Clean Energy Champions

The Importance of State Programs and Policies

PREPARED BY

CleanEnergy States Alliance

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BY WARREN LEON

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JUNE 2015

ACKNOWLEDGMENTS

This publication would not have been possible without the Clean Energy States Alliance (CESA) members from across the country who contributed to this report by submitting ideas, sharing information, supplying photographs, and/or reviewing sections of the draft report. We offer our thanks and appreciation to them and to the many other people unconnected to CESA who we interviewed, and who are quoted, in the case studies contained in this report.

We are especially grateful to the CESA Board members—Andrew Brydges, Lise Dondy, Sara Fisher-Goad, Janet Joseph, Suzanne Korosec, Jeremy McDiarmid, Taresa Lawrence, Lewis Milford, Bentham Paulos, Timothy Tutt, and Peter West—for providing initial guidance as we were conceptualizing this project and for commenting on preliminary drafts of key chapters.

Maria Blais Costello copyedited the report and coordinated all the many details involved with producing such a complex publication. Other CESA staff colleagues—Seth Mullendore, Todd Olinsky-Paul, and Robert Sanders—reviewed report chapters and used their expertise to help shape specific sections. Dana Drugmand and Meghan Monahan proofread the report, and David Gerratt of DG Communications was not only responsible for the design and layout but made useful suggestions on the text.

Early on, several clean energy experts—Lori Bird, Jeff Deyette, Elizabeth Doris, Karen Harris, Jenny Heeter, and Ryan Wiser—gave us valuable advice that influenced the scope of the report and the choice of case studies. Then, towards the end, several clean energy experts—Galen Barbose, Jeff Deyette, Jenny Heeter, Betsy Kauffman, and Rob Sargent—reviewed some or all of the manuscript, and provided suggestions that measurably improved the final version.

Design: David Gerratt/NonprofitDesign.com

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Executive Summary

The clean energy industry is growing today in great part because states across the country have embraced clean energy and put in place beneficial programs and policies. Without the states, there would not be nearly as much electricity generation from wind, solar, biomass, and other clean energy technologies. Moreover, there would be far fewer clean energy jobs. Three pillars—the states, the federal government, and the private sector—have all played crucial roles in starting to reshape the nation's electricity system over the past two decades. By showing how state policies and programs have been essential, this report makes the case that the state pillar needs to remain strong.

The states have pursued many paths to the robust clean energy expansion underway today. Because the federal government has not dictated a top-down, one-size-fits-all approach, the states have innovated and experimented with their own clean energy policies and programs. This diversity has served the needs of the states and it bodes well for continued clean energy expansion in the future.

The report provides the first-ever comprehensive review of all the significant ways in which states have advanced clean energy. It is primarily descriptive and draws on previously published studies to paint a richly textured picture of state activities. While it covers some well-known policies and programs, it also reveals others less obvious and less recognized that still have had a major impact. The initiatives covered in the report emanate from all parts of the country, from states large and small, urban and rural, with Republican majorities as well as Democratic ones. The report is organized into six overview chapters followed by 31 case studies of specific state programs.

Developing the Clean Energy Supply

The most prominent way in which the states have supported renewable energy has been by implementing policies and programs that directly incentivize the installation of clean energy generation. Electricity generation from wind, solar, biomass, geothermal, and hydro represents only a modest share of America's electricity supply, but it is important to point out that there is currently much more generation from wind and solar than the U.S. Energy Information Administration projected at the start of the century. State policies and programs played a key role in this greater-than-expected expansion. Most importantly, the rapid adoption of state renewable portfolio standards (RPSs) required electricity suppliers to increase the percentage of their electricity from renewables. RPSs altered the decisionmaking and operations of electricity regulators, utilities, the energy industry, and other stakeholders.

Beyond RPSs, other potent state policies have included the provision of tax credits related to clean energy investment and production. Net metering for solar photovoltaics (PV) has been another important policy and is offered by the majority of states. It gives PV system owners credit, most often at retail rates, for the electricity their systems add back to the electricity grid. In addition, some states have adopted special solar-friendly provisions within their RPSs, offered rebates to purchasers of PV systems, and created group buying programs that bring down system costs.

The most prominent way in which the states have supported renewable energy has been by implementing policies and programs that directly incentivize the installation of clean energy generation.

States have also targeted other clean energy technologies that are well matched to their particular economy and geography. For example, some states have promoted biogas digesters that generate electricity from various organic materials, including manure, food waste, yard waste, and municipal wastewater solids. States are also encouraging the use of renewable energy for heating and cooling, with technologies like low-emissions wood-burning systems, geothermal heat pumps, air source heat pumps, and solar hot water systems.

Overcoming Barriers by Building the Infrastructure for Clean Energy Growth

States have made a wide range of investments aimed at building or improving the infrastructure needed for clean energy growth. They created tracking systems that enable large-scale, regional markets for electricity from renewable energy sources. They supported the development of physical infrastructure, such as electricity transmission lines, high-tech electricity meters, and batteries for energy storage. They updated and streamlined long-established administrative processes that were inhibiting clean energy development. They strengthened necessary financial infrastructure by creating and enabling financial innovations. Finally, they developed organizations and mechanisms for information sharing, collaboration, and dissemination of best practices.

These sorts of infrastructure improvements may not be headline news or easy to understand, but they are essential.

Building a Vibrant Clean Energy Industry

States across the country have helped clean energy businesses to grow, because they want to capture the resulting job creation and other economic benefits. Sometimes, they offer the same types of temporary tax reductions, loans, and related assistance given to businesses in other industries seeking to expand in their state. But the states have also created special programs targeted specifically at clean energy businesses. They established clean energy research centers at state universities. They created business incubators that provide expertise and services aimed at nurturing small firms. They provided grants to companies to deploy innovative, early-commercialization-stage technologies, sometimes targeting a particular clean energy industry with potential to prosper in a given state. They sponsor and run facilities that enable clean energy companies to test new technologies. And they address workforce development through internship programs and other activities.

Protecting and Including Consumers

The many tens of thousands of individuals, businesses, and organizations that each year consider purchasing distributed generation systems—solar electricity, combined heat and power, fuel cells, small wind turbines—need sound information and assurances that they are dealing with reputable, competent vendors and contractors. States are taking the lead in looking out for the interests of consumers, even though those actions are not always widely recognized as "consumer protection."

Among other things, many states require equipment installers to have specific licenses and to undergo special training. States also set equipment standards that, in the absence of any official national standards, sometimes serve as informal, *de facto* national standards. They take action to ensure systems are properly sited and perform well. They publish information to help consumers make informed decisions.

The states are also addressing a different type of consumer issue—the uneven ability of state residents to benefit from clean energy technologies, such as solar electricity. With that concern in mind, they are taking a variety of steps to ensure that all income groups can reap the rewards of solar.

Lessons for State Activities

Examination of the broad scope of state activities over the past 15 years suggests four lessons for maintaining the states' effectiveness in advancing clean energy.

INNOVATION IS KEY TO THE STATES' SUCCESS

The states have been seedbeds of ingenuity and innovation. They have served as "laboratories of democracy," testing policy ideas and then spreading the successful ones across the country. Although it could be tempting for states to slow the pace of new program development now that they have many well-established programs and policies in place, it is important to continue to experiment and innovate. States can achieve continued program improvements by emphasizing program evaluation, identifying issues that have not received adequate attention, and closely monitoring industry trends in order to develop new programs and strategies, including targeted support aimed at assisting promising emerging technologies and new business models. To be able to carry out these important tasks, the states can make sure they are providing state agencies working on clean energy with adequate funding and staff.

The states have been seedbeds of ingenuity and innovation and have served as "laboratories of democracy," testing policy ideas and then spreading the successful ones across the country.

CONSUMER PROTECTION ACTIVITIES ARE INCREASINGLY IMPORTANT

As noted above, states are already having a significant impact by imposing standards, requiring professional training, and educating the public. This consumer protection role will increase as the market penetration of distributed clean energy technologies grows. To prepare, states can forge stronger ties between their energy agencies and the consumer assistance sections of their attorney general offices.

They can also identify the specific consumer protection issues that may arise in their state and work together across state lines so that the costs of consumer protection measures will be reduced for industry, as well as for the states.

STATES' DISTRIBUTED GENERATION POLICIES HAVE DRIVEN CLEAN ENERGY EXPANSION

Policies such as net metering and streamlined permitting have fueled the rapid spread of rooftop solar and other distributed technologies. This has led to concerns about the potential impacts on utility revenues and on the cost of electricity for ratepayers who do not have PV systems. Utilities' business models will likely need to change in the future and some state policies may need to be modified. This is an extremely important issue for state policymakers to address. They should thoroughly study various alternative policy proposals, such as minimal bills, value of solar tariffs, and utility ownership of solar installations. Because, with few exceptions, the market penetration of distributed generation is not yet large enough to have a significant impact on either utility profits or customers' electricity rates, states have time for careful policy review in order to identify and adopt the best policies for simultaneously maintaining robust clean energy growth, preserving the viability of the electric utility industry, avoiding large electricity price spikes, and delivering value to consumers.

CLEAN ENERGY IS NOT A PARTISAN ISSUE

There has been very broad-based state participation in advancing clean energy. While there are certainly some hot button issues in some states, there are still opportunities for bipartisan and nonpartisan discussion on issues related to clean energy. State policymakers and program managers

A small, 4.4 kW hydroelectric project in Oregon generates about 25,000 kWh annually.

should continue to maintain active communication with peers from other regions and with other political views. By exchanging ideas across state lines, they can learn from each other and identify policy ideas that make the most sense for their state.

Lessons about the Role of the Federal Government

The federal government has been an essential partner for the states. Looking at how these two pillars of clean energy growth have intersected, it is possible to draw three lessons that suggest how the federal government can continue to encourage state leadership and innovation.

The federal government, especially through DOE and the national energy laboratories, has helped the states arrive at sound policies by providing data and analysis on clean energy technologies and on policy options.

THE FEDERAL GOVERNMENT PROVIDES STATES WITH NECESSARY INFORMATION AND ANALYSIS

The federal government, especially through U.S. Department of Energy (DOE) and the national energy laboratories, has helped the states arrive at sound policies by providing data and analysis on clean energy technologies and on policy options. It also plays an essential convening and coordination role. Those activities have become even more important as clean energy market penetration has increased. The federal government can help by providing accurate data and analysis of the economic implications of various clean energy technologies and policies. It can also help the states figure out how to most effectively integrate large quantities of renewable energy into the electricity system.

FEDERAL FINANCIAL INCENTIVES HAVE WORKED WELL IN COMBINATION WITH STATE INCENTIVES

State clean energy incentives have been effective, because they have complemented federal policies, not been a substitute for those policies. Although it may be appropriate to alter or reduce some of the federal tax credits and other federal incentives, it should be recognized that there has been a partnership between the states and the federal government to support clean energy. That partnership should continue.

STATES' EXISTING CLEAN ENERGY PROGRAMS CAN BE IMPORTANT TO EPA'S CLEAN POWER PLAN

If U.S. Environmental Protection Agency (EPA) plan is implemented, state compliance plans will be able to draw on the whole suite of existing state clean energy policies and programs. Renewable energy generation should be given considerable encouragement in the Clean Power Plan. That plan should be carefully constructed to avoid weakening state RPSs. In addition, U.S. EPA and the states should work together to explore adapting the existing regional renewable energy tracking systems for broader monitoring of state activities under the Clean Power Plan.

Highlights from Case Studies

The report's 31 case studies demonstrate the breadth of the pioneering and influential state programs that have been implemented around the U.S. They also highlight specific states that have been leaders in certain policy or program areas. While the case studies detail a wide range of activities, they are only a sampling of the collective efforts of all states that have worked to deploy clean energy across

Energy storage batteries at the Santa Rita Jail microgrid in California.

the country over the past 15 years. Furthermore, most of the states that are featured in the case studies have implemented multiple programs that successfully support clean energy, but the report has room for only one or two case studies about any state, with the exception of California, which has three. Here are highlights from some of the case studies:

- Alaska helped remote communities that have stand-alone electric grids switch from high-cost diesel generators to renewable energy.
- California significantly built the market for utility-scale energy storage technologies by mandating energy storage use and investing in research.
- Colorado enabled people unable to put solar on their own roofs to participate in "community solar gardens" that provide the same economic benefits as home installations.
- Connecticut helped commercial building owners make clean energy improvements by offering a statewide, cash-flow-positive financing program that is attracting private investors.
- District of Columbia brought the benefits of solar to Washington's low-income residents.
- Hawaii created a unique financing mechanism to make low-cost loans for PV systems available to thousands of households.
- Illinois invested in modernizing its electric grid to allow for "smart grid" technologies and the inclusion of more clean energy generation.
- Massachusetts created and funded an innovative workforce development program that placed nearly 1,200 paid interns in 262 clean energy companies.

- Maryland prepared for offshore wind energy development by carrying out marine spatial planning, working with industry, and creating an offshore wind component in its RPS.
- Minnesota formally studied the value of solar to the electricity system, creating an alternative methodology for setting electricity rates for solar customers.
- North Carolina used an RPS to greatly increase its use of renewable energy.
- Nevada provided incentives that attracted a $5 billion factory that will make electric car batteries and stationary batteries for homes, businesses, and utility-scale use.
- New Hampshire promoted better wood heating by incentivizing high-efficiency wood pellet boilers and furnaces.
- New Jersey developed the third-most solar capacity in the United States by developing a special solar program within its RPS.
- New Mexico used a production tax credit, an RPS, and investment-grade maps of wind resources to ramp up clean energy generation and increase state land lease revenues.
- New York created a catalog of modular, pre-packaged, combined heat and power (CHP) systems to reduce the cost and ensure the performance of the technology.
- Oklahoma instituted a production tax credit and other incentives for wind farms, thereby tripling the state's wind capacity since 2011.
- Oregon pioneered conduit hydro projects that generate power from irrigation ditches and municipal water, while also enabling water-saving infrastructure upgrades.
- Rhode Island tested the proposition that distributed solar generation can defer or potentially eliminate grid upgrades and enhance reliability
- Texas invested in new transmission capacity that led to the development of more wind energy than in any other state.
- Vermont made it easy to obtain permission to install small solar systems by streamlining permitting and interconnection.
- Wisconsin promoted and popularized biogas digesters that convert manure into renewable energy and yield useful products, including organic fertilizer and animal bedding.

