ensure public well-being, quality-of-life, and economic growth. They can also advance public policy objectives such as reducing carbon dioxide and other greenhouse gas emissions; conserving water, land, and other resources; improving public health; and meeting policy targets for low-carbon, clean, and renewable energy. In a time of deepening economic, environmental, social, and public health challenges, energy innovation investments offer a tool for state governments to advance economic recovery and reinvigoration while keeping parallel priorities, such as climate change, energy affordability, reliability, and resiliency, in focus.

The Case for State Involvement in Cleantech Innovation

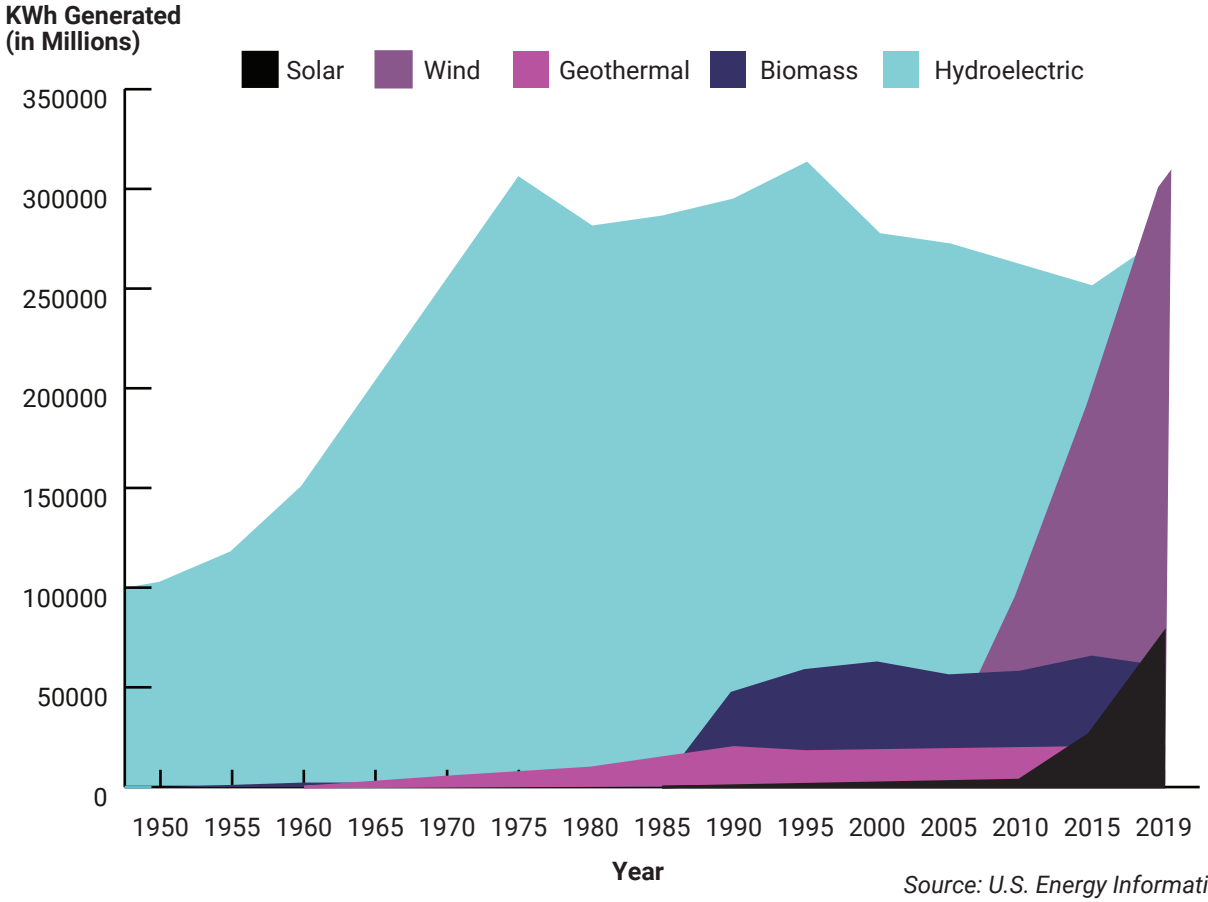
The U.S. energy economy has changed drastically over time. Energy production, delivery, and consumption continue to shift in response to the availability and cost of various sources of energy, changing consumer patterns and priorities, and public and private sector investments and decision-making. Public policy at the state level has proven to be a key motivator of cleantech advancement, driving innovation by supporting technology advancement directly, facilitating stakeholders, and bolstering end markets through policies, programs, and incentives.

Yet, cross-cutting challenges and priorities, such as climate resilience and mitigation, affordability, public health, and economic growth, have placed a spotlight on the need for continued, accelerated, and more equitable advancement and deployment of clean energy technologies. To meet these challenges, state involvement and leadership in innovation, in partnership with the private sector and federal government, are crucial.

State Impacts on Cleantech Commercialization and Deployment

Over the past few decades, some clean energy technologies have catapulted from niche to mainstream, with significant impacts to the U.S. economy. Renewable power-generating capacity in the United States has doubled in the past ten years,[2] a growth supported in great part by new capacity additions in solar, wind, geothermal, and biomass.[3] Energy efficiency investments have enabled the U.S. economy to produce twice as much output from the same amount of energy as compared to 40 years ago.[4] U.S. biofuel production rose from 1.6 billion gallons annually in 2000 to 16 billion gallons in 2018.[5] Together, these clean energy industries employ millions of workers and power trillions of dollars of economic activity across the country.[6]

U.S. Electricity Generation from Renewable Energy Sources, 1950-2019



Source: U.S. Energy Information Administration (May 2020)

Motivated by a variety of public policy priorities, from environmental quality and climate change to economic development and job creation, state governments have propelled much of this transition. Approximately half of all growth in U.S. renewable electricity generation and capacity since 2000 can be attributed to state-level Renewable Portfolio Standards,[7] which now operate in 29 states, three territories, and the District of Columbia.[8] Thanks to many state and federal incentives and programs, which helped support early deployment of clean technologies and infrastructure, renewable energy projects are now often cost-competitive with traditional fossil fuel options.[9] In 2017, energy efficiency policies such as vehicle, appliance, and equipment standards and building energy codes increased energy productivity by shaving an additional 20 percent off of energy consumption.[10] State investments in the deployment of alternative fuel vehicles and associated refueling infrastructure are helping to increase adoption of these technologies by fleets and consumers alike. State Energy Office-led policy and program initiatives in Maryland, Massachusetts, New Jersey, New York, and Rhode Island have been vital in offshore wind market development, which is expected to surpass nine gigawatts by 2026.[11]