Conclusion

Up to now, the states have been an essential pillar of clean energy growth. They have been able to play that role because governors, legislators, and state agency staff have given significant attention to clean energy as an issue. They have been willing to put in place new innovative policies and to modify them over time, as necessary. They have provided sufficient budgets to carry out those policies and to staff the agencies that oversee them. By taking a similar approach in the future, states across the country will continue to be a central pillar of clean energy growth in the future.

CHAPTER 1

Introduction

America has embarked on a journey towards a cleaner electricity system. With more than 50,000 wind turbines and more than 650,000 solar installations producing power for electricity consumption across the United States, most people routinely see these symbols of a new energy era. Less visually iconic technologies, including biogas digesters, combined heat and power (CHP) co-generation, and energy storage devices, are also helping to make the electric system cleaner and more efficient. Although the transition of America's electric power generation from fossil fuels to renewable energy is still in its early stages, we would not be nearly as far along—and would not be poised to make nearly as much progress in the coming decades—if individual states had not created and implemented policies and programs to advance clean energy.

This report, prepared by the Clean Energy States Alliance[1] (CESA), describes and extols the many important ways in which states across the nation are advancing clean energy generation. Some state programs are relatively well known, such as renewable portfolio standards and rebates for purchasing solar panels. But the states have had significant impacts in other less obvious, less recognized ways:

- States have built the infrastructure necessary to overcome barriers and to allow clean energy markets to flourish. For example, they have designed regional systems for tracking renewable electricity, upgraded transmission infrastructure, created new methods for financing clean energy, and streamlined administrative procedures to speed permitting and interconnection for clean energy installations.
- States have directly helped clean energy businesses to grow, often giving special attention to the difficulties start-up companies face. Among other things, they have created business incubators, sponsored facilities for testing emerging technologies, and offered business loans.
- States have implemented a wide range of actions —requiring warranties, setting equipment standards, providing consumer information—that collectively protect the public and reduce the chances of consumer dissatisfaction with an industry with few national consumer protection standards.

- The states are trying to ensure that all segments of society benefit from clean energy. Their programs are increasingly working to reach and serve low- and moderate-income households and communities.
- States are giving increasing attention to making the nation's electric system more resilient and flexible. They are using clean energy generators combined with energy storage to help police stations, emergency shelters, and other critical facilities remain functioning during power outages. They are also modernizing the electric grid with smart grid technologies and making it able to accommodate generation from distributed and variable power sources.

Different states have focused on different issues, but collectively they are having a major impact in all of the areas listed above. As this report will show, innovations and important initiatives have come from states in all parts of the country, from large states and small ones, from urban and rural ones, and from those with solid Republican majorities as well as those with solid Democratic majorities. Elected officials and administrators recognize that clean power confers economic, social, and environmental benefits, and that supporting clean energy development is sound policy that transcends partisan politics.

Elected officials and administrators recognize that clean power confers economic, social, and environmental benefits, and that supporting clean energy development is sound policy that transcends partisan politics.

The report starts with the most obvious arena for state action—policies and programs to encourage and incentivize the installation of clean energy generating facilities. It then delves into the other topic areas listed above. The report concludes with key lessons learned that show how the states can continue to maintain their key role in advancing clean energy, and how the federal government can encourage continued state leadership and innovation. To a considerable extent, this report tells the story of state success through case studies of individual programs that have been influential in one of two ways: they have been adopted widely or they have shaped the development of the clean energy market at a regional or national level.

Of course, the states have not operated in isolation. Many electric utility companies have worked closely, and even eagerly, with states utility regulators and policymakers to implement clean energy programs and policies. Some public utilities, most notably Austin Energy and the Sacramento Municipal Utility District, have established pioneering programs that have spread widely and influenced the states. Many municipalities have embraced clean energy and have enthusiastically partnered with the states on joint projects.

State actions and associated activities with utilities and municipalities are certainly not the only reasons why clean energy has been making strides. Businesses—both young start-ups and long-established firms—have developed new products, financing approaches, and business models that have made possible the commercialization of clean energy technologies.

The federal government has been especially important through the U.S. DOE's funding of essential research by the national laboratories, universities, and businesses, as well as through federal tax credits, loans, and grants. Looking forward, the Environmental Protection Agency's Clean Power Plan could become another important federal driver of clean energy development.

Clean energy growth has rested on several pillars with the federal government, the private sector, and the states playing crucial roles. This report explores the shape and importance of one of those pillars. By showing all the many ways in which state policies and programs have been essential, the report will make the case that this pillar needs to remain strong and dynamic.

CHAPTER 2

Developing the Clean Energy Supply

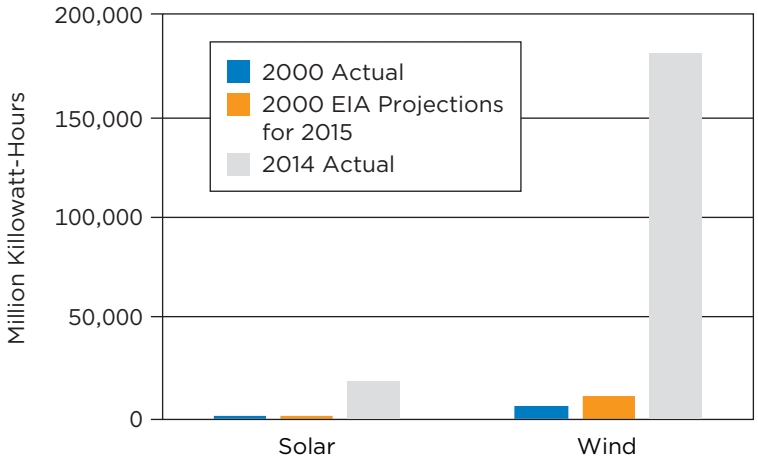
Every year, the U.S. Energy Information Administration (EIA) issues a report with projections of the nation's future electricity supply. It predicts how much electricity will be generated from all the different energy sources—coal, natural gas, nuclear, biomass, hydro, wind, solar, etc.—going 20 or more years into the future. In the last month of the 20th century, EIA projected that if trends continued until 2015, and no additional policy incentives were implemented, the nation's wind energy generation would more than double to nearly 12 billion kilowatt-hours annually, enough to power more than a million average American homes.[2] Solar electricity from photovoltaics (PV) and concentrating solar would increase more than fourfold to over 2 billion kilowatt-hours.[3]

Although we obviously do not know exactly how much electricity will end up being generated by the end of year 2015, EIA has published the numbers for 2014. In that year, wind energy produced more than 15 times more electricity than EIA projected for 2015, while solar produced nearly nine times more.[4] This was enough electricity to power 16.7 million average homes from wind and 1.7 million from solar PV. In addition, since the year 2000, electricity generation from wood and other biomass has also increased, although in less dramatic fashion, from the equivalent of 3.4 million homes' consumption to 3.9 million.[5]

Although there are many reasons why solar and wind generation have advanced faster than EIA expected—everything from faster-than-anticipated drops in the cost of manufacturing solar PV panels to the impact of federal spending through the *American Recovery and Reinvestment Act of 2009*—state policies and programs played a large role. Most prominently, the rapid adoption of state renewable portfolio standards (RPSs) required electricity suppliers to get a growing percentage of their electricity from renewables. EIA's turn-of-the-century *Energy Outlook* report projected that the relatively few state RPS policies then in place would require an additional 5.2 gigawatts of renewable energy generation capacity to be built over the next 20 years leading up to 2020. Instead, RPS-driven additions to capacity actually averaged more than 6 gigawatts each year from 2008 through 2014.[6]

FIGURE 1

Growth in Solar and Wind Generation (2000–2014)



Source: U.S. Energy Information Administration

So, how did the RPSs contribute to clean energy growth? And what other ways did state policies and activities lead to expanded clean energy generation? These questions are the focus of this chapter.

RPSs Lead to New Clean Energy Generation

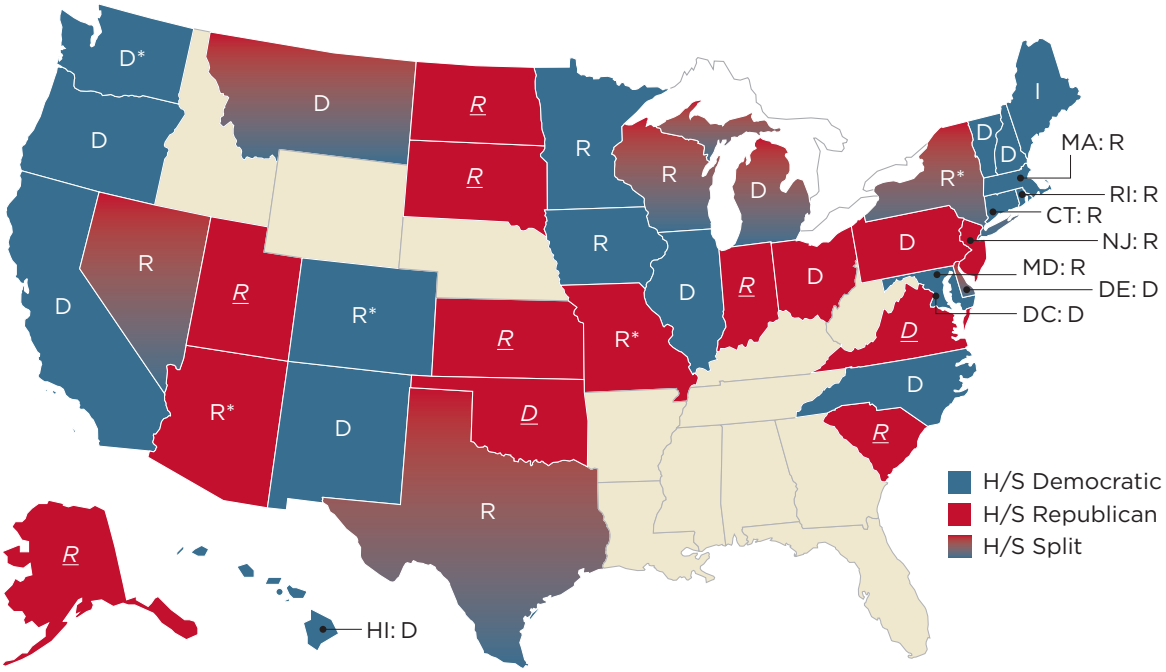
An RPS or a similar policy under a different name has been established in 29 states plus the District of Columbia.[7] These standards require electricity suppliers to get an increasing share or amount of their electricity from renewable energy and other clean energy technologies. An additional eight states have non-binding goals that encourage utilities to support clean energy development. With the exception of the greater southeast (from West Virginia to Louisiana), where North Carolina is the only one of 12 states with an RPS and South Carolina and Virginia are the only ones with non-binding goals; all but four states in the rest of the country have either an RPS or voluntary goals.

Although RPSs have recently become politically controversial in some states, they were established with broad bipartisan support and in states controlled by both political parties. Of the 37 states with an RPS or voluntary goals, 20 had Republican governors at the time they were established, 16 had Democratic governors, and one had an Independent governor. As Figure 2 shows, control of the states' legislatures was also split between the political parties.

According to Lawrence Berkeley National Laboratory (LBNL), "60% (45 GW) of all non-hydro renewable capacity additions from 1998–2013 are under-contract or owned by entities with RPS obligations and entered operation after RPS enactment."[8] As the LBNL researchers acknowledge, this statistic is an imperfect measure of the impact of RPSs, because some of those renewable energy projects would have been built even without the impetus of an RPS.

FIGURE 2

Renewable Portfolio Standard: A Bipartisan Policy



This map shows the party in control of the state legislature (House/Senate) and governors office at time of enactment of RPS or voluntary renewable energy goal. *Italicized* and underlined text indicates a state with a renewable energy goal.

*Both AZ and NY adopted RPS policies through regulatory proceeding, though in NY it was at the explicit direction of the governor. RPS policies in CO, WA, and MO were initially adopted via ballot initiative.

Courtesy of Union of Concerned Scientists

Because of Constitutional issues having to do with interstate commerce, most RPSs allow renewable energy generators beyond a state's border to participate.[9] In Wyoming, a non-RPS state, wind farms qualify for the Oregon RPS. Likewise, North Dakota wind farms participate in the Minnesota RPS and Vermont landfill gas facilities participate in the Massachusetts RPS.[10] There are many other examples of projects that have benefitted from the existence of an RPS in a nearby state. The exact contribution of RPS policies to the growth in total U.S. renewable energy capacity is impossible to quantify with precision, but there can be no doubt that it has been significant.

Beyond simply providing an additional revenue stream for renewable generation facilities, RPSs have catalyzed far-reaching changes, altering the decisionmaking and operations of electricity regulators, utilities, the energy industry, and other stakeholders. When a state institutes an RPS, such as requiring 10 percent of a state's electricity supply to come from designated clean energy sources within 10 years, the various players involved in supplying and overseeing the state's electricity begin to think of all the changes they need to make in order to meet the RPS mandate. That can involve changes in how utilities and other electricity suppliers contract for electricity, how public utility commissions plan for new transmission capacity, and how project developers decide about which projects to develop. It has required the creation of new systems for tracking the production and sale of electricity from renewables.

RPSs have also given many participants in the electricity system experience with clean energy technologies. The implications of significant renewable energy development are now much better known and are given much greater attention. Before RPSs, most utilities had little familiarity or experience with small-scale, distributed, variable-output electric power generation. (See ***Case Study 1*** on North Carolina's RPS policy.)

Case Study 1—North Carolina

RPS policy in North Carolina. See page 55.

Case Study 2—Oklahoma

Oklahoma wind energy efforts. See page 57.