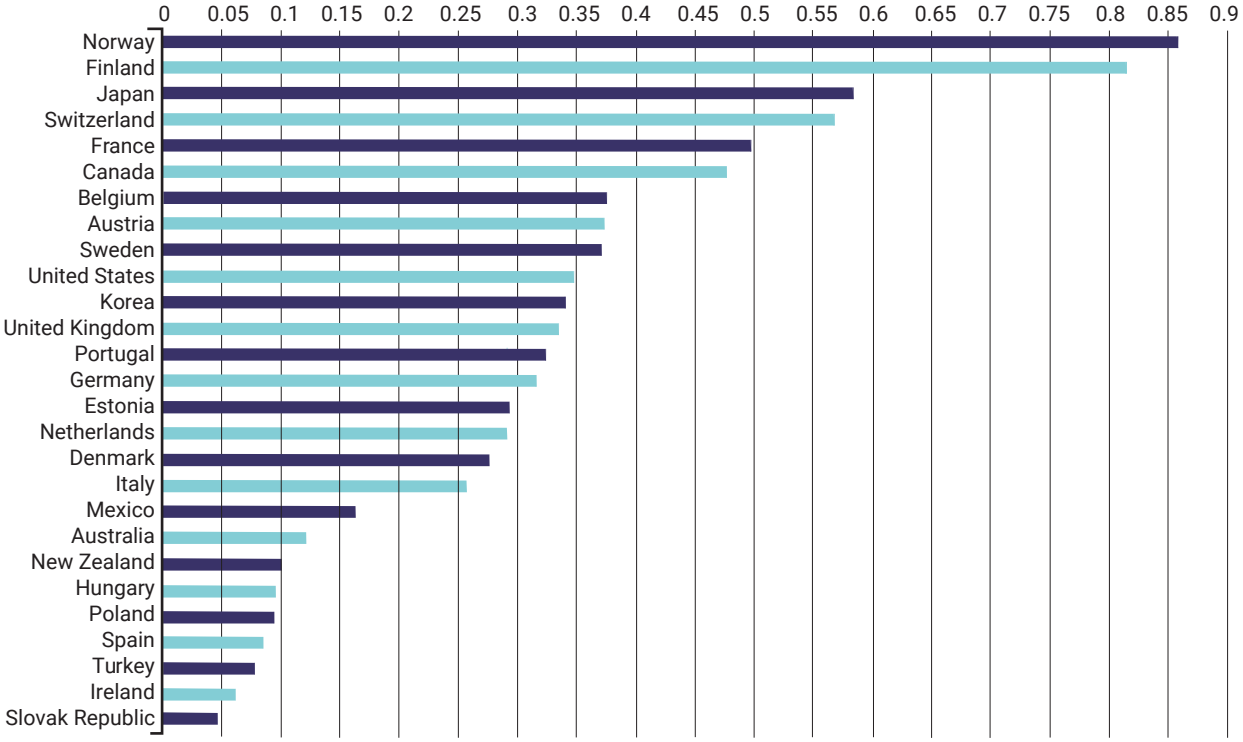
The Need for Continued State Action, Leadership, and Coordination with Partners

Despite these advances, the current market penetration of clean energy remains limited; it is unable to rapidly or cost-effectively reduce America's myriad uses of fossil fuels and high greenhouse gas emissions levels. Such limitations put the entire U.S. economy at risk. The National Oceanic and Atmospheric Administration tallies the total cost of weather and climate disasters in the United States over the last three years (2017 to 2019) at more than $460 billion.[12] The threat is especially acute in communities whose geography or access to resources

makes them more vulnerable to sea level rise, wildfires, and extreme weather events. Climate change presents immediate economic, environmental[13] and health[14] vulnerabilities, with low- and medium-income households and racial minorities (particularly African Americans and Latinx Americans) facing disproportionate impacts.[15]

On the global stage, U.S. cleantech research and manufacturing have lost their edge as other nations expand their own clean energy industries, invest in science, technology, engineering, and mathematics (STEM) initiatives and gain market share in response to increased consumer demand for clean energy solutions.[16] Relative to many developed countries, the U.S. government dedicates a smaller share of public budgets to energy RD&D, and U.S. energy companies spend only 0.3 percent of their sales on research and development.[17]

Public Energy RD&D Budgets per Thousand Units of GDP by Country (2018)



**per thousand units GDP*

Based on IEA data from IEA (2018) Energy Technology RD&D Budgets, IEA, www.iea.org/statistics, All rights reserved; as modified by NASEO.

A transformational shift toward clean energy could help the United States reduce its dependence on and use of fossil fuels, as well as cut greenhouse gas emissions from industries through improved processes, greater efficiencies, and carbon capture, use, and sequestration technology. The emissions reduction benefits would not be limited to carbon dioxide; clean energy actions would also help to address emissions of non-carbon high global-warming-potential gases, including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which are used in a wide array of manufacturing processes and consumer products such as air conditioners, refrigerators, aerosols, insulation, and electric power transmission.[§]

[§] According to the Minnesota Pollution Control Agency, "like other greenhouse gases, these gases trap heat in the atmosphere, but they are hundreds to thousands of times more effective at trapping heat, which leads to greater warming of the planet, compared to carbon dioxide….Emissions of these chemicals are only a result of human activities. They are released through direct use of various products, or unintentionally as an industrial byproduct. These chemicals are very stable and remain in the atmosphere for a very long time, so the concentrations of these potent GHGs will continue to rise for as long as they are in use." (Minnesota Pollution Control Agency. High global warming potential gases. Accessed April 1, 2020. https://www.pca.state.mn.us/quick-links/high-global-warming-potential-gases.)

Recent private sector responses to climate change signal a new inflection point in clean energy and climate technology investment. Within the past year, major players such as investment manager BlackRock have begun divesting from companies that present "high sustainability risks." [18] Global petroleum companies, facing criticism and litigation for their purported role in perpetuating the climate crisis, have announced plans to invest heavily in carbon reduction initiatives.[¶] Mission-driven investors such as Breakthrough Energy Ventures, Vertuelab, Energy Impact Partners, and dozens of others[19] are introducing new waves of patient, risk-tolerant capital to cleantech and climate solutions.

Yet, private sector action alone is insufficient in combatting the economic, environmental, and social challenges of continued fossil fuel use. State involvement and leadership, in coordination with the private sector, academia, and federal government, are crucial in continuing to accelerate and amplify clean energy technology advancement, dissemination, and adoption, leading to lower energy costs and strengthened U.S. economic leadership.

States themselves stand to benefit from answering this call. Clean energy investments can promote industrial productivity, reduce costs, and increase revenue generation opportunities.[20] They also tend to create jobs that command above-average salaries and wages, both for workers with college degrees and those with vocational or on-the-job training.[21] Together, technology innovation, energy and climate change policy, and economic development form a powerful nexus that states can address simultaneously and with high-impact results.

Tech-Based Economic Development and State Cleantech Actions

The principles of technology-based economic development help shed light on strategies that states can use to realize the long-term job creation, revenue generation, and environmental benefits of cleantech innovation and commercialization.

According to the State Science and Technology Institute (SSTI), "competing in a global economy, regions must have an economic base composed of firms that constantly innovate and maximize the use of technology in the workplace. Technology-based economic development…is the approach used to help create a climate where this economic base can thrive." SSTI identifies the following building blocks of a technology-based economy:

- A research base that generates new knowledge;
- Mechanisms for transferring knowledge to the marketplace;
- An entrepreneurial culture;
- Sources of risk capital; and,
- A technically skilled workforce.[22]

As noted in a 2015 NASEO white paper on state involvement in energy technology transitions, the economic development mission of many State Energy Offices drives an interest in clean energy technology-based economic development. Their involvement is not limited to the advancement of basic science, but rather extends across the research, development, demonstration, and *deployment* (RDD&D) continuum. This economic development lens fosters "market-opening" and "market-expanding" policies and programs, "[helping] labs and private technology developers gain visibility in the marketplace, become integrated into state and local 'lead by example' energy programs and initiatives, [inform] innovative energy policies and goals, and make strategic partnerships to help expand their business." [23]

[¶] Carbon Engineering, a Canadian start-up firm, has drawn headlines for recent announcements by Chevron, Occidental Petroleum, and BHP to invest in its "direct-air-capture" technology, which is piloting methods to extract carbon dioxide in the atmosphere and convert it into a clean-burning synthetic fuel. (Krauss, Clifford. "Blamed for Climate Change, Oil Companies Invest in Carbon Removal." New York Times, April 17, 2019.)

How Can State Energy Offices Advance their Cleantech-Based Economy?

Based on SSTI's "Elements of a Technology-Based Economy", https://ssti.org/TBED.

1 Develop a Research Base that Generates New Knowledge

Strengthen capacity to conduct research in universities, labs, or the private sector

- Offer incentives, grants, and cost match for cleantech R&D
- Invest in university and lab research efforts that support state energy, climate, and resilience goals

2 Create Mechanisms for Transferring Knowledge to the Marketplace

Promote the conversion of research into technologies and products with high commercial potential

- Facilitate the use of state-owned facilities to test, validate, and scale new technologies
- Encourage the adoption of innovative procurement policies to enable state agencies to adopt and use newly commercialized products and technologies
- Support proof-of-concept centers and Entrepreneurs-in-Residence programs

3 Promote Entrepreneurship

Increase the capacity of entrepreneurs to grow and start companies

- Partner with and support cleantech incubators, accelerators, and other mentorship programs for innovators
- Encourage the creation of and partner with clean energy business councils and associations
- Provide training and resources in business development, executive management, and fundraising to innovators
- Diversify and expand the innovation ecosystem by prioritizing funding and resources for small, woman-owned, and diverse-owned startups

4 Support Sources of Risk Capital

Increase access to capital by using public funds to leverage and attract private investment

- Structure public funds to provide patient, risk-tolerant capital that attracts additional private investment
- Support small and startup businesses in accessing federal and private sector capital and programs
- Remove regulatory and cost barriers that may inadvertently favor incumbent technologies over emerging technologies

5 Advance a Technically Skilled Workforce

Encourage STEM education, internships, technical trainings, and workforce development

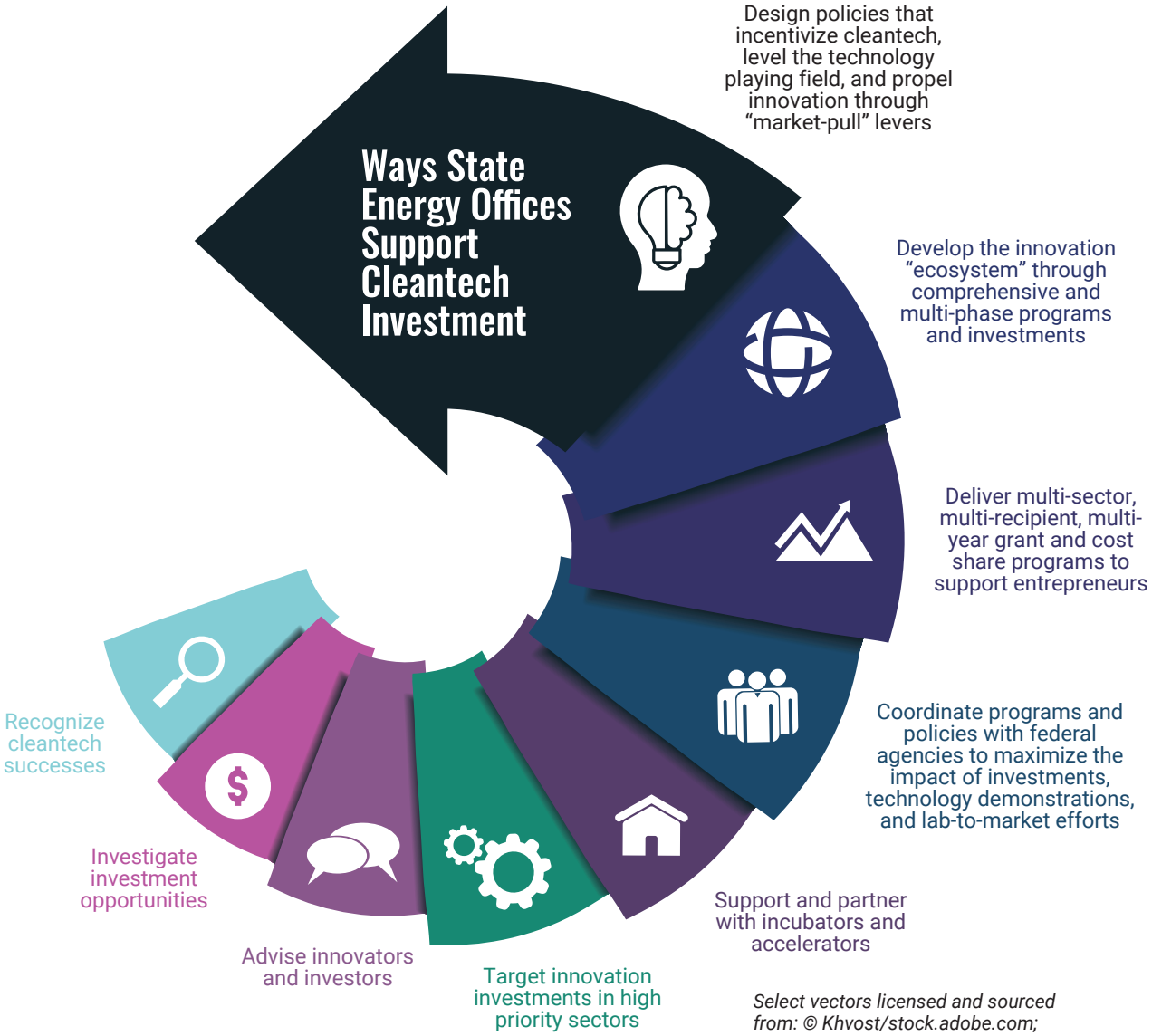
- Advance STEM education through focused curricula and scholarship programs
- Support internships, apprenticeships, and vocational training/retraining for energy sector workers

The following section offers a deeper dive on strategies that State Energy Offices have used to integrate innovation and commercialization into their work, priorities, and investments.