In their initial incarnations, state RPSs focused on utility-scale renewable energy generation. The goal was to get the most renewables installed at the lowest cost, without quotas for specific renewable energy sources and technologies. Since then, many RPSs have been modified and now include special provisions to assist certain technologies. Nevertheless, wind has been the primary beneficiary of RPS programs with 76 percent of the RPS-related energy coming from wind between 1998 and 2013. Of the remaining, 12 percent was from biomass, 8 percent from solar, and 4 percent from geothermal. However, it is important to note that the balance between the energy sources has shifted recently, with solar accounting for more new RPS supply than wind in 2013.[11]

Tax Credits Help Renewables

Although RPSs have been the primary state policy vehicle for stimulating utility-scale development of renewable energy, some states have used tax credits to good advantage.

Oklahoma, for example, has become a major center of wind development by offering targeted tax benefits. Wind farms there receive a tax credit of $0.005 per kilowatt-hour generated, which is refundable if the wind farms do not have enough income to claim the credit. In addition, wind farms are exempt from local property taxes for five years, although that policy is being phased out. (See ***Case Study 2*** on Oklahoma's wind energy efforts.)

New Mexico offers wind and biomass energy producers a refundable personal or corporate tax credit of 1 cent per kilowatt-hour for projects greater than 1 megawatt. The credit is $0.027 per kilowatt-

hour on average for solar projects. These credits combined with an RPS and gross receipts tax exemptions create a powerful package of incentives. (See ***Case Study 3*** on New Mexico's Renewable Energy Tax Credit.) Iowa also combines the two types of policies, including a tax credit of $0.015 for "wind, biogas recovery, biomass, methane gas recovery, solar, or 'refuse.'" Utah's Alternative Energy Development Incentive provides a "tax credit for 75 percent of new state tax revenues (including, state, corporate, sales and withholding taxes) over the life of the project, or 20 years, whichever is less," for projects greater than two megawatts.[12]

States have been most effective when they have put in place an integrated bundle of long-term policies and programs that together give solar a powerful boost.

States Support Solar with a Bundle of Policies

Solar energy has benefitted significantly from state programs and policies. The states' enthusiasm stems from its exceptionally high public support, its suitability for a wide variety of locations, and the ability of a large number of individual households and businesses to take advantage of the technology directly by installing it on their property. Moreover, although there are sometimes objections from neighbors and communities, proposed solar PV projects are less likely to receive vocal opposition than other types of electricity generating projects.

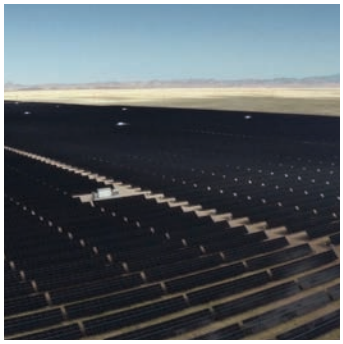
States have been most effective when they have put in place an integrated bundle of long-term policies and programs that together give solar a powerful boost.[13] This provides market certainty, which allows solar businesses and other market participants to make long-term plans. California pioneered and modeled this idea of sustained orderly development of the solar industry. (See ***Case Study 4*** on California's solar development goals.) Although that state has advantages when it comes to solar development, including an excellent solar resource and high electricity prices, the disproportionately large share of the nation's solar development that has taken place in California—48 percent of total PV capacity at the end of 2014[14]—can only be explained by the state's suite of policies and programs.

Net metering has been a key component of the solar policy bundle, not just in California but in most other states. This policy "allows residential and commercial customers who generate their own electricity from solar power to feed electricity they do not use back into the grid." In places where net metering is available, there can be times in the day when the PV system generates more electricity than the customer needs. The excess electricity is credited against the times at night when the solar PV system is not producing power. In effect, the customer's electricity meter runs backward when excess power is produced.[15]

More than 40 states have some type of net metering, although the scope and specific provisions vary considerably. According to an annual report by Vote Solar and the Interstate Renewable Energy Council that grades the effectiveness of the states' net metering policies, 18 states get top scores for having programs that are financially advantageous for solar system owners and that allow for wide participation.[16]

Over the past two years, utilities in some states have started to voice opposition to net metering, because of the negative impact that the growing popularity of rooftop systems could eventually have on their revenues. Although modifications to net metering rules may be made in some states, the strong underlying public enthusiasm for solar technology will most likely ensure that policy support for solar will continue

Case Study 3—New Mexico



New Mexico's renewable energy tax credit. See page 59.

Case Study 4—California

California's solar development goals. See page 61.

in some form in most places and that there will still be financial benefits from installing solar. To the extent that states consider alternatives to net metering, it will not necessarily mean a turning away from solar. Minnesota has studied and implemented a "value of solar tariff" as an alternative that would still allow for robust solar growth. (See ***Case Study 5*** on Minnesota's efforts to "value" solar.)

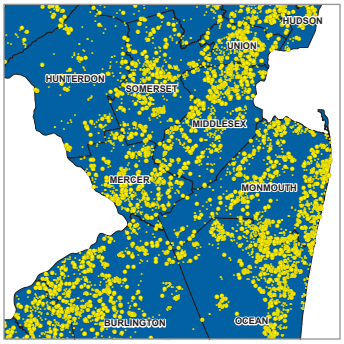
Every state with an RPS allows solar electricity to qualify as an eligible technology to meet the RPS obligation. But until recently, solar's higher cost when compared to electricity from utility-scale wind, biomass, and geothermal projects has meant that PV generation was not used for compliance in the main tier of state RPSs. For that reason, some states created a special carve-out (also sometimes called a set-aside) within their RPS to require a certain share of the RPS-mandated electricity to come from solar or from small, distributed generation technologies including solar. New Jersey has an especially ambitious RPS carve-out for solar. (See ***Case Study 6*** on New Jersey's SREC program.) At the moment, 17 states and the District of Columbia have either a solar or a distributed generation carve-out.[17] As an alternative or a supplement to a carve-out, a few states, such as Michigan and Nevada, give solar extra credit towards meeting an electricity supplier's RPS compliance obligations.[18]

A study by three academic researchers led by Andrea Sarzynski from the University of Delaware proved solar carve-outs to be especially effective policies. Using sophisticated regression analysis of the impact of various state policies during the years 1997 to 2009, they found that, once other variables were factored out, states with solar carve-outs "installed over 722 percent more PV capacity, on average, than states without solar carve-outs."[19]

Case Study 5—Minnesota

Minnesota's efforts to "value" solar. See page 65.

Case Study 6—New Jersey



New Jersey's SREC program. See page 67.

In addition to net metering and RPS carve-outs, states have offered rebates and grants to customers who wish to purchase and install a solar electricity system. In the early years of the market, state incentives were often one of the main factors, along with the federal solar tax credit and net metering policies, which enabled households and businesses to afford solar. Over time, as the market has matured and the cost of solar has declined, the states have been able to ramp down or even eliminate their rebates and grants, but that does not diminish the importance that those incentives had in giving PV technology a foothold in the electricity market. The University of Delaware-led study found that state cash incentives, such as rebates and grants, led to "consistently stronger deployment of PV technology" than would otherwise have been the case. "Holding all other variables constant, the presence of a cash incentive in any given state was associated with a 248 percent higher amount of PV installed, on average, as compared to states not having a cash incentive."[20]

Case Study 7—Solarize

State Solarize campaigns.
See page 69.

Among the other financial incentives that many states offer are property tax exemptions or reductions. Different states do this differently. In Wisconsin, for example, the value added to a property by a PV system installation (as well as a biogas or wind installation) is exempt from general property taxes, so installing solar on a home does not increase the property's assessment for tax purposes. Maryland, New Jersey, and Texas are a few of the states that have similar laws, sometimes only for PV and sometimes for a range of clean energy technologies. North Carolina gives an exemption for 80 percent of the system's total value. Montana grants an exemption for 10 years and limits it to $20,000 for a single-family home and $100,000 for a multi-family residence or commercial building. Alaska has a law giving municipalities the option to exempt residential renewable energy systems from property taxes. Colorado and New Hampshire have similar laws that cover more classes of property.[21]

In terms of non-financial incentives, states have made it easier to issue permits for a PV system and to interconnect it to the utility grid. Those infrastructure changes are discussed in Chapter 2, as is the role of states in developing solar financing innovations—leases and power purchase agreements—that reduce or eliminate the need for upfront costs to acquire a PV system.

State agencies have provided financial and technical support for marketing campaigns that use group purchasing and community-based outreach to reduce the cost of solar and increase its rate of adoption.

Finally, state agencies have provided financial and technical support for marketing campaigns that use group purchasing and community-based outreach to reduce the cost of solar and increase its rate of adoption. These campaigns, usually branded with the "Solarize" name, started in Oregon and have since spread to Massachusetts, Connecticut, and 17 other states. (See ***Case Study 7*** on state Solarize campaigns.)

Not all states with active solar markets have the same bundle of policies and programs. A 2014 Environment America report found that the 10 states with the highest per capita installed solar capacity vary in their sizes, geographies, and climates, but they have a robust package of policies compared to the typical state that is not in the top 10. Nine of the 10 states have strong net metering policies, all of them have an RPS, eight have a solar or distributed generation carve-out within the RPS, nine have favorable interconnection policies, and nine allow solar businesses to offer innovative financing options. The top 10 states have 26 percent of the nation's population but 87 percent of the total installed solar capacity.[22]

Targeted Strategies for Emerging Clean Energy Technologies

For clean energy technologies that are not yet widely deployed, states have pursued focused strategies combining policy changes, financial incentives, and public education. Different states have targeted different technologies, depending upon which best match their economy and geography.

Biogas digesters, for example, can turn manure, a waste product of livestock agriculture, into an asset. Farmers who install a biogas digester can power much or all of the farm from the waste while reducing methane emissions and the risk of water pollution. The digested manure that remains at the end of the process can be used as fertilizer, mulch, or animal bedding.

Wisconsin's Focus on Energy program developed and implemented a multi-faceted initiative to help dairy farmers install biogas digesters. It included state rebates, help with securing grants from the U.S. Department of Agriculture's Renewable Energy/Energy Efficiency Program, and extensive outreach to farmers. (See ***Case Study 8*** for more on Wisconsin's biogas digester program.) The Wisconsin initiative was probably the most thorough state effort and it influenced other states. Among the other states that have worked with farmers on biogas projects are New York, Oregon, Pennsylvania, and Vermont.

Case Study 8—Wisconsin

Wisconsin's biogas digester program. See page 71.

The U.S. EPA, which runs a voluntary outreach program promoting the recovery of methane from animal manure, earlier this year estimated "that there are approximately 247 anaerobic digester systems operating at commercial livestock farms in the United States." Of those systems, 202 were at dairy farms and most of the rest were at pig farms. Unsurprisingly, Wisconsin had the largest number of systems with 37. The other states that had active programs also have a large number of systems in place relative to the size of their agricultural sector.[23]

Similar technology can be used to convert food waste, yard waste, and municipal wastewater solids into electricity and heat. In Gresham, Oregon, technical and financial assistance from Energy Trust of Oregon and the Oregon Department of Energy helped the energy management team of the city's

The City of Gresham Wastewater Treatment Plant. By collecting and diverting fats, oils, and grease (FOG) out of the waste-water collection stream and using anaerobic digesters to create biogas from the waste, this system enables the wastewater treatment facility to reach its net-zero energy use goals.

wastewater treatment plant to make that facility the first in the Pacific Northwest to achieve net-zero energy consumption from a combination of renewable energy production and energy-efficiency investments. Over the course of a year, two biogas-fueled, co-generation engines plus a solar array will produce as much electricity as the wastewater treatment plant needs to operate. To increase the volume of biogas produced in the digesters, the facility accepts fats, oils and grease from nearby restaurants and food processors. This reduces waste disposal fees for those institutions while increasing renewable energy generation and the collection of tipping fees.[24]

To reduce organic waste, Massachusetts has developed a coordinated inter-agency effort that includes a ban on landfilling or combusting commercial organic material and regulatory changes that make anaerobic digestion easier to implement. The goal is to reduce disposal of food waste by an additional 350,000 tons per year by 2020. The Massachusetts Clean Energy Center's Commonwealth Organics-to-Energy Program funds public education about food-waste-to-energy technologies and provides support for feasibility studies and project construction.[25]

Energy Trust of Oregon has actively advanced a different type of technology: small, environmentally friendly hydroelectric projects in places where water is already dammed or diverted, such as agricultural irrigation pipelines. In recent years, it has completed 10 such projects. Based on that experience, it submitted comments to the Federal Energy Regulatory Commission that helped lead to a simplified permitting process nationwide for small hydropower projects that do not involve new dams. (See ***Case Study 9*** on Oregon's efforts to expand small hydropower.)

In recent years, some states have become more interested in promoting renewable energy for heating and cooling, rather than just for electricity generation. Eleven states now include some sort of renewable heating technology—biomass, geothermal heat pumps, air source heat pumps, solar hot water—in their RPS and make provision for measuring the heat output of heating systems and converting that output into the equivalent of renewable energy certificates from electricity generating facilities.[26] New Hampshire has been especially active in promoting low-polluting, efficient wood-burning heating systems, not only including them in a special renewable thermal RPS carve-out but also offering rebates for wood pellet systems. (See ***Case Study 10*** for more information on New Hampshire's efforts to expand biomass thermal technologies.)

Case Study 9—Oregon

Oregon expands small hydropower. See page 73.

Case Study 10—New Hampshire

New Hampshire supports biomass thermal technologies. See page 75.

Setting the Stage for Offshore Wind Development

Paradoxically, even though no offshore wind projects have yet been built in the U.S., offshore wind shows how important state efforts are to advance clean energy development. In this case, it also shows how many barriers the states need to overcome and how long the development process can be to deploy emerging clean energy technologies.

In Europe, more than 8,000 megawatts of offshore wind are already in operation. In the U.S., the offshore wind resource is impressively large. According to the National Renewable Energy Laboratory, in just Mid-Atlantic and Northeast waters, there is the wind resource potential to develop more than 400 gigawatts in water up to 30 meters, enough to produce enough electricity for about 120 million typical American homes. Additional offshore wind could be installed in waters between 30 and 60 meters in depth.[27] Of course, not all of the theoretical locations for offshore wind would be practical or desirable, but considerable energy could be produced.

The great potential of the offshore wind resource explains the desire of the states and the federal government to tackle the hurdles to development. The federal Bureau of Ocean Energy Management has established task forces in most Atlantic coast states, has identified Wind Energy Areas for offshore development in some areas offshore of the Northeast states, and has auctioned off leases in some of the areas. The Department of Energy's Offshore Wind Advanced Technology Demonstration Project has provided nearly $169 million in funding to seven projects.

As for the states, several of them have grouped together to address ocean planning. Two states, Massachusetts and Rhode Island, have passed and are implementing comprehensive state marine spatial plans. States have partnered with the federal government to conduct ecological surveys and have worked with the federal government to streamline permitting processes.

As examples the many diverse steps the states have taken, Virginia in 2007 established the Virginia Coastal Energy Research Consortium to provide research and development required for the commercialization and implementation of new coastal energy technologies. Maine, primarily through the University of Maine, has been a leader in innovative wind platform design to reduce costs and make installations in deep water feasible. New Jersey's 2010 Offshore Wind Development Act created a special carve-out within the state's RPS to provide financial support for large-scale offshore wind development. Massachusetts has invested $100 million to construct the Marine Commerce Terminal in New Bedford, a first-in-the-nation facility specifically designed to construct, assemble, and deploy offshore wind projects along the Atlantic Coast. Rhode Island partnered with a developer, Deepwater Wind, in late 2008 to develop and build a 30-megawatt project in state waters off of Block Island. That project, which began construction in 2015, will become the nation's first offshore wind project in 2016.[28]

Maryland has been one of the states with large, multi-faceted offshore wind efforts. The state has analyzed its offshore wind potential, collected information from wind developers interested in constructing an offshore wind project off the coast, carried out marine spatial planning, created an RPS carve-out for Offshore Wind Renewable Energy Credits, and led three overseas delegations. Thanks to these and other state activities, a major project is under development in the Wind Energy Area off the Maryland coast. (See ***Case Study 11*** on Maryland's efforts to develop offshore wind.)

Case Study 11—Maryland

Maryland's efforts to develop offshore wind. See page 77.

A wind turbine blade being delivered to the Massachusetts Wind Technology Testing Center.

Setting Big Goals

While states have advanced clean energy by focusing on targeted initiatives for offshore wind, biomass, and other specific resources, they have also made progress by establishing comprehensive and forward-thinking state energy goals. Those goals can provide motivation for establishing and implementing specific policies and programs.

A renewable portfolio standard, described earlier in this chapter, provides near-term, incremental, legally binding targets to drive clean energy development, but there can be other types of state goals. Vermont's 2011 Comprehensive Energy Plan outlines a path for the state to get 90 percent of its energy from renewables by 2050.[29] Michigan Governor Rick Snyder recently gave a special message on energy in which he said the state should aim at getting between 30 and 40 percent of its electricity needs from renewables and energy efficiency within a decade.

The Hawaii Clean Energy Initiative, a partnership between the state and the U.S. DOE, has set a goal and produced a roadmap that seeks to achieve 70 percent clean energy by 2030, with 40 percent of that coming from renewable energy and 30 percent from energy efficiency.[30] In May 2015, the state's legislature built on this goal by passing an expansion of the Hawaii RPS, requiring 30 percent renewables in 2020, 70 percent in 2040, and 100 percent in 2045.

Greenhouse gas reduction goals can motivate renewable energy development as well as other energy changes. For example, in 2006, California passed a law requiring an 80 percent cut in emissions by 2050. Governor Jerry Brown raised the bar in early 2015 by issuing an executive order requiring the state to achieve half of that reduction by 2030.

Setting state goals allows participants in the market to make decisions on when and where to invest. State leadership has been a major determinant of where clean energy technologies will be deployed, and where they will be ignored.

CHAPTER 3

Overcoming Barriers by Building the Infrastructure for Clean Energy Growth

When researchers develop a new technology and entrepreneurs seek to commercialize it, they understandably focus on making sure that it works well and has potential to fill a market need at a competitive price. In the case of clean energy, costs have come down and reliability has increased over the past two decades. But that is insufficient to ensure that clean energy will capture a significant share of the electricity generation market. A variety of barriers—some obvious, but others less evident—can slow market penetration.

To overcome those barriers, states have taken a wide range of actions to build or improve the infrastructure needed for clean energy growth. They created tracking systems that enable large-scale, regional markets for electricity from renewable energy sources. They supported the development of physical infrastructure, such as electricity transmission lines, high-tech electricity meters, and batteries for energy storage. They updated and streamlined long-established administrative processes that were inhibiting clean energy development. They also strengthened necessary financial infrastructure by developing and enabling financial innovations. Finally, they created organizations and mechanisms for information sharing, collaboration, and the dissemination of best practices.

These sorts of infrastructure improvements may not always be headline news, but they are essential. This chapter presents an overview of the different types of infrastructure improvements that are surmounting the often obscure but daunting barriers to clean energy growth.

A Market for Renewable Electricity Becomes a Reality

There are several reasons why some electricity suppliers and consumers choose to purchase electricity generated from renewable energy sources. When a state has an RPS, utilities and other electricity suppliers need to purchase renewable electricity to comply with the state standard. Many consumers and businesses voluntarily elect to buy electricity from renewables in order to reduce or offset their air pollution and greenhouse gas emissions.

These purchasers are willing to pay a premium to get their electricity from renewables. But they need assurance that they are getting what they are paying for. Because an electron generated by a renewable energy facility is indistinguishable from an electron generated by a fossil-fueled power plant, there is no way to detect the source of an electron when it reaches its end destination. There was therefore a need for a simple, secure system for tracking renewable energy from generator to purchaser and for proving that the same renewable energy was not being sold to more than one party.

To address this problem, stakeholders, including NGOs and private sector electricity marketers, developed the concept of tradable renewable energy certificates (RECs) in the mid-to-late-1990s. Developers of this concept wanted to simplify implementation of certain state energy policies, including a proposed California RPS and state environmental disclosure labels in New England.[31] They divided the output from renewable energy facilities into two products: generic electricity and its non-power, environmental attributes: RECs. Every time a wind farm, for example, generates a megawatt-hour of electricity, it has two things to sell: a megawatt-hour of generic electricity and a REC, which proves that the electricity was produced at that specific wind farm.[32] The two products can be bundled together into a single sale or they can be sold separately ("unbundled"). In that way, a business or household that wishes to gets its power from wind, but does not live near any wind farms, can purchase generic power from the local utility company but purchase the desired number of RECs from a distant wind farm.

This system of tradable RECs allowed the renewable energy market to flourish by dramatically increasing the number of sale options for generators and purchase options for buyers of renewable electricity. Renewable energy generators could receive payment for the environmental attributes of their electricity by selling RECs to any party that valued those attributes, even if that party did not have a contract to purchase the actual electricity.

The REC trading system would not have worked if it was not widely adopted or if there was a risk that the generator could sell RECs linked to the same megawatt-hour of electricity more than once. That's where the states stepped in. In 2001, Texas became the first state to begin using tradable RECs. The Public Utility Commission of Texas set up rules and mechanisms for how RECs would be registered, monitored, and tracked to ensure accuracy and prevent double-counting.[33] Other states that had passed RPS laws in the late-1990s also needed a way to monitor RPS compliance, so they adopted the REC approach. In New England, the states developed the New England Power Pool Generation Information System (NEPOOL GIS) for keeping track of electricity generation and RECs across the entire six-state region.[34] It went into effect in 2002 and established a regional market for renewable energy. For example, electricity suppliers in Connecticut were able to purchase RECs from wind farms in Maine in order to comply with the Connecticut RPS.

Case Study 12—Midwest

Regional M-RETS tracking system. See page 79.

Over time, states in other parts of the country developed regional tracking systems (see Figure 4). Each system records the creation, ownership, and retirement of RECs. Several Midwest states, for example, created the Midwest Renewable Energy Tracking System (M-RETS). (See ***Case Study 12*** to learn more about this regional REC tracking system.) California determined that a regional tracking system would be essential to the smooth functioning of the California RPS, so it funded the development of the Western Renewable Energy Generation Information System (WREGIS). The California Energy Commission supplied $5.5 million for the tracking system; the Western Electricity Coordinating Council, the Western Governors' Association, and the Western Regional Air Partnership helped to develop and begin implementing WREGIS, which now covers all or portions of 14 states, two Canadian provinces, and northern Baja Mexico.[35]

Without tradable RECs and the regional tracking systems, the voluntary green power market would be just a fraction of its current size. In 2013, 5.4 million households, businesses, and other customers purchased 62 million megawatt-hours of renewable electricity through the voluntary market. That was more than all the retail electricity sales in the state of Colorado.[36] Most of those transactions relied on RECs and REC tracking systems. As the authors of the National Renewable Energy Laboratory annual census of the voluntary market point out, "Voluntary action provides a revenue stream for

renewable energy projects and raises consumer awareness of the benefits of renewable energy."[37]

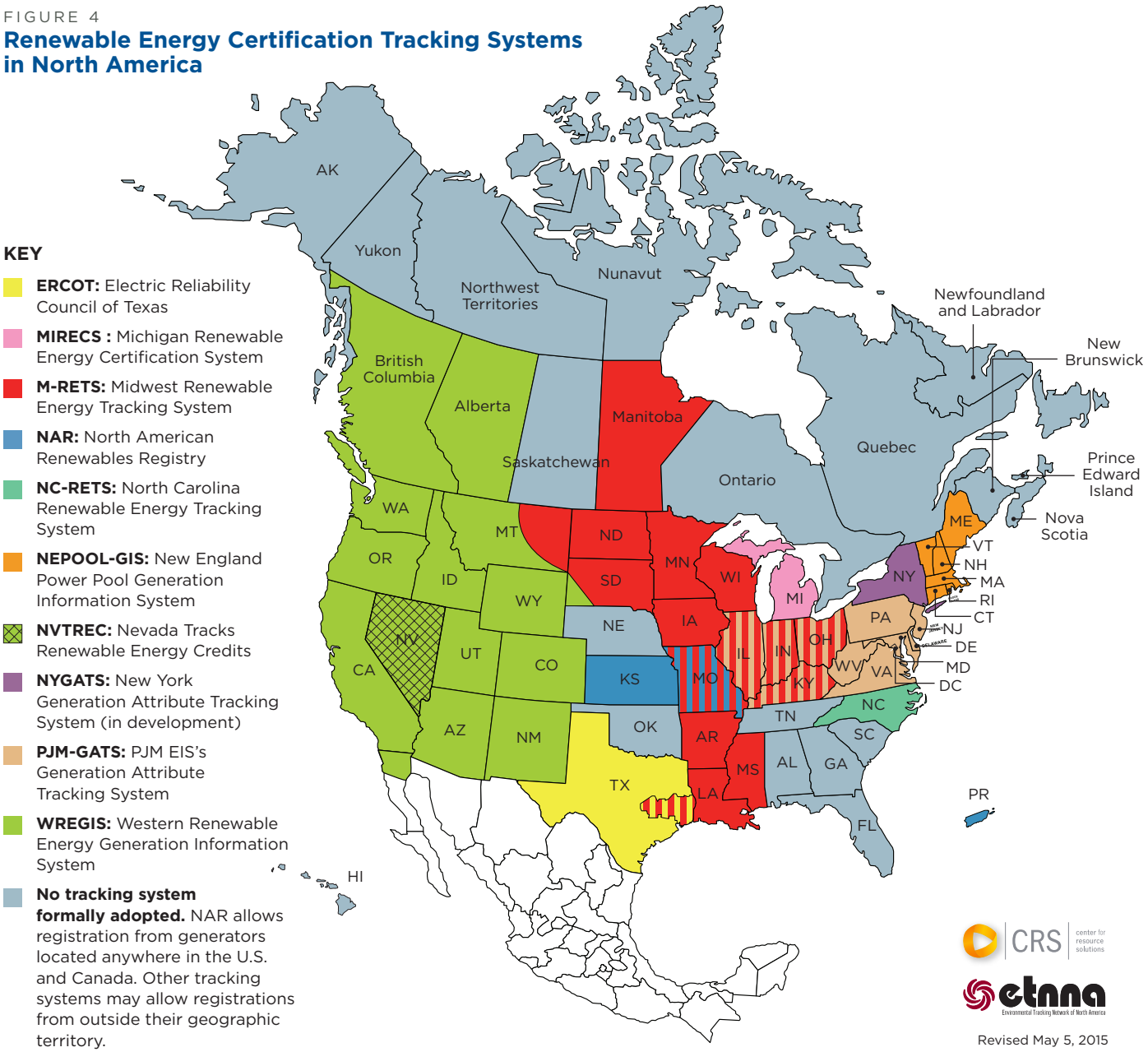
The size and scope of the REC market continues to expand for both RPS compliance and voluntary purchases. Not only has the country been divided into several large regions, but the different tracking systems have worked out arrangements for how renewable electricity and RECs can be traded across regions.

Upgrading Transmission Infrastructure

Many of the best locations for clean energy production are far removed from areas with high electric power demand. That is especially the case with wind power, since wide open spaces, mountain ridge lines, and ocean waters offer the highest wind speeds. But it does little good to place large numbers of wind turbines in those locations if there aren't transmission lines for moving the power to where it is needed.

FIGURE 4

Renewable Energy Certification Tracking Systems in North America



CRS center for resource solutions

etnna Environmental Tracking Network of North America

Revised May 5, 2015

In many cases, the private developers who install wind farms, large utility-scale solar arrays, and other renewable energy facilities pay for transmission upgrades. But sometimes what is needed is a transmission improvement not tied to a single project. For example, a new trunk line may need to be built to open up development opportunities for a large number of projects, or a network upgrade may provide multiple benefits. In those cases, the states (often through their public utility commissions), the federal government, and utility companies have together planned for and helped implement transmission improvements.

Case Study 13—Texas

Texas designated wind siting areas. See page 81.

Texas provides the most dramatic and successful case of a state stepping in to upgrade transmission capacity in order to enable new clean energy generation. The Public Utility Commission of Texas authorized 2,400 miles of transmission line upgrades in order to link centers of electricity load with wind-rich Competitive Renewable Energy Zones (CREZs), established by the state legislature in western Texas and the Panhandle. (See ***Case Study 13*** for more information on how Texas transmission improvements.) This has enabled the development of thousands of megawatts of wind energy.