Models for Clean Energy Tech-Based Economic Development

Each State Energy Office pursuing cleantech innovation and commercialization uses a unique combination of policies, programs, investments, and partnerships. Many states utilize federal U.S. State Energy Program funds to pursue these policies and leverage private investment. Some states have focused their efforts on a specific industry sector or single stage of the technology development process, whereas others have established comprehensive frameworks that align policies, programs, and resources across their states' entire innovation ecosystem.

The planning, partnership, program, and policy models discussed below include options not only for direct financial support of technology innovation but also for other mechanisms, such as stakeholder coordination and mentorship and advisory opportunities, that cater to diverse state priorities as well as a variety of State Energy Office missions, budgets, and staff sizes.



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Stakeholder Coordination and Communications

While State Energy Offices should not favor individual companies, they can help draw attention to and create connections among various stakeholders. The State Energy Offices' convening power enables them to bring together, cultivate relationships, and raise visibility among energy innovation stakeholders such as laboratories, companies, academic institutions, incubators, entrepreneurs, investors, consumers, and others.

Recognizing Cleantech Successes

State Energy Offices, particularly those with direct ties to governors or other high-level state officials, can use the power of their offices to draw attention to and raise visibility for cleantech advancements.

Two examples from Washington and Utah illustrate this strategy. In February 2017, Governor Jay Inslee of Washington spoke at the Clean Energy Institute's event to unveil the Washington Clean Energy Testbeds, a Seattle-based facility that provides access to fabrication, characterization, and computational instruments supporting ultra-low-cost solar cells, batteries, and systems integration software for vehicles, buildings, and the grid.[24] In November 2019, the Utah Governor's Office of Energy Development participated in the announcement of a pilot project to capture and convert vented methane from the Navajo Nation's oil-producing operations into hydrogen, for use in fuel cell vehicles and other equipment.[25]

While it may not be realistic for a governor or State Energy Office to be involved in the announcement of every new technology deployment or deal, taking the opportunity to lend their office's cache to highlight important developments offers a relatively low-touch way to recognize and increase public awareness of and enthusiasm for cleantech innovation.

Advising Innovators and Investors on Policy Issues

Innovators and investors often have limited clarity on the market conditions that new technologies will confront as they are commercialized and deployed. State Energy Offices can supplement their understanding by offering their expertise on policy, legal, and regulatory issues.

To illustrate, many State Energy Offices lead, support, or participate as members of organizations that advance clean energy technology-based economic development. The head of the Maryland Energy Administration is an ex officio board member of the Maryland Clean Energy Center, a corporate instrumentality of the state with a mission of advancing clean energy and energy efficiency products, services, and technologies.[26] Similarly, the Commissioner of the Massachusetts Department of Energy Resources serves as a board member of the Massachusetts Clean Energy Center, a state economic development agency focused on accelerating the growth of the state's clean energy sector.[27] In Tennessee, the Department of Environment and Conservation participates in the Tennessee Advanced Energy Business Council, which connects, educates, and promotes partnerships among business leaders and public officials to foster the growth of advanced energy technologies, companies, and jobs within the state.

The Alaska Wood Energy Development Task Group is a collaboration of 20 governmental agencies, including the Alaska Energy Authority, and not-for-profit organizations. Its goal is to help communities displace fossil fuel usage and reduce heating costs through the use of locally sourced woody biomass, which will, as a result, reduce "economic leakage" and create local employment opportunities. Through a cooperative funding model and the solicitation of extensive stakeholder input, the Task Group has completed over 170 feasibility studies and has been instrumental in the successful startup of nearly all of the operational biomass systems in the state.[28]

Market Studies, Assessments, and Strategic Planning

Cleantech advancement processes are fragmented and complex, involving networks of scientists, engineers, innovators, incubators, investors, mentors, and end-users operating at multiple levels – local, state, regional and national – in different settings, from backyards and garages to specialized laboratories and demonstration facilities. No single actor possesses all the information, resources, skills, and assets needed to successfully commercialize innovative technology. Various human, financial, and scientific resources are needed as inputs to the innovation process, as are complementary assets, such as related technologies, manufacturing skills, and marketing capabilities. Innovators must address institutional arrangements, such as intellectual property, standards, and regulations. Potential customers and sometimes regulators may require assurances and warranties that the new technology will work and that they will abide by regulatory standards.

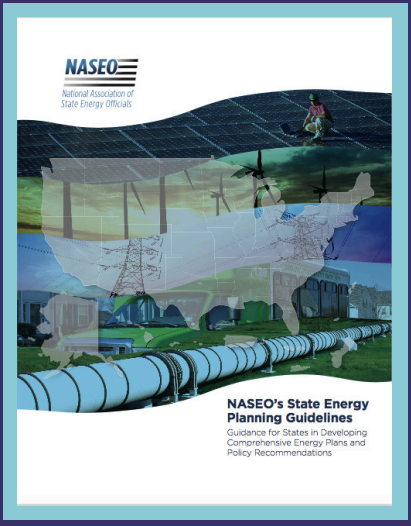
In-depth market studies and assessments can assist states in organizing and understanding their cleantech ecosystem by convening key stakeholders; identifying high-priority technology and policy needs; understanding the technical, workforce, and financial resources needed to achieve them; and directing state investments, partnerships, and policies strategically.

For example, in 2018 the Colorado Energy Office commissioned a study of floating photovoltaic potential across the state, to inform the potential future development of policies and programs that could help accomplish the state's renewable energy goals.[29] Similarly, through its statewide energy plan, the New Jersey Board of Public Utilities identified the need for a workforce assessment to ensure the state has sufficient labor resources to meet its goals in offshore wind development, building energy efficiency, and the transition to a clean energy economy.[30]

The Iowa Energy Office, which is housed within the Iowa Economic Development Authority (IEDA), has used stakeholder engagement, market analysis, and planning to help accelerate the market for battery technology projects. In 2019, it issued the Energy Storage Action Plan, which used input from a 17-member committee to devise recommendations on how the state can "prepare for and embrace storage as a technology with immense economic potential." The actions identified by the committee align heavily with the technology-based economic development framework described above and emphasize the need for state policy and program support across the entirety of the RDD&D continuum: identifying and removing barriers to storage expansion; encouraging and supporting storage pilot projects to

The Role of State Energy Planning in Technology Innovation

State energy plans and the planning process help to guide and build consensus among stakeholders in moving toward a shared goal of meeting future energy needs in a cost-effective and sustainable manner. Recommendations found within state energy plans – grounded in robust data collection and reflective of extensive stakeholder input – inform the development of policies that enable private sector innovation and lead to a prosperous energy future. A well-constructed state energy plan provides an assessment of current and future energy supply and demand, examines existing energy policies, and identifies emerging energy challenges and opportunities. Comprehensive state energy planning is a key tool for Governors and Legislatures to advance their state's energy-related economic development, security, and environmental quality goals. NASEO's State Energy Planning Guidelines offer guidance for states in engaging stakeholders, analyzing data, and developing state energy plans.