The California Energy Commission, California Public Utilities Commission, and the California Independent System Operator, joined by the Northern California Power Agency, Southern California Public Power Authority, and the Sacramento Municipal Utility District, formed the Renewable Energy Transmission Initiative (RETI) in 2007 to develop a conceptual statewide transmission plan that could support the state's 33 percent RPS goal. Although the initiative did not have legal standing, this 30-member stakeholder collaborative—government agencies, utilities, generation developers, ratepayer advocates, Native American tribes, and others—significantly influenced transmission planning and implementation in the state.[38] The initiative served as a model for similar transmission planning efforts by the Western Governors' Association and the Western Electricity Coordinating Council. As renewable energy generation increases in the future, many more transmission improvements will be necessary. The federal government has played a key role by envisioning, planning for, and encouraging those improvements. The National Renewable Energy Laboratory (NREL) has engaged in extensive analysis of the transmission system and potential future transmission needs. Its 2010 *Eastern Wind Integration and Transmission Study,* for example, examined what would be needed to supply 20–30 percent of the eastern two-thirds of the country's electricity needs from wind energy.[39] The Federal Energy Regulatory Commission in 2011 issued Order 1000, which expanded regional and inter-regional transmission planning. Although the order is not focused exclusively on clean energy generation, it requires transmission planners to take into account state RPSs and other similar public policies when deciding which upgrades should proceed and how costs should be allocated.

In many cases, the private developers who install wind farms, large utility-scale solar arrays, and other renewable energy facilities pay for transmission upgrades. But sometimes what is needed is a transmission improvement not tied to a single project.

The U.S. DOE's most ambitious effort to advance transmission planning gave a central role to state officials and unleashed unprecedented cooperative transmission planning among the states. With funding from the *American Reinvestment and Recovery Act* (ARRA) in 2009, the Office of Electricity Delivery & Energy Reliability established planning processes for the nation's two major utility grids, the Eastern Interconnection and Western Interconnection, as well as in the smaller Texas

Interconnection. In all three cases, U.S. DOE provided funding that allowed key stakeholders—the states, utilities, generation owners, NGOs, and others—to develop scenarios of the electricity future in their region and then analyze transmission requirements in each of those futures. In all cases, the states played a central role.

As part of the planning process in the Eastern Interconnection, for example, the U.S. DOE established the Eastern Interconnection States' Planning Council, which presented the states' perspective and ensured that the transmission scenarios would be useful to the states and would be used by them. While the federal funding was essential, so was the willingness of multiple representatives from 39 states—public utility commissioners, Governors' advisors, and state energy officers—to meet repeatedly and to provide input through several working groups. This massive effort addressed more than just clean energy generation and has been valuable for preparing for wider use of clean energy technologies.[40]

Building a Smarter Electricity Grid

For clean energy markets to thrive, the electric grid needs to change in ways beyond increasing its transmission and distribution capacity. It needs to adapt to two characteristics of certain clean energy technologies: variable output and distributed generation. First, the grid needs to incorporate wind, solar, and hydro facilities whose output varies and which are sometimes unable to produce power because of weather conditions. Second, the grid needs to interconnect with a massive number of small, distributed generators—rooftop solar, CHP, biogas digesters, fuel cells, small wind turbines—on or in customers' buildings and properties.

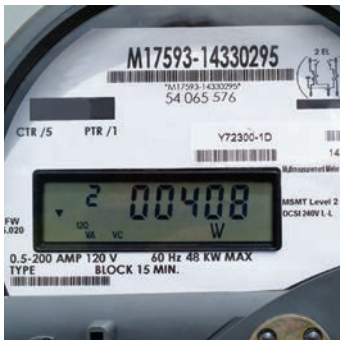
These two issues feed into a larger imperative to modernize the grid. Although the National Academy of Engineering has called the grid the greatest engineering feat of the 20th century,[41] it needs to keep up with a rapidly changing electricity system. As a recent report on the future of the electricity grid

noted, the electricity industry is experiencing "fundamental changes on a scale not witnessed since the creation of the electric system more than 100 years ago."[42] Those changes—the availability of modern information technologies, intermittent renewables, customer-sited generation, increased opportunities for customers to control their energy use, plug-in electric vehicles, and concerns about cybersecurity and severe weather events—all require an already complex electric grid to deal with increasing complexity. The grid needs to be made "more flexible, adaptable, and responsive."[43]

There has been a widespread effort to create a "smart grid" that would include such things as more advanced electric meters, energy intelligence software, computer-based remote control, automation of the electricity distribution system, and demand response.[44] The federal government has been playing a leading role in promoting the smart grid. As part of ARRA, U.S. DOE made $3.4 billion of investments, including demonstration projects, new technologies, and analysis.

States have also invested in modernizing the grid and have developed policies that make a smart grid possible. The GridWise Alliance and the Smart Grid Policy Center, organizations advocating for a smart grid, publish an annual ranking of the states' grid modernization activities. It found that Texas, California, Illinois, Pennsylvania, and Maryland had done the most to pave the way for a smart grid, although many other states have also taken important steps. For example, 99 percent of Nevada and 95 percent of District of Columbia customers have access to advanced metering infrastructure.[45] The Illinois legislature in 2011 passed the *Energy Infrastructure and Modernization Act*, which is having a notable impact there. (See ***Case Study 14*** to learn more about Illinois' grid modernization policies.)

Case Study 14—Illinois



Illinois' grid modernization policies. See page 83.

The New York Public Service Commission has begun a process it calls "Reforming the Energy Vision" (REV). This initiative seeks to create a more flexible, responsive and transparent energy system that will incorporate more variable generators and distributed energy resources, such as PV and energy storage; give customers more control over their energy use; and employ advanced energy management technologies to make the grid more reliable and resilient. REV contemplates an increased role for distribution utilities, as the grid becomes more decentralized, and envisions changes in regulatory and incentive structures to better align utility interests with the Commission's goals. The Massachusetts Department of Public Utilities has begun a similar grid modernization process aimed at empowering customers to manage energy costs, enhancing grid reliability and resiliency, integrating more renewables and distributed resources, and moving from flat rates to time-varying rates for most customers.

Using Clean Energy Technologies to Improve Reliability

At the same time that states are improving the electricity grid to benefit clean energy, they are using clean energy to benefit the grid. In particular, they are using clean energy technologies to increase the resiliency of the electric system as a whole, as well as to make individual facilities and communities less vulnerable to power outages from severe storms and other disruptive events.

Florida, for example, has installed PV combined with battery storage at more than 115 schools designated as community hurricane shelters. The solar+storage systems will continue to provide power to hurricane protection areas within those schools during a grid outage. Rather than relying on dirty diesel generators that have a tendency to fail during emergencies, the Florida approach is advancing clean energy.[46]

Similarly, Massachusetts has funded 18 municipal resilient power projects that rely on solar PV, energy storage, CHP, anaerobic digesters, and other clean and high-efficiency energy technologies

to support critical facilities during a grid outage. In April 2015, New Jersey announced funding for 13 energy storage projects that use batteries and renewable generation to provide resilient power to critical facilities.

Other states, including Connecticut, California, and New York, have promoted and helped fund microgrids, which are local energy grids covering a single building, a few buildings, a campus, or a community. At most times, the microgrids remain connected to the wider electricity grid, but they have the ability to disconnect and continue operating if the wider grid goes down. These states are working to make clean energy technologies part of the microgrids they support. The Connecticut Department of Energy and Environmental Protection has funded 11 resilient power microgrids over the first two rounds of a three-year program that aims to create islands of resilient power across the state. California has funded 11 microgrids through a program titled "Demonstrating Secure, Reliable Microgrids and Grid-Linked Electric Vehicles to Build Resilient, Low-Carbon Facilities and Communities." New York has initiated a statewide microgrids competition that aims to fund between five and seven microgrids around the state.

Case Study 15—Alaska

Alaska promotes renewables.
See page 85.

In Alaska, there are no electric grids in many areas of the state. For some 200 rural communities, there are only microgrids. Those microgrids have historically relied on diesel generators for most of their power, so both air pollution emissions and electricity costs have been high. The Alaska Energy Authority has looked for opportunities to incorporate hydro, wind, landfill gas, storage (batteries and flywheels), and other clean technologies into the local microgrids to reduce the dependence of rural communities on diesel fuel. (See ***Case Study 15*** for more information on Alaska's efforts to promote renewables in the city of Kodiak, Alaska.)

Rhode Island is using clean energy to benefit the electric grid in a different way. Working with National Grid, the state's major utility company, it has targeted a few communities where the distribution system is reaching capacity and would normally need to be upgraded to allow greater electricity imports from outside the community. By incentivizing the installation of rooftop PV systems, the state and utility plan to test how increasing the amount of electricity generated within those communities could potentially defer the need to upgrade distribution capacity. The state is also giving special funding to property owners who orient their solar panels towards the west and southwest, so that they will generate electricity in the late-afternoon and early evening when electricity demand is at its peak. (***Case Study 16*** details how Rhode Island's efforts to test how solar PV can enhance grid reliability.)

If the electricity from solar panels and wind turbines could be stored cost effectively for use when it is most needed, it would be easier to incorporate large quantities of renewables into the electricity system.

Overcoming Variable Output

If the electricity from solar panels and wind turbines could be stored cost effectively for use when it is most needed—when demand for electricity goes up or when the renewable energy generators are not operating—it would be easier to incorporate large quantities of renewables into the electric system. Pumped hydroelectric storage has long been an effective way to store energy to balance supply and demand on the grid, but other storage methods have received considerable attention in recent years. Universities, the national laboratories, and businesses have all been researching, developing, and improving energy storage technologies. The states have been playing an important role in helping to bring those technologies to market and to scale.

Most notably, California passed a law in 2010 requiring investor-owned utilities to procure large-scale energy storage. The state wanted to make a sufficiently large investment in storage to jumpstart the market. The California Public Utilities Commission is requiring utilities to procure 1.3 gigawatts of storage by 2020, and this is already changing the cost and availability of storage technologies nationally. (See ***Case Study 17*** to learn more about California's energy storage mandate.) In June 2015, Oregon became the second state within an energy storage mandate.

Although not on the scale of the California initiative, large-scale storage demonstration projects have been the subject of solicitations in several states, including Vermont and Washington. Storage on distribution grids is an integral part of grid modernization efforts in Hawaii, Massachusetts, and New York. In Puerto Rico, all new utility-scale solar and wind projects must include a minimum energy storage component to help them integrate into the grid.

Many of the above-mentioned state energy storage and resilient power initiatives have benefited from the support of the U.S. DOE Office of Electricity. That office also funds the Energy Storage Technology Advancement Partnership (ESTAP), which is managed by CESA and works to partner states with DOE and Sandia National Laboratories on joint energy storage project deployment.

Besides energy storage, there are many other ways to address the variable output of renewables. The Western states have been concerned about how to integrate large quantities of wind and solar onto the grid most efficiently and at the lowest cost. The

Case Study 16—Rhode Island

Rhode Island PV enhances reliability. See page 87.

Case Study 17—California

California's energy storage mandate. See page 89.

A battery storage system in Washington State.

Western Governors' Association commissioned a major study on *Meeting Renewable Energy Targets in the West at Least Cost: The Integration Challenge.*[47] The report examined strategies for using demand response for better dispatching and scheduling generators, and for "electronically transferring generation from the balancing authority area in which it physically resides to another balancing authority area in real-time,"[48] among other things. Some of these strategies are already being applied.

States in other regions are considering and are implementing similar strategies. There has been especially great state interest in demand-response programs that enable utilities and grid operators to encourage electricity consumers to lower their electricity use at times of when it is beneficial to reduce demand.

Knocking Down Soft Cost Barriers

The states have also worked on a very different type of infrastructure—the administrative systems necessary for bringing distributed generation technologies on line. When contractors install CHP systems, rooftop solar panels, or small wind turbines, they usually need to get several different building permits and then have the systems inspected. They also need to work with the local utility to interconnect the system with the grid. Unfortunately, these permitting, inspection, and interconnection processes are often painfully cumbersome, slow, and costly.

In the case of PV, U.S. DOE has recognized that, as the cost of the hardware has declined precipitously, most of the remaining costs of a rooftop system are now linked to non-hardware soft costs, including permitting and interconnection, but also financing and customer acquisition. Therefore, the best way to achieve further cost reductions is to target those soft costs. That is what the U.S. DOE's impressive SunShot Initiative has been doing.[49] But U.S. DOE needed cooperation from the states.

The states have been enthusiastic partners for the SunShot Initiative. In fact, when that initiative started up, many of them had taken steps to tackle permitting, interconnection, and other non-hardware costs. Some states have made significant progress on those issues while others have lagged behind. The most recent annual scorecard of state interconnection procedures by the Interstate Renewable Energy Council and Vote Solar gave seven states—California, Massachusetts, New Mexico, Ohio, Oregon, Utah, and Virginia—an "A" but others received "Ds" and "Fs".[50] These variations show that state action can greatly impact the deployment of renewable energy technologies.

Oregon was the first state to adopt a statewide solar energy code. In 2010, the state instituted the Solar Installation Specialty Code, which imposes minimum requirements on local jurisdictions for processing solar permits and inspection fees. Although the code does not govern the electrical requirements of solar installations, it has substantially standardized the requirements that apply to building permits for solar. Oregon has also enacted separate permitting legislation that effectively makes the approval of certain solar permit applications a non-discretionary decision and forbids local jurisdictions from charging solar permit fees on top of the building permit fees required for a project.

Oregon has also taken steps to streamline the process of applying for financial incentives. In 2015, the Oregon Department of Energy launched an online paperless platform that allows homeowners to e-sign residential energy tax credit applications. The platform is integrated with Energy Trust of Oregon programs that provide cash rebates for PV systems, so that a single application can be used for both incentive programs.

In 2014, California enacted legislation requiring the state's local governments to adopt streamlined permitting processes for residential solar by September 30, 2015. By mandating a streamlined permitting process for small rooftop solar systems, California is helping lower the cost of residential installations statewide.