understand operational and financial challenges; collaborating with Iowa's colleges and universities; realizing the employment and economic benefits associated with storage investments; and updating policies, such as building codes, standards, and regulations, that influence end-use markets for storage technologies.[31] In line with these recommendations, the Iowa Energy Office has provided cost-share to battery and battery-plus-storage pilots, as well as analyses documenting project outcomes and lessons learned.[32]

The State Energy Office in Mississippi has collaborated with external partners, including university researchers and non-profit organizations, to conduct state-wide and regional feasibility studies quantifying the types and amounts of biomass available for conversion into biofuels and bioproducts. One such study, the single largest of its kind, focused on the Mississippi River, covering 98 counties in five states. A more recent effort culminated in an in-depth evaluation of the geographic distribution of five different types of biomass in Mississippi (woody biomass, herbaceous biomass, poultry litter and other agricultural residues and landfill gas potential), along with complementary infrastructure, workforce training, and research capacity. This effort took over a year and sought input from farmers, loggers, poultry growers, integrators and policy makers.[33]

Partnerships for Cleantech Ecosystem Development

State Energy Offices may also choose to pursue partnerships that develop, expand, or create business opportunities for their state's cleantech sector.

State Energy Offices can partner with intermediary organizations that provide services to innovators as they navigate the technology and business development process. In Texas, the State Energy Conservation Office provides funding to university-based cleantech incubators at the University of Texas at Austin and Texas A&M Engineering Experiment Station.[34] The state's investments have helped raise $29.5 million in capital for innovative energy technology, with nearly $36.3 million in direct, indirect and induced economic impact.[35]

In Mississippi, the Energy and Natural Resources Division of the Mississippi Development Authority (MDA) works closely with MDA's Entrepreneur Center as well as local economic development organizations to evaluate and coach early-stage cleantech ventures. Technologies evaluated recently have ranged from waste-to-energy, hydrogen generation and distribution and wind energy, to transformer manufacturing and natural gas liquids production and transportation. Services include business model review, market analysis and networking with investors and relevant subject matter experts.

Another set of partners can be found in university research and technology transfer institutions whose research portfolios can be used to advance state goals. The Office of Energy in the Florida Department of Agriculture and Consumer Services (FDACS) supports and oversees the Florida Energy Systems Consortium, which was created by the Florida state government to promote collaboration among the energy experts at its 12 supported universities. Its charge is to "perform R&D on innovative energy systems that lead to alternative energy strategies, improved energy efficiencies, and expanded economic development for the state," and its research portfolio aligns significantly with many FDACS objectives, including efforts to advance energy efficiency, solar, biomass, and energy resiliency in the state.

A third set of partners can be found in private sector investment and financing firms, who can help multiply the impact of public funding for cleantech advancement. In Virginia, through a partnership with the Center for Innovative Technology (CIT), the Department of Mines, Minerals and Energy (DMME) supports the Commonwealth Energy Fund. Since its launch in 2011, the Fund has received $2.6 million in financial support from DMME, including from U.S. State Energy Program funds, and DMME also participates in the Fund's Investment Advisory Board as an ex officio member.

The Commonwealth Energy Fund offers a compelling model for states seeking to leverage and attract private investment to the cleantech sector. It is structured as a "near-equity" investment program, in that the capital funds initiate as debt and convert downstream to equity, at CIT's option. Loans can be converted in several ways: they can be paid back in the same manner as a typical loan; they can undergo a liquidity event such as an acquisition, merger, or other transaction that enables CEF to cash out its share; or they can be converted into equity held by CIT. This approach, considered a convertible debenture model, maximizes return to the fund so that capital is continually available for new loans. Loan recipients receive not only financing, but also strategic business assistance through the Fund's Investment Advisory Board, which enables participating businesses to raise private money that may be otherwise inaccessible.[36]

Yet another partner can be found in the U.S. government.** Many State Energy Offices, especially those that are home to the national laboratories or other federal campuses and facilitates, have robust project and program experiences with federal entities. For instance, the California Energy Commission and the U.S. Department of Defense Environmental Security Technology Certification Program jointly funded a vehicle-to-grid demonstration project at the Los Angeles Air Force Base. The multi-partner project is expected to demonstrate the security, environmental,

Bolstering and Formalizing State-DOE Innovation Connections

The significance of DOE and DOE-supported programs, such as the DOE national laboratories, energy innovation hubs, Energy Frontier Research Centers, Advanced Research Projects Agency-Energy, and Small Business Innovative Research and Small Business Technology Transfer programs, cannot be understated, as they represent billions of dollars in investment annually and multiples more in economic impact.[39] To illustrate the economic impact of a single DOE office, a summary of six impact evaluations of the Office of Energy Efficiency and Renewable Energy's R&D investments came to the following conclusions:

- *A total taxpayer investment of $12 billion (inflation-adjusted 2015 dollars) in EERE's R&D portfolio has yielded more than $388 billion in net economic benefits to the United States, undiscounted;*
- *The overall annual rate of return on the R&D investments was more than 27 percent;*
- *The undiscounted benefit-to-cost ratio was 33 to 1 (11 to 1 at a 7 percent discount rate), indicating that economic benefits have far exceeded the cost of these R&D investments.[40]*

Individual states may have one-on-one relationships with DOE technology offices or its national laboratories, or can help direct innovators and startups to DOE-supported programs such as the Small Business Voucher, Small Business Innovative Research, and Small Business Technology Transfer programs. The Office of Technology Transitions, branded as the "front door" of DOE's R&D and commercialization programs apparatus, defines DOE's policy and vision for expanding the commercial impact of its research investments. Since its creation in 2015, the Office has provided a significant service to many stakeholders in the U.S. cleantech ecosystem, including states, by conveying information, streamlining access to DOE's national labs and sites, and fostering partnerships that will move innovations from the labs into the marketplace.

Yet, formal and systematic connectivity between federal and state cleantech efforts is limited, and there remain missed opportunities for synergy and coordination. Greater and more formal engagement with DOE's applied research and commercialization efforts, in particular through the Office of Technology Transitions, can offer opportunities to streamline state and federal investments in clean energy technology advancement, highlight opportunities for federally-supported innovations to reach state and local markets, and enhance state, federal, and private sector communications on emerging technologies and technology transfer opportunities. Such engagement can take the form of regular peer-exchange and collaboration activities to connect DOE technology transfer experts, State Energy Office program and policy leaders, energy technology and research institutions, and private company leaders. Importantly, it would aid in speeding the transfer of new technologies from labs, academia, and the private sector to market and it would inform research investments, realizing benefits at the business, local, state, and federal levels.