New York has taken a different approach. The New York State Energy Research and Development Authority (NYSERDA) provides a funding incentive to municipalities that adopt a unified permit. Municipalities that opt to use the unified solar permit for systems sized 12 kilowatts or less are eligible to receive between $2,500 and $5,000, depending on population, through NYSERDA's Cleaner, Greener Communities program.

Vermont has been especially aggressive in breaking down the permitting barriers to solar installations. Instead of retaining a permitting and interconnection process that can drag on for months, Vermont has instituted a streamlined, 10-day, solar registration process for small PV installations, up to 15 kilowatts. All the permitting is granted through the Vermont Public Service Board, a single centralized entity, rather than through individual municipal building departments. Once a solar applicant requests approval to install and interconnect a PV system, the local utility company has 10 days to raise concerns and provide recommendations for how to resolve those concerns. Otherwise, the installation is automatically allowed to go forward. (See ***Case Study 18*** to learn how Vermont reduces solar soft costs.)

Innovative Financing to Deal with High Upfront Costs

Case Study 18—Vermont

Vermont reduces solar soft costs. See page 91.

Many clean energy technologies have very low operating costs when compared to fossil fuel power plants that use large quantities of fuel. However, the vast majority of the cost to acquire clean energy must be paid upfront when the solar panels, hydroelectric equipment, or wind turbines are first installed. These high upfront costs create a barrier that can make it difficult to install clean energy projects, even if the installations will save the customer money over time. Energy efficiency measures, such as improved heating equipment, high-efficiency motors, advanced lighting, and insulation, have the same problem of requiring large upfront investment.

By stepping in to address this problem, states have helped to create finance tools to help customers install clean energy projects. However, they have not always acted alone. In the case of distributed solar for homes and businesses, the most important development of the past few years has been the arrival of solar leases and power purchase agreements (PPAs) offered by large private-sector companies. With these financing innovations, a third party pays for and owns the PV system on the property owner's building.

Under a solar lease arrangement, the property owner enters into a contract to pay monthly predetermined payments to a solar leasing company that installs and owns the solar panels and equipment. With a PPA, the project developer installs, maintains, owns, and operates the PV system and then provides all of the electricity the system produces back to the property owner at an agreed-upon, per-kilowatt-hour rate. The use of leases and PPAs has exploded and now more than 60 percent of homeowners who install solar take advantage of them.[51] But even in this case, where the private sector has been driving the financial innovation, the states have played an important role. In many cases, states modified their regulations and incentive programs to allow for leases and PPAs. For example, in May 2015, Georgia Governor Nathan Deal signed the *Solar Power Free Market Financing Act*, which makes third-party power purchase agreements legal for rooftop solar.

High upfront costs create a barrier that can make it difficult to install clean energy projects, even if the installations will save the customer money over time.

Connecticut played a direct role in building the solar lease market. In 2008, it created the Connecticut Solar Lease Program, the first residential solar lease financing program supported by a public organization. At that time, private lease financing was not yet available. The program helped to popularize the concept of third party financing for residential solar. In addition, the program brought U.S. Bancorp into the solar financing market; that company subsequently became the single largest tax equity player in the residential solar PV market. The Clean Energy Finance and Investment Authority (now The Connecticut Green Bank) also made valuable data from its solar lease program publicly available so that it could inform the design of future residential solar programs.[52]

Two other approaches—on-bill financing (OBF) and property assessed clean energy (PACE)—also overcome high upfront costs for distributed clean energy technologies and are direct results of states establishing new financing infrastructure. OBF enables utility customers to invest in energy efficiency and clean energy improvements by borrowing money that is paid back over time through an additional charge on the customer's electricity bill. As of 2012, at least 22 states either offered or were in the process of implementing OBF programs.[53] Most of those programs use the utility's balance sheet as the source of capital.

Case Study 19—Connecticut

Connecticut Green Bank's C-PACE program. See page 93.

PACE programs allow property owners to attach the cost of clean energy improvements to their property tax bill through a special tax assessment that remains in place for the life of the obligation. Because the obligations are secured by the underlying properties, they can support repayment terms of 20 years or longer at extremely attractive interest rates, enabling more energy upgrades to become cash-flow positive. PACE has worked especially well for commercial properties, and there are active programs in 10 states plus the District of Columbia. The Connecticut Commercial PACE (C-PACE) program has led the way with more than $65 million of energy improvements financed in that state. (***Case Study 19*** describes the Connecticut Green Bank's C-PACE program.)

PACE programs for homeowners have spread more slowly because of concerns raised by the Federal Housing and Finance Agency (FHFA) that PACE provides too great a risk for holders of residential mortgages.[54] Nevertheless, several states have taken steps to address the issues raised by FHFA's concerns. Most notably, California established a $10 million loan-loss reserve fund "to mitigate risk to potential first mortgage holders by making them whole for losses incurred due to the existence of a first-priority PACE lien on a property during a foreclosure or forced sale."[55] As a result, the California residential PACE market is booming, with more than a half billion dollars of projects either completed or approved. Elsewhere, Florida has a program that is primarily subscribed to by homeowners who own their homes outright and are thus unaffected by FHFA's mortgage concerns. Vermont has implemented a program that allows a subordinate lien on a property when located in an eligible PACE district.

Large utility-scale clean energy projects require different types of financing assistance than small, distributed projects. Yet the finance challenge is the same—clean energy requires a substantial upfront investment.

Large Projects Require Large Investments

Large utility-scale clean energy projects require different types of financing assistance than small, distributed projects. Yet the finance challenge is the same—clean energy requires a substantial upfront investment. In order to receive financing from bankers and other financial institutions, large wind farms and solar developments usually need to show that they have purchasers for the electricity and RECs from the project thereby proving they will have an assured revenue stream. RPSs in states with regulated utility industries can provide that assurance by encouraging utilities to enter into long-term contracts with specific renewable energy facilities.

Utilities in states with retail competition would not normally sign long-term contracts for power. A few of those states, including Connecticut, Massachusetts, and New Jersey, have passed laws or implemented special programs to provide new renewable energy facilities with such contracts. New York has taken a different approach. The New York State Energy Research and Development Authority (NYSERDA) offers long-term contracts for RECs, as part of that state's uniquely structured RPS. Without these types of state initiatives, the pace of utility-scale, clean energy development would be slower.

The Importance of Information Sharing

With so much clean energy policy and finance experimentation and innovation taking place at the state level in all parts of the country, progress will be accelerated if good ideas, best practices, and needed information can spread quickly from one jurisdiction to others. The states have understood

this and have sought to share information and lessons learned using networks of associations and organizations. This has not only increased the speed of clean energy transformation for power generation, but it has also improved the efficiency of state government by avoiding duplicative research and program development efforts.

The states have relied in part on a pre-existing set of well-established organizations. The National Association of State Energy Officials (NASEO) links state energy offices, while the National Association of Regulatory Utility Commissioners (NARUC) works with the leaders and staffs of the regulatory agencies that oversee the electricity industry. Both NASEO and NARUC have given considerable attention to clean energy through their annual meetings, research initiatives, and active topical committees of state officials.

Two associations of state policymakers—the National Conference of State Legis-latures (NCSL) and the National Governors Association (NGA)—have broader mandates than just energy, but they have been very active on clean energy matters. Regional organizations for states, including the Coalition of Northeastern Governors and the Western Governors' Association, have also taken up clean energy issues.

After some states in the late-1990s established public benefit funds for advancing clean energy in the electricity sector, they realized that they would benefit from sharing ideas and best practices while they developed plans for how to most effectively use those funds. They came together to launch the Clean Energy States Alliance (CESA), a national consortium of state and municipal clean energy organizations. (Learn more about CESA in ***Case Study 20.***) With CESA, clean energy program managers

Case Study 20—CESA

Learn more about CESA.
See page 95.

Case Study 21—RGGI

Learn about RGGI.
See page 97.

from across the country benefit from the collective knowledge of a national network. The share best practices and identify solutions to common challenges.

In addition, states that have renewable portfolio standards have shared information and best practices through the State-Federal RPS Collaborative, an initiative that is managed by CESA and funded by the U.S. DOE and the Energy Foundation.

From Sharing to Collaboration

States sometimes need to go beyond information sharing to forge partnerships and collaborations to advance clean energy. The regional REC tracking systems, described above, exemplify this.

The most important multi-state collaboration related to clean electricity is the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort by nine states from Maryland to Maine to reduce greenhouse gas emissions from power plants. This cap-and-trade program has not only lowered emissions but has provided significant funding for clean energy development. (Learn more about RGGI in ***Case Study 21.***) There is strong evidence that a regional effort, like RGGI, can be less expensive than individual state efforts. For that reason, U.S. EPA has encouraged states to consider collaborative programs to comply with EPA's Clean Power Plan. Organizations, including NARUC and NASEO, have explored strategies for state cooperation in meeting U.S. EPA's targets.

CHAPTER 4

Building a Vibrant Clean Energy Industry

States across the country have helped clean energy businesses to grow because they value the resulting job creation and other economic benefits. In many cases, the assistance the states have given to clean energy firms has been the same as they offer to other businesses seeking to locate or expand in their state. This can include temporary tax exemptions or reductions, help with finding suitable building sites, and loans.

In one recent notable example, the state of Nevada provided a generous package of incentives for Tesla Motors to build a mammoth battery factory in the state. (For more information about the State of Nevada's incentives, see ***Case Study 22***.) But beyond these types of assistance, many states have pursued targeted strategies aimed specifically at clean energy businesses.

The assistance the states have given to clean energy firms has included temporary tax exemptions or reductions, help with finding suitable building sites, and loans.

Leveraging State Universities

State universities have aided clean energy business development in a variety of ways. Most simply, university research projects can lead to spin-off clean energy businesses. But the states have also established major research centers that collaborate with the private sector on joint projects and provide services to clean energy businesses. The Florida Solar Energy Center is one of the oldest of these collaborative centers, established in 1975 by the Florida legislature. It is housed at the University of Central Florida and continues to receive $3 million in operating funds annually from the university, although it also receives funding from external sponsors for specific projects. The Center, with a staff of 150, has a long history of work on solar thermal technologies, but also works on photovoltaics and building technologies.[56]

The University of Massachusetts Wind Energy Center also dates from the 1970s, while the North Carolina Clean Energy Technology Center at North Carolina State University was established by the state in 1987, initially as a solar energy center. Other significant research centers that receive state funding and provide services for the clean energy industry include the National Wind Institute at Texas Tech University, the Alaska Center for Energy and Power at the University of Alaska, and the California Renewable Energy Center at the University of California at Davis.

The State of Colorado forged the Colorado Energy Research Collaboratory, a partnership among four clean energy research centers at three Colorado universities, in

Case Study 22—Nevada

Learn about Nevada's incentives for Tesla. See page 99.

cooperation with the National Renewable Energy Laboratory. The Collaboratory's centers work together and with industry and public agencies to "[c]reate and speed the commercialization of renewable energy technologies, energy management systems, and energy efficiency," and "[s]upport economic growth in Colorado and the nation with renewable energy industries."[57]

The State University of New York Polytechnic Institute (SUNY Poly) has developed especially deep ties to industry. Gehrlicher Solar America Corporation recently announced plans to house some of its employees in SUNY Poly's Zero Energy Nanotechnology building. The two organizations, along with Gerlicher's parent company, M+W U.S., will also "collaborate on a 5 year, $105 million solar power plant construction initiative that will create up to 400 jobs statewide."[58] Several years earlier, with the help of a major research grant from U.S. DOE, SUNY Poly and SEMATECH, along with the University of Central Florida, started the U.S. Photovoltaic Manufacturing Consortium. It aims to speed the commercialization of advanced solar photovoltaic technologies.[59] In addition, SUNY Poly's Solar Energy Development Center features an 18,000-square-foot prototyping and demonstration manufacturing facility where next-generation thin film solar cells can be piloted and tested.

States Sponsor and Manage Facilities for Testing Clean Energy Technologies

In the case of SUNY Poly's PV testing, the industry participants are well-established companies seeking to test new products before bringing them to market. State testing facilities for emerging technologies are primarily used by smaller firms.

Companies developing technologies for harnessing hydrokinetic energy from river flows can take advantage of the Alaska Hydrokinetic Energy Research Center. The center's testing services save small companies time and money, because all the monitoring equipment and necessary permits required for river testing are already in place. The companies do not need to go through the cumbersome process of acquiring permits before they can begin testing. (See ***Case Study 23*** to learn more about testing hydrokinetic energy technologies in Alaska.)

Case Study 23—Alaska

Testing hydrokinetic energy technologies. See page 101.

The Alaska center partners with facilities in two other states that offer other types of hydrokinetic energy testing. The Northwest National Marine Renewable Energy Center, which receives funding from the U.S. DOE as well as from the participating states, has facilities connected to Oregon State University and the University of Washington. Oregon has a site for wave energy testing for generators up to 100 kilowatts and is developing a second site about five miles offshore for even larger units. It will be only the second testing site in the world where utility-scale wave energy generators can connect to the grid. Washington offers smaller testing sites in Puget Sound and Lake Washington.[60]

For a better established technology, the Massachusetts Clean Energy Center's Wind Technology Testing Center, which opened in 2011, offers the first facility in the nation capable of testing large-scale wind turbine blades up to 90 meters in length. Funded by the state and the federal government, it conducts a full suite of certification tests for turbine blades. The testing center provides the latest wind turbine blade testing and prototype development methodologies to help the wind industry deploy the next generation of land-based and offshore wind turbines.[61]

New York, through NYSERDA, provided most of the funding for a facility at Clarkson University for testing small and medium-sized wind blades. It is managed by the Center for Evaluation of Clean Energy Technology, an affiliate of Intertek, a testing laboratory company.[62]

Massachusetts Wind Technology Testing Center.

Incubators Aid Early-Stage Companies

Beyond establishing technology testing centers, states have given special attention to emerging technologies and start-up companies, assisting them through the business development cycle from concept to selling products and services. Many companies fail during these early stages before they have commercial sales. If a state can increase the success rate, it will have more jobs and thriving businesses.

Business incubators can provide services and expertise to help small companies develop. The number of state-connected clean energy incubators has expanded dramatically in recent years. These incubators offer start-up companies office space (often at a reduced rate), mentoring, assistance with business planning, connections to potential investors, and a congenial environment with other clean energy companies and clean energy entrepreneurs. For example, the Maryland Clean Energy Center, a public agency established by the legislature, partnered with the University of Maryland, Baltimore County to establish the Maryland Clean Energy Technology Incubator at the university's research site.

Texas has had an active clean energy business incubator program with the Austin Technology Incubator at the University of Texas, which has long been active in clean energy. In recent years, the State Energy Conservation Office has provided grants to get other energy incubators started, including one at the Texas A&M Energy Institute. When, in 2014, U.S. DOE launched a National Incubator Initiative for Clean Energy, it gave one of its three major grants to the Austin Technology Incubator to create a Southwest Regional Clean Energy Incubation Initiative supporting entrepreneurs across Texas and New Mexico.

New York has made clean energy incubators an economic development priority. NYSERDA has established six of them across the state, each affiliated with an in-state university. (Learn more about NYSERDA's clean energy incubator program in ***Case Study 24.***)

Case Study 24—NYSERDA

NYSERDA's clean energy incubator program. See page 103.

The Range of Business Development Strategies

Along with business incubators, states have pursued a varied range of strategies to help companies in various stages of their development. The Game Changer Program of the Maryland Energy Administration, for example, offers grants of $50,000 to $250,000 for firms to deploy "innovative, early-commercialization stage energy generation (electric or thermal energy) systems." The funding is used, in part, by companies to collect performance data for their systems and to evaluate the benefits and costs.[63]

Along with business incubators, states have pursued a varied range of strategies to help companies in various stages of their development.

Some states have targeted a specific clean energy industry that they believe is well placed to expand locally. Connecticut concluded that the fuel cell industry had potential to be a significant local employer. Through its clean energy programs, it has offered a wide range of support to help the industry, including funding assistance for fuel cell installations across the state, mentoring, and managing the Connecticut Hydrogen-Fuel Cell Coalition, which includes industry representatives, government agencies, and other stakeholders.

The Ohio Third Frontier Technology Validation and Start-up Fund, administered by the Ohio Development Services Agency, includes fuel cells/energy storage and photovoltaics among its 10 target technology areas. The fund is designed to help "start-up companies that commercialize technologies developed by Ohio institutions of higher education, other Ohio not-for-profit research institutions and federal labs located in Ohio." The research institutions and start-ups can apply for funding to "generate the proof needed to move technology to the point that it is . . . ready to be licensed by an Ohio start-up company;" to fund prototypes, demonstrations, and other validation activities; and to "support Ohio start-up companies that have licensed technology developed at Ohio research institutions during the critical early life of the company, and accelerate the time to market of this technology." The program has $4.5 million available for calendar year 2015.[64]

New York's Proof-of-Concept Center Initiative illustrates the value of investing in entrepreneurship early in the research cycle. NYSERDA has invested $15 million over five years in three centers that connect inventors and scientists to investors and entrepreneurs, thereby helping transition academic teams into start-up businesses. The initiative uses the LeanLaunchPad methodology of customer discovery and market validation. NYSERDA is also launching a clean energy business competition that will provide up to $20 million to bring additional clean energy jobs to the state's southern tier. Entrepreneurs and companies will "compete for funding, technical assistance, and other services."[65]

Case Study 25—MassCEC

Massachusetts Clean Energy Center's work to build a vibrant clean energy sector.
See page 105.

Massachusetts, through the Massachusetts Clean Energy Center (MassCEC), has pursued an unusually wide-ranging strategy aimed at building a large cluster of clean energy companies in the state. Among other things, it has funded an annual week of events that includes opportunities for early-stage companies to pitch their business plans to potential investors, supported business incubators, offered matching funds to companies needing those funds to qualify for grants from U.S. DOE, provided grants so that early-stage companies can bring innovative technologies closer to commercialization, and created an innovative internship program that has placed nearly 1,200 paid interns in 262 companies. (See ***Case Study 25*** to learn more about Massachusetts Clean Energy Center's work to build a vibrant clean energy sector.)

CHAPTER 5

Protecting Consumers

Consumer protection is becoming an ever more important issue for distributed clean energy technologies. State agencies are taking the lead in looking out for the interests of consumers, even though their actions are not always widely recognized and they may not label those actions with a "consumer protection" banner.

Each year, tens of thousands of PV systems, CHP systems, fuel cells, and small wind turbines are installed at homes, businesses, and institutions. Very few of the buyers of these systems are energy experts. Most have never installed a clean energy system before, and they need sound information before they make their purchasing decisions. They need assurances that they are dealing with reputable, competent vendors and contractors. As with other emerging technologies, clean energy could lose public support if consumers feel that the equipment they purchased does not perform as advertised or if they feel misled by unreliable vendors and service providers.

For PV, the most widely adopted distributed generation technology, there have been relatively few problems with system performance, and most consumers are satisfied with their purchases. But part of the reason for that is that states have set standards for equipment and system installers, and they have shared information on system performance. In the absence of any official national standards, the states have established standards.[66]

Standards and Training for Solar Installers

In 2010, when the Interstate Renewable Energy Council (IREC) put together a database of state solar licensing practices, 14 states required installers to have specific licenses, "usually sub-classifications of electrical or plumbing licenses." In 17 states, in order to install PV systems that qualify for state rebates and other state incentives, solar installers needed training and certification from a group such as the North American Board of Certified Energy Practitioners (NABCEP).[67] States often publish a list of those installers and contractors who are approved to do installations as part of their incentive programs.

Rhode Island passed a law in 2014 establishing a new type of contractor, the Renewable Energy Professional. An individual is able to qualify in several ways, including by holding a Solar Energy International Professionals Certificate for Residential and Commercial Photovoltaic Systems, being certified by NABCEP, receiving PV Installer Certification through a program offered to members of the International Brotherhood of Electrical Workers and the National Electrical Contractors Association, or earning an Associate's degree or higher in renewable or solar energy installation from an accredited educational institution.[68]

In Oregon, solar installation is a licensed trade and installers are required either to hold a Limited Renewable Energy Technicians license or a General Journeyman Electricians license. Oregon also has

the nation's only statewide solar building code, which standardizes the structural and fire access requirements as well as permit fee calculations for solar installations across all jurisdictions. In order to work on projects that receive rebates from Energy Trust of Oregon, solar installers must apply to become a Solar Trade Ally. Those who qualify are listed on Energy Trust's website and receive referrals when people make inquiries about solar through that website. To qualify, installers must have a Construction Contractors Board license, carry additional liability insurance beyond the minimum required by the state, and participate in solar program training offered by Energy Trust. For installers working on residential projects that qualify for the Oregon Residential Energy Tax Credit, they also need to obtain Tax Credit Technician status for photovoltaics from the Oregon Department of Energy. That requires passing a solar program quiz and having either NABCEP certification or a Limited Renewable Technicians License.[69]

States often publish a list of those installers and contractors who are approved to do installations as part of their incentive programs.

In some cases, states have provided funding for training of solar professionals or for increasing training standards. For example, NYSERDA has provided funding and issued requirements for training organizations to become accredited through IREC's Trainer Provider Accreditation Program. In 2011, Minnesota gave funding to state-supported institutions to become accredited as training centers.

Standards and Requirements for Solar Equipment

States have developed standards for solar equipment as well as for the people installing it. One key issue has been equipment warranties. Solar panels normally last at least 25 years and are unlikely to fail before then, but it can cause serious problems for the purchaser if something goes wrong in the early years. Today's models of inverters, which convert the DC current produced by the solar panel to AC current, generally last at least 10 years, but here too the consequences of early failure can be significant. Warranties on this equipment are important to protect consumers.

Early on, some equipment, especially the inverters, was sold with only minimal warranties, even though some of the early inverters could be unreliable. That put consumers at risk until states started requiring warranties under their incentive programs and ratcheted them up over time. California played a lead role by requiring strong warranties and by establishing a standard that many other states followed. California currently requires panels and inverters to have "a minimum 10-year warranty to protect against defects and undue degradation of electrical generation output."[70] Even in places where warranties are not required by state regulations or incentive programs, solar equipment now generally comes with significant warranties.

Case Study 26—California

California Solar Equipment list.
See page 107.

California went further than simply requiring warranties. In 2006, the legislature directed the California Energy Commission to establish standards for equipment eligible for rebates under the state's solar incentive programs. For solar panels, inverters, performance meters, and other equipment to be added to the the Energy Commission's approved list, they needed certification from a nationally recognized testing laboratory and one-time field testing by an accredited test laboratory to verify performance in the field. (See ***Case Study 26*** to learn more about the California Solar Equipment list.) Fifteen other states refer to and use California's list to determine whether equipment is eligible for incentives or tax credits and/or to calculate incentive amounts.

Ensuring Good System Performance

Solar panels will not produce their maximum rated output if they are installed at an improper angle, in a suboptimal direction, or are heavily shaded. In the early years of this century, system underperformance became an important issue for state clean energy programs, because many of them were giving out rebates and grants based on the potential capacity of the PV systems rather than their actual performance. That meant that the public funds supporting the installation of the systems were not always achieving all the expected environmental and energy benefits. As researchers from LBNL explained, "Although owners of PV systems have an inherent incentive to ensure that their systems perform well, many homeowners and building operators may lack the necessary information and expertise to carry out this task effectively."[71]

Over the past decade, states have taken a variety of approaches to ensure that PV systems performed well. In some cases, they imposed minimum design standards; in other cases, they switched to performance-based incentives.

Over the past decades, states have taken a variety of approaches to ensure that PV systems perform well. In some cases, they imposed minimum design standards, withholding rebates or grants if a system was shaded too much of the time or if the panels were pointed too far from their ideal direction. In other cases, they switched in whole or in part to performance-based incentives, which provide funding in proportion to how much electricity is actually generated, rather than to the system's size. Some states did a calculation up front of how much electricity a system is likely to produce and then based the funding incentive on that calculation. And some states conducted inspections of all or a sample of the systems that they support.[72] But whichever approach they took, their actions gave consumers added protection.

Good Information Makes for Discerning Consumers

States have helped their residents make informed choices about solar by providing useful information. For example, Arizona's Residential Utility Consumer Office (RUCO) offers a three-page *Consumer Guide to Rooftop Solar Photovoltaic (PV)*. It identifies things a consumer should consider before purchasing a system, explains how having a system affects a homeowner's relationship to the electricity grid, provides guidance on choosing an installer, and offers other advice.[73] As RUCO Director Pat Quinn points out, "Like any industry, especially a younger one, there are some reputable companies and others that are less trustworthy. … We are also troubled by high-pressure sales tactics and sales people not familiar with the regulatory process. Because of these concerns, RUCO has developed [the] consumer guide to give potential buyers an evenhanded source of recommended best practices."[74]

Iowa, Ohio, and Oregon are a few of the many other states that have published guides with advice for potential solar purchasers. Recently, as leases and power purchase agreements have entered the solar financing markets, states have realized consumers need credible, objective information about those options. Several states worked with CESA to publish *A Homeowner's Guide to Solar Financing*.[75] Massachusetts, New Mexico, and New York are each preparing a special version of that guide tailored specifically to the programs and markets in their state.

As a source of information for consumers, states have published data on the cost of actual installed systems. As NREL notes, "Making data on installed costs publicly available can serve two purposes. First, doing so can protect solar customers who are unfamiliar with solar costs from extortive pricing. Second, making the data publicly available can help provide downward price pressure on the installer community, which should improve the likelihood of greater market penetration of solar in the future."[76]

The states that share such data can protect confidential information by only publishing aggregate statistics, but even the redacted information is still very valuable. The California Solar Initiative does the most thorough, creative reporting on installed systems and has a helpful website.[77] Rather than simply report the data, California uses it "to protect consumers from price gouging. New applicants that are quoted at an installed cost (on a per watt basis) that is greater than one standard deviation from the previous 12-month mean installation cost must submit a form signed by the customer confirming his or her understanding of that system's elevated costs."[78]

Case Study 27—ITAC

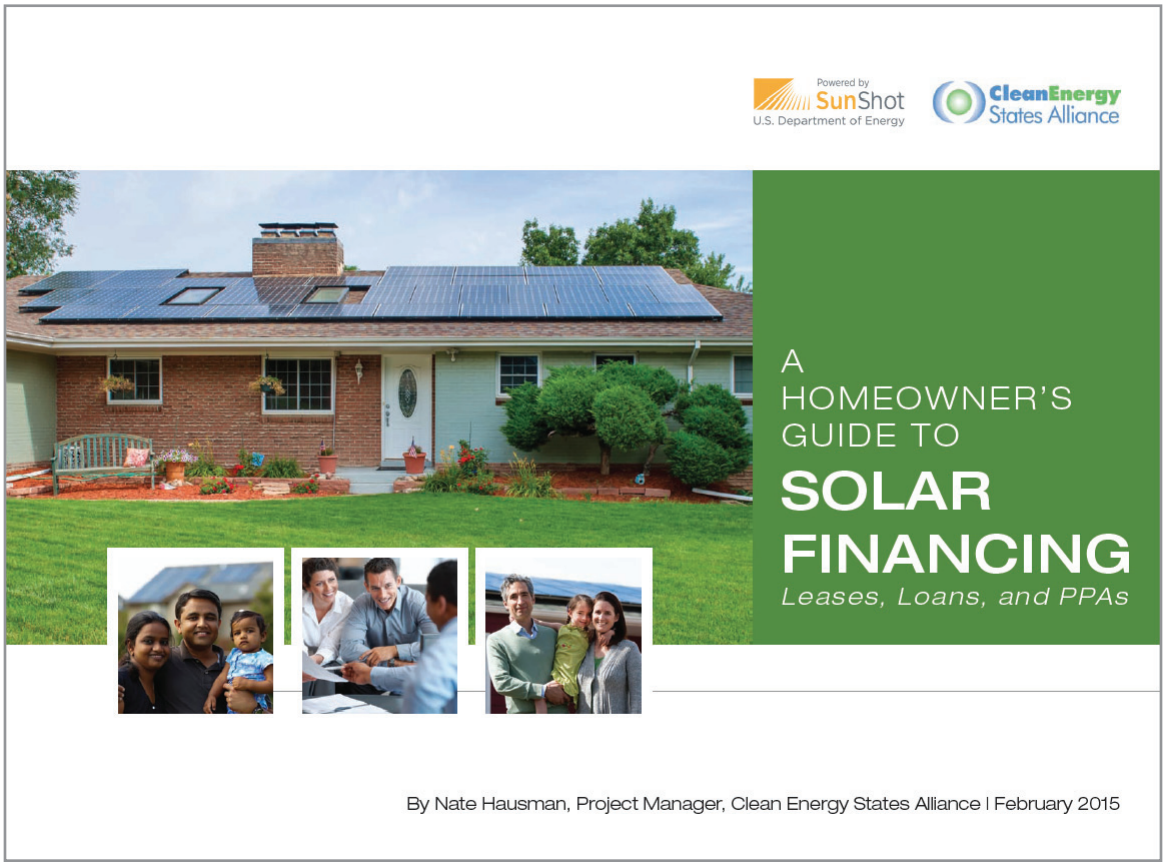
ITAC's unified list of wind turbines.
See page 109.