** A list of select federal agency programs in cleantech research, development, and demonstration is available at https://naseo.org/issues/technology-innovation/federal-activities.

and cost benefits of reducing the use of fossil-powered military vehicles, as well as validate the integration of plug-in electric vehicles with buildings and the electric grid.[37]

The construction of the Frontier Observatory for Research in Geothermal Energy (FORGE) field laboratory in Milford, Utah further illustrates how state and federal funding and technical assistance can be aligned for greater impact. In 2018, FORGE was selected to receive $140 million in DOE funding over five years to support cutting-edge R&D in enhanced geothermal systems. The project lead, the University of Utah's Energy and Geoscience Institute, had collaborated with the Governor's Office of Energy Development (OED), the Utah Geological Survey, and other agencies to develop the research and program scope. Following the announcement of the DOE funding, OED approved a grant to Beaver County for assistance in the construction of infrastructure related to the project – a top priority in the county's economic development plan submitted to Governor Herbert.[38]

Support for Technologies and Innovators

Another set of options for State Energy Offices is to provide direct support for cleantech innovations based on specific technology areas and/or stages of technology or business development. Through such initiatives, states have advanced projects to pilot and demonstration stages; supported technology incubation, acceleration, and mentorship programs; and provided or facilitated the funding of universities, labs, and other entities focused on advancing innovations in line with state energy, economic development, and climate goals.

Targeted Research, Development, and Demonstration Projects and Programs

Even with limited funds, State Energy Offices can strategically support technology advancements that align with their energy, climate, and economic development goals. In Iowa, wind energy has been a target for policy and financial investment for decades, enabling the state to become a national leader in renewable generation. The problem of ice buildup in cold weather, which impairs turbine blade performance, prompted the State Energy Office within the Iowa Economic Development Agency to grant $303,000 to Iowa State University to develop new ice-repelling coatings. This research may increase the availability of cost-effective ice-protection options in the Midwest and in other cold regions, which will ultimately improve the performance, economics, and scalability of wind power.[41]

State Energy Offices can also facilitate the use of state facilities for demonstration projects to test and validate new technologies. In 2018, the Nevada Governor's Office of Energy awarded a grant to support the installation and monitoring of a Tesla battery energy storage system in the Grant Sawyer State Office Building in Las Vegas. The demonstration project is expected to reduce the state's energy costs by thousands of dollars annually and will deliver performance data that will assist the Nevada Department of Administration in determining whether to deploy the technology to additional state buildings.[42]

Many states offer grant programs to support RD&D in specific technology areas. For instance, the Ohio Coal Development office of the Ohio Development Services Agency (which also houses the State Energy Office, separately) offers the Coal Research and Development Program, which uses public solicitations to support projects that improve combustion efficiencies, remove various pollutants from emissions, develop productive uses for the by-products of combustion, and investigate new uses for coal as a feedstock. The program is supported by general obligation bond proceeds through the State Treasurer.[43]

In another example, the Florida Office of Energy in FDACS is supporting the development of the state's growing aquaculture economy through the Efficiency and Renewable Improvements in Commercial Aquaculture (ERICA) grant program. In the past, it supported Florida agricultural

partners in R&D for biomass, renewable energy, and energy efficiency demonstration projects. Funding for the ERICA program comes from state statute, enacted for the purpose of supporting technologies that significantly increase energy efficiency for commercial aquaculture farms and facilities.[44]

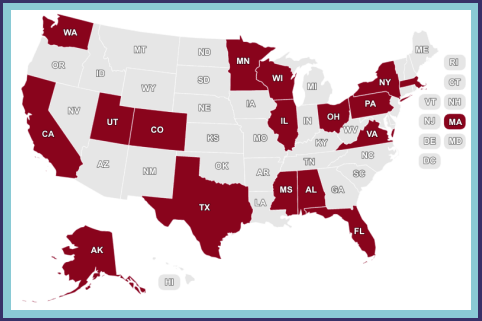
Multi-recipient, Multi-technology, and Multi-year Programs and Investments

State Energy Offices can also support larger, multi-recipient, and/or multi-year programs that deliver sustained financial support and incentives to innovators. As opposed to the targeted, strategic interventions discussed previously, these programs are likely to require greater commitments of funding and staff support. In these cases, innovation programs are often designed as competitive solicitations, inviting proposals from innovators across a wide array of technology areas that align with their states' energy, climate, and economic development goals.

Overseen by the Division of Energy Resources in the Minnesota Department of Commerce, the Conservation Applied Research and Development (CARD) Grant Program funds energy R&D projects to identify new technologies or strategies to maximize energy savings, improve the effectiveness of energy conservation programs, and document the carbon dioxide reductions from energy conservation projects.[45] Since the start of the CARD program, the Department of Commerce has issued over $15 million dollars to more than 119 projects that directly support the priorities of the state's Conservation Improvement Program, including its energy savings goal of 1.5 percent of annual retail electricity and natural gas sales for all utilities in the state. The Next Generation Act of 2007 authorizes the Commissioner of the Department of Commerce to assess utilities $3.6 million annually for grants for applied R&D projects, of which $2.6 million goes to CARD.[46]

In another example, the Alaska Energy Authority Emerging Energy Technology Fund supports projects that test emerging energy technologies or methods of conserving energy, improve an existing technology, or deploy an existing technology that has not been previously demonstrated in the state. Eligible projects include a wide array of technologies, including renewables, efficiency, effective use of hydrocarbons, and systems integration, but the technologies must

State Energy Office Technology Innovation Programs



NASEO's State Energy Office Technology Innovation Program Map highlights State Energy Office programs that help new energy technologies or technology improvements to reach market. What it shows is that there is considerable opportunity for states to nurture a supportive energy technology innovation ecosystem. State Energy Offices can play vital roles in supporting cleantech friendly markets in their states by providing various types of support consistent with their resources, objectives, and authority, such as

- *Funding RD&D;*
- *Supporting access to federal and other RD&D and technology transfer support (such as the Small Business Innovative Research and Small Business Technology Transfer programs);*
- *Supporting technology incubators and cleantech accelerators;*
- *Incentivizing private investment in clean energy RD&D and commercialization;*
- *Promoting STEM education and workforce training;*
- *Coordinating policy, programs, and investment across key state and local partners, such as economic development entities, innovation agencies, educational entities, and other pertinent offices;*
- *Encouraging the creation of and partnering with clean energy business councils and associations;*
- *Exploring innovative procurement and funding processes to encourage the use of state-owned and other public facilities as testbeds to demonstrate and validate new technologies; and*
- *Sending market signals through the creation of clean energy deployment policies, goals, plans, incentives, and regulations, among others.*

Explore the map, State Energy Office roles in cleantech advancement, and other resources at https://naseo.org/issues/technology-innovation.

have a reasonable expectation of becoming commercially viable within five years.[47] In 2016, the Alaska Energy Authority reported several positive impacts from this program, including in-state development of energy efficiency technologies for buildings, power electronics, and diesel generation efficiency as well as a partnership with the University of Alaska to expand the use of its technology testbeds for hydrokinetic testing and power systems integration. The fund was created by the state legislature in 2010 to promote the expansion of energy sources available to Alaskans.[48]

Strengthening Cleantech Innovation through STEM and Workforce Initiatives

In addition to states' investments in technologies, innovators, and innovation ecosystems, State Energy Offices' policies and programs to support the energy sector workforce also bear mentioning. As the backbone of a cleaner, more competitive, and more efficient U.S. economy, energy workers are crucial to any plans to commercialize, deploy, or improve innovative technologies. As with the technologies and products that are part of the cleantech economy, the U.S. energy labor force is expansive, numbering in the millions across all 50 states, and covers a wide range of occupations, technologies areas, and skill levels.[49]

To build a skilled and diverse workforce capable of meeting states' innovation, economic development, and environmental goals, State Energy Offices have used a variety of tactics. Some programs provide education and career development opportunities to encourage students and researchers to enter into STEM fields. Others advance training and workforce development opportunities for existing U.S. workers. In this fashion, states' support of education and training can not only prompt a new generation of innovators and researchers to develop solutions to energy and environmental problems, but also equip existing energy professionals with tools, resources, and skills to implement and deploy innovative technologies.

Refer to page 20 to see how State Energy Offices support STEM and workforce initiatives.

Innovation Ecosystem Support through a Coordinated, Multi-program Approach

A small number of State Energy Offices have advanced comprehensive programs that provide funding and developmental support across multiple technology areas and stages of the technology and business development process. These are high-touch efforts, requiring sustained and significant financial and oversight commitments, but offer great opportunity for market impact and transformation.

The New York State Energy Research and Development Authority (NYSERDA) offers a comprehensive and coordinated suite of programs through the state's Clean Energy Fund. The Market Development and Innovation and Research portfolios of the Fund are expected to deliver over $3.5 billion to cleantech business growth, workforce advancement, and clean energy demand creation initiatives through 2028, with certain program investments expected to leverage up to $15 of outside investment for every dollar of state funds applied.[50]

NYSERDA cleantech innovation resources include proof-of-concept centers, an Entrepreneurs-in-Residence Program, the Emerging Technologies and Accelerated Commercialization Program, incubators, testing centers, executive management programs, and other support structures.[51] The agency also offers significant resources in clean energy workforce development, having committed nearly $70 million over the next 10 years to support training for building and operations staff on systems maintenance; on-the-job training for new clean energy workers; internships; enhanced curricula; and the building of a talent pipeline that connects directly to New York clean energy businesses.[52]

The State of Washington's Clean Energy Fund, overseen by the State Energy Office in the Department of Commerce and funded through state appropriations, uses an annual competitive solicitation process to support Washington's research institutions, organizations, and clean energy technology companies. Eligible projects include, but are not limited to: advancing energy storage and solar technologies, advancing bioenergy and biofuels, developing new earth

abundant materials or lightweight materials, engineering advanced energy storage materials, implementing innovative approaches for recycling of battery components, and developing new renewable energy and energy efficiency technologies. Since its inception in 2013, the Washington state legislature has invested capital budget in the program, and it has been heavily championed by Governor Jay Inslee.[53]

A key goal of the program is to increase the competitiveness of Washington-based R&D organizations by providing cost-share or matching funds for federal or other similar funding opportunities.[54] The Clean Energy Fund is one of several programs that Washington uses to attract clean energy, STEM, and computational researchers, workers, and companies to the state, along with tax incentives and connectivity to world-class research institutions such as the Pacific Northwest National Laboratory, the University of Washington, and Washington State University.[55]

Since 2013, California's electricity, natural gas, and cybersecurity research, development, and deployment portfolios across the California Energy Commission and the Public Utilities Commission have resulted in more than $1 billion in investment.[56] Within the California Energy Commission's Electric Program Investment Charge (EPIC) initiative, which invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals, the state provides funding for R&D as well as grants, capacity-building, business planning assistance, and prototype awards for individuals, startups, small businesses, and nonprofit organizations.[57]

State Energy Office Workforce Resources and Programs

Many states have partnered with the National Energy Education Development (NEED) Project, whose mission is "to promote an energy conscious and educated society by creating networks of students, educators, and business, government, and community leaders to design and deliver objective, multi-sided energy education programs." Learn more at www.need.org.

The State Energy Offices in New York, Vermont, and Rhode Island have developed Clean Energy Industry Reports, which reveal insights and trends about each state's clean energy market and labor force. View the reports and other workforce analyses at https://www.usenergyjobs.org/research.

In partnership with Chevron, the Utah Governor's Office of Energy Development offers the Utah Energy Workforce Scholarship, which supports high school seniors intending to pursue STEM or Career and Technical Education (CTE) in Utah. More information is at https://energy.utah.gov/k-12-education/scholarship/.

Many states have begun to focus on the principles of "just transition" to inform how to support workforce transition and training as the energy sector continues to evolve. In Colorado, the legislature created a new office, the Just Transition Office within the Department of Labor and Employment, charged with assisting coal transition workers with completing education and training and providing coal transition communities with grants to support economic diversification and revitalization (https://leg.colorado.gov/bills/hb19-1314). Similarly, in planning for its 2021 State Energy Strategy, the Washington State Energy Office has identified just transition as a potential theme, as the state continues to transition away from coal, natural gas, and petroleum in its economy (https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/).

Connecting Underserved Communities to Cleantech Innovation

Women, minorities, and people from disadvantaged communities are less likely to be represented in the high-tech workforce,[58] including in the energy sector, and especially at the executive level. Simultaneously, low-income and minority households are typically less likely to access energy programs successfully, due to a variety of factors such as housing instability, bill payment challenges, geographic dispersion, lack of access to career development opportunities, lack of access to capital, lower homeownership rates, immigration status, and policy and program limitations.[59] States can address these disparities by designing technology innovation and deployment policies and programs to prioritize underrepresented individuals and communities.

A key underpinning of California's innovation investments is the Energy Commission's Diversity Commitment, which requires that at least 25 percent of the state's electricity technology demonstration and deployment funding be reserved for projects in disadvantaged communities, with an additional 10 percent set aside for projects located in, and benefiting, low-income communities.[60] The Commission's California Sustainable Energy Entrepreneur Development (CalSEED) Initiative exemplifies this commitment by investing in clean energy startups, with a priority focus on small, woman-owned, and diverse-owned businesses that are committed to developing energy and climate solutions for the state's vulnerable populations. With $11 million in funding delivered to 42 startups (including five woman-led businesses), CalSEED has leveraged an additional $45 million in follow-up funding.[61]

A recent EPIC-funded project illustrates how disadvantaged communities can benefit from cleantech innovation and commercialization. In 2018, a team of community-based organizations, local government officials, and university researchers analyzed data to develop an advanced energy community[††] design and financing plan for Avocado Heights/Basset. Avocado Heights/Basset is an unincorporated area of Los Angeles County that has high percentages of renters, low-income, and limited English-speaking residents, as well as high vulnerability to extreme heat. Once implemented, the design is expected to provide various benefits, including reliability and resiliency improvements for the area utility; more affordable energy, better-performing buildings, energy cost savings, and workforce opportunities for the community; and workforce expansion, market innovation, and economic growth for the county.[62]

Policies and Programs Influencing End-Markets

States have discretion, authority, and influence over energy program design, investor-owned utility regulation, transportation planning, tax policy, state investment and procurement strategies, and other areas affecting the energy sector. In this regard, they possess a wide array of policy tools that can drive (or, in some instances, impede) clean energy technology-based economic development. For this reason, state policies and programs to propel clean energy technology innovation and commercialization can come in many forms.