Strategies for Other Technologies

Although other distributed, clean energy technologies are purchased much less often than PV, states have still taken steps to educate and protect potential buyers. They sometimes provide the same types of consumer guides as for solar, but they also use different approaches.

In the case of small wind turbines, which had some serious performance issues early on, seven states and two utilities are working together through the Interstate Turbine Advisory Council (ITAC) to vet turbines and manufacturers. They agree on a unified list of qualifying turbines that they all publicize and use when providing financial incentives to turbine purchasers. (Learn more about ITAC in ***Case Study 27.***)

For CHP systems, NYSERDA realized that potential purchasers risked getting a CHP system that was too costly or did not perform as well as anticipated. The main problem was that each installation was designed as a one-off with different components being sourced from different manufacturers. To



Case Study 28—NYSERDA

NYSERDA's CHP program.
See page 111.

Case Study 29—DC

DC's solar programs.
See page 113.

address this, NYSERDA developed a catalog of modular, pre-packaged systems, all of which it vetted for quality, reliability, and durability. (See ***Case Study 28*** to learn more about how NYSERDA is supporting CHP.)

Helping Consumers Access Solar's Benefits

As the cost of solar panels has declined and the number of installations has risen, many states have begun to focus on a different consumer issue—the uneven ability of their citizens to benefit from the technology. Solar electricity can save people money on their electric bills and reduce the risk that those bills will go up because of future spikes in fossil fuel prices. But many people cannot easily install PV on their home. For example, it does not make sense to install solar on homes that are heavily shaded or whose roof will soon need replacement.

Although there are many reasons why a particular individual might not be able to install solar, the one that most concerns policymakers is the greater difficulty that low- and moderate-income households have in accessing the benefits of the technology and the state programs that incentivize its deployment. Many low- and moderate-income households are less likely to own their home, which is usually a prerequisite for placing a solar system on the roof. They are also less likely to have the funds to make an outright purchase of a system. They may not have a sufficiently high credit score to qualify for a lease, loan, or power purchase agreement that avoids the need for a large upfront payment. Moreover, they may not have sufficient income to benefit from available tax credits.[79]

During the years when the solar electricity market was first developing, none of this was a major concern. Only a few people were installing PV systems and the cost was so high that the financial advantages were few. Most early adopters purchased PV systems because of a desire to help the broader society (e.g., by reducing environmental harms or by contributing to energy independence) or in the hope that they might have some financial benefit many years down the road if the price of conventional electricity were to rise significantly. But now, the financial benefits from installing PV can be immediate and substantial.

States have taken a variety of steps to ensure that all income groups can reap the rewards of solar, and they are likely to give more attention to this issue in the coming years. This has been a particular concern in the District of Columbia, where the District Department of the Environment and the DC Sustainable Energy Utility are using solar installations to help low-income residents reduce their energy costs. (***Case Study 29*** details the District's Small-Scale Solar Initiative.)

The Connecticut Solar Lease Program, discussed in Chapter Two, made special efforts to reach beyond those people who were able to qualify for conventional bank loans. The program did not require a down payment, used a lower credit score cutoff, and restricted the program to homeowners with no more than 200 percent of the state's median family income.

Hawaii, through its Green Energy Market Securitization (GEMS) program, has identified an innovative way to use bonds to raise funding to finance clean energy installations. It is making sure that an expanded range of consumers, including renters and those with low credit scores, can access that financing. The borrowers who receive the financing can then pay back the loans through a charge on their monthly electric utility bill. (For more information on Hawaii's GEMS program, see ***Case Study 30.***)

Several of California's programs have sought to bring the benefits of solar to low- and moderate-income households. The Single-Family Affordable Solar Housing Program within the California Solar

Initiative (CSI) "provides fully subsidized 1 kW systems to very low-income households, and highly subsidized systems to other low-income households."[80] The program has a budget of $108 million. A separate program focuses on multifamily affordable housing and is spending a comparable amount. Because of high demand, the program's incentives have already been exhausted in some utilities' service territories. CSI also offers enhanced incentives for installing solar hot water systems on low-income single and multifamily residences.

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The California New Solar Homes Partnership has also taken steps to ensure that all income groups participate. Of the more than 14,000 systems installed through that program, 21 percent are in communities where the median household income is less than $50,000. Because of larger-than-average systems on multifamily housing, 25 percent of the program's total installed capacity is in those communities.[81]

Community Solar Projects

An effective way to expand access to solar's benefits is to allow multiple households to share the electricity produced from a single, large, solar PV system sited in a suitable location. For that to work, the state usually needs to pass enabling legislation and/or issue regulations to allow such collectively owned solar systems to connect to the utility grid and to enable the owners to take advantage of financial incentives for solar development. Delaware, for example, is one of a growing number of states that allow a participant in a shared solar project to receive the same net metering benefits as if the solar system was on the participant's roof.

Depending upon the state, shared solar projects are called by different names, including community solar or solar gardens, but they always expand the potential market for solar. There are currently community solar programs in 19 states, and a few other states are considering proposals to enable shared solar.[82] Colorado's Community Solar Gardens have been especially interesting, because they encourage and require participation by low- and moderate-income households. (See ***Case Study 31*** to learn about Colorado's 2010 Community Solar Gardens Act.) The District of Columbia has also been seeking ways to use shared solar to benefit all income groups.

Energy Resiliency for Low-Income Communities

As states have worked to make the electricity system less vulnerable to power outages from severe storms and other unexpected events (see Chapter Two), some of them have given special attention to low-income residents and other vulnerable populations. Residents of low-income communities may experience greater difficulty escaping a storm-ravaged area or coping with the loss of power. Moreover, such communities may find it difficult to attract financing to install resilient power at a community shelter or firehouse.

In affordable housing, senior centers, and assisted-living facilities, there is a great need to protect people from severe weather-related power outages, but the typical protection is far from ideal. Outmoded diesel generators, or nothing at all, are usually all that stand between the most vulnerable citizens and the damaging effects of power outages.

Case Study 30—Hawaii

Hawaii's GEMS finance program. See page 115.

Case Study 31—Colorado

Colorado's 2010 Community Solar Gardens Act. See page 117.

However, this is beginning to change. Affordable housing and other developers are teaming up with solar+storage vendors to ensure that critical building loads are covered when the power grid fails. In many instances, only a limited amount of resilient power may be needed to provide critical lighting, power a common area "cool room," or cover essential medical/communications equipment.

For instance, in the Bronx, NYSERDA provided major funding support under New York's Advanced Buildings Program to the Via Verde multifamily affordable housing project. Implementation of the 60 kW, 80 kWh solar+storage project (consisting of a lithium-ion battery bank connected to grid-tied battery-based inverters) is underway. Similar projects for low-income communities are in discussion in Baltimore, MD; Boston, MA; Chicago, IL; Cumberland, MD; Duluth, MN; Los Angeles, CA; Newark, NJ; New York, NY; San Francisco, CA: and Salt Lake City, UT.

In Massachusetts, the Department of Energy Resources (DOER) has announced that grant awards under its Community Clean Energy Resiliency Initiative includes $25.9 million to 21 municipal resilient power projects to protect the electricity supply at critical community facilities, such as police stations, fire stations, and emergency shelters. DOER considered municipal per-capita income in its award calculations, meaning that poorer communities were eligible for greater awards. Similarly, the New Jersey Bureau of Public Utilities has announced awards under its $3 million Renewable Electric Storage Competitive Solicitation to 13 solar+storage projects that include community facilities benefiting low-income communities, such as schools serving as emergency shelters.

CHAPTER 6

Lessons Learned and the Path Forward

As the previous chapters of this report have shown, state investments, policies, and programs have been essential to clean energy growth in the United States. Without the states, there would not be nearly as much electricity generation from clean energy technologies nor as many clean energy jobs. The states have helped set the stage for much greater clean energy use in the future.

This chapter highlights seven lessons drawn from the experiences of the states during the 21st century. It points out implications of those lessons for the states' future activities and for the federal government.

Lessons for State Activities

1. INNOVATION IS KEY TO THE STATES' SUCCESS

The previous chapters reveal the states to have been seedbeds of ingenuity and innovation during the past 15 years. The 31 case studies in the next part of this report illustrate the range of creative state programs and policies that have been developed for advancing clean energy. The states have truly served as "laboratories of democracy," embodying the metaphor that Judge Louis Brandeis popularized when describing the role of the states in the American political system. They have experimented, testing ideas and then spreading the successful ones across the country. With 50 state laboratories, there has been opportunity to try a wide range of approaches to clean energy policy with variations that meet local conditions and needs.

Going forward, it will remain important to continue this spirit of experimentation and innovation. However, now that states have many well-established programs and policies with solid track records of success, it could be tempting to slow the pace of program development. But markets, technologies, and consumer preferences continue to change, in part as a result of state programs and policies.

Here are a few ways to unleash further innovation and achieve continued program improvements:

- States can emphasize program evaluation. Many current clean energy initiatives have been in place long enough to provide sufficient data to assess impacts and cost-effectiveness. Evaluations can focus explicitly on ways to improve existing programs.[83]
- States can identify clean energy issues and topics that have not received adequate attention, similar to the way in which some states have recently targeted energy storage and others have targeted the needs of low-income residents. The states can then develop new programs or modify existing ones to address the issues they identify.

- Because clean energy technology is evolving rapidly and new business models are appearing, states can closely monitor industry trends to determine whether any new policies or programs would be desirable. For example, they may want to develop targeted forms of support for specific emerging technologies that potentially hold special promise for their state.
- States can seek to identify programs and activities that are no longer necessary. They can move out of markets when program goals have been achieved and state assistance is no longer needed.

States can seek to identify programs and activities that are no longer necessary and can move out of markets when program goals have been achieved.

- To be able to effectively carry out program evaluation, program revisions, and new program development, the states can ensure that state agencies that work on clean energy are adequately funded and staffed for undertaking those activities.
- The clean energy industry and other stakeholders can embrace the need for continued policy change and innovation, rather than simply defend existing programs. They can explicitly affirm that they realize that some existing policies will need to change over time and that they stand ready to work cooperatively with state officials to explore modifications and alternatives.

2. CONSUMER PROTECTION ACTIVITIES ARE INCREASINGLY IMPORTANT

Chapter Five highlighted an important state role that has largely gone unrecognized: the states' diverse activities to protect consumer interests and provide consumers with useful information. Sometimes, even the states themselves do not recognize all the existing consumer protection dimensions of their programs. But those programs are having a significant impact by imposing standards, requiring professional training, and educating the public.

As the clean energy industry grows and more people choose to purchase its products and services, the states' consumer protection and education roles will become even more important, and there will be additional consumer issues to confront. To prepare for this expanded role, the states can forge stronger ties between their energy agencies and the consumer assistance sections of their attorney general offices. They can also systematically identify the specific consumer protection concerns that may arise in their state and develop plans for addressing those issues. As with the Interstate Turbine Advisory Council, groups of states can work together to tackle issues, so that the costs of consumer protection measures will be reduced for industry, as well as for the states.

3. STATES' DISTRIBUTED GENERATION POLICIES HAVE DRIVEN CLEAN ENERGY EXPANSION

Chapter Three showed how policies such as net metering and streamlined permitting have fueled the increasingly rapid spread of rooftop solar and other distributed generation technologies. While this expansion was the intention of the policies, some utilities and energy analysts have started to express concern about the potential impacts on utility revenues and on the cost of electricity for ratepayers who do not have solar systems.[84] They warn that ratepayers without solar will have to pay higher rates as those with solar pay less money to the utility company for maintenance of the electric grid.

Although some of the warnings have overstated the threat to utilities and non-solar ratepayers, this is an extremely important issue for states to address. Utilities' business models will likely need to change in the future and some state policies may need to be modified.

State policymakers should methodically study various alternative policy proposals, such as minimal bills, value of solar tariffs, and utility ownership of solar installations. It is not yet clear which policy changes would be desirable. Thorough, transparent analysis, including a full accounting of the benefits and costs of distributed generation technologies, is critical to getting the policy details right. Because, with few exceptions, the market penetration of distributed generation is not yet large enough to have a significant impact on either utility profits or customers' electricity rates,[85] states have time to undertake this type of careful study. As the various policy proposals undergo greater scrutiny, the states should be able to identify and adopt the best policies for simultaneously maintaining robust clean energy growth, preserving the viability of the electric utility industry, and avoiding large electricity price spikes.

4. CLEAN ENERGY IS NOT A PARTISAN ISSUE

This report confirms very broad-based state participation in advancing clean energy. States of different regions, sizes, and political perspectives have all implemented clean energy policies and programs. Of course, each state has designed its policies and programs to meet its particular interests and needs.

States have had different motivations for promoting clean energy, resulting in a wide range of programs as illustrated by this report's case studies. In fact, part of the reason for the broad-based support is that political leaders have perceived a wide