For one, they may establish long-term public investment and program directions. Technology innovation is not a fast or an inexpensive process; it can take decades for a new energy technology to reach market, requiring significant, sustained, and multi-faceted support. To illustrate, State Energy Office activities over the past three decades have contributed to the meteoric rise of land-based wind power in the U.S. energy mix. Together with federal and private

[††] The California Energy Commission defines Advanced Energy Communities as those that minimize the need for new energy infrastructure costs such as transmission and distribution upgrades; provide energy savings and local greenhouse gas emissions reductions; support grid reliability and resiliency by incorporating technologies such as energy storage; provide easier grid integration and alignment with the California Public Utilities Commission's (CPUC) Long-Term Procurement Plan and the California Independent System Operator's local capacity requirements process; can be replicated and scaled-up to further drive down costs; are financially attractive from a market standpoint (developers, home buyers, renters); provide affordable access to renewable energy generation, energy efficiency upgrades, and water efficiency and reuse technologies that reduce electricity consumption for all electric ratepayers within the community; and makes use of smart-grid technologies throughout the community, among other criteria. California Energy Commission. 2018. *The EPIC Challenge: Accelerating the Deployment of Advanced Energy Communities, Phase II*.

sector research investments, states' efforts in planning, wind resource mapping, siting, and the establishment of the nation's first renewable electricity standards (as early as 1983 in Iowa) have enabled wind technology to become cost-competitive with even the least expensive forms of fossil-based generation.[63]

Policy innovations may also help create a level playing field between emerging solutions and incumbent technologies that have benefited from additional years of market penetration, incorporation into standards, and other forms of technological and institutional "lock-in." [64] In recent years, states have entertained various options to achieve this goal, such as through targeted financing and tax structures; reductions in permitting, siting, and soft cost barriers to clean energy development; and the reform of clean energy standards to include no-carbon options like nuclear and hydropower.

Policies may also seek to increase and/or shift demand for clean energy technologies. Many State Energy Offices offer financial incentives and low-cost financing to support business, household, and institutional adoption of energy efficiency and renewable energy technologies.

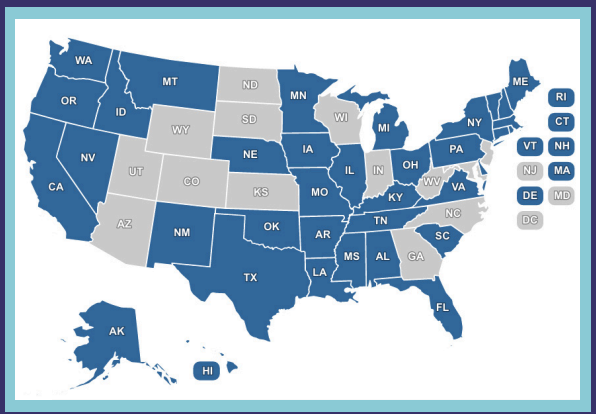
Environmental standards and permitting processes can also promote the creation of cleaner technologies. For instance, regulations by the California Air Resources Board have been influential in spurring refrigeration systems manufacturers and facilities to manage leaks and emissions of high-global-warming-potential gases,[65] and to seek alternative refrigerant solutions.[66]

By the same token, however, standards and permitting processes can also impede innovation if they are designed to favor existing technologies over newer, less well-demonstrated technologies.[67] State Energy Offices can engage standard-setting entities in order to create a level playing field for promising technologies, whether well-established or newly emerging.

Likewise, utility regulation, including rate structures and utility compensation mechanisms, can either encourage or discourage markets for innovative energy technologies, including distributed and grid-interactive energy technologies.[68, 69] In Massachusetts, the Department of Energy Resources is currently developing a new Clean Peak Standard, which can serve as a lever for clean energy market growth and technology deployment. Expected to go into operation in June 2020, the standard will create price signals that incentivize clean electricity or energy demand reduction during seasonal clean peak demand periods. The state predicts that the Standard will save consumers $710 million over the first ten years and prevent 560,000 metric tons of carbon dioxide from entering the atmosphere.[70]

Deploying Cleantech with Innovative Financing

Low-cost and user-friendly financing options can help consumers access clean energy technologies. State energy financing programs date back to the 1970s and 1980s, when early pioneers, such as the states of Nebraska and Texas, used petroleum violation escrow and oil overcharge funds to launch revolving loan funds for energy efficiency and renewable energy projects. Since then, these programs have expanded significantly. Today, the majority of states operate at least one financing program, with many using federal and state funds, greenhouse gas auction revenues, bond issuances, and private capital in innovative ways. Loan portfolio performance data across many states showcase the "investibility" of energy efficiency and renewable energy technology adoption, with several programs across the country with near-zero default rates. NASEO tracks state energy efficiency and renewable energy financing programs, such as revolving loan funds, credit enhancement programs, and other offerings, at www.naseo.org/issues/energy-financing/revolving-loan-funds.



Building codes, appliance standards, and local land-use regulations can also influence market signals for energy technology innovation. The California Energy Commission was authorized by SB-49 (2019) to include flexible demand technology as well as energy efficiency in its appliance standards. Under Massachusetts' Green Communities Act of 2008, localities can choose to adopt a state-approved "stretch code" of greater energy efficiency stringency than the state's base building energy code. Such policies can strengthen cleantech markets and attract innovators to develop solutions and business models to satisfy those markets.

Conclusions

State Energy Office action in the field of cleantech innovation can spark performance improvements and cost reductions in existing technologies, as well as scale-up in investment and deployment of much-needed energy and climate solutions.

State Energy Offices seeking to grow and support their energy innovation ecosystems have many robust tools at their disposal. The policymaking, program design, and stakeholder convening roles played by State Energy Offices offer an opportunity to connect emerging technologies and their innovators with on-the-ground realities about markets, public priorities, and regulations. In addition to offering targeted investment and support of cleantech innovation, State Energy Offices can serve as a focal point of information, communications, and coordination in their cleantech innovation ecosystems, bringing together both private and public partners and helping to bridge federal, regional, state, and local stakeholders as well.

Additionally, enhancing State Energy Office coordination with federal and private sector RD&D investments offers multiple potential benefits, including heightened understanding of state and local policy and market conditions that may affect energy technology markets and commercialization opportunities, greater support for technology incubation and acceleration, and increased ability to leverage state-level investments, financing, and incentives for promising emerging technologies.

There is enormous need for continued investment in solutions that address climate change and environmental impacts; enhance energy affordability, security, reliability, and resilience; modernize the nation's energy infrastructure and strengthen industrial competitiveness; and deliver benefits to all residents, businesses, and communities. The nation's State Energy Offices possess critical tools, resources, and insights to support accelerated progress to meet this need.

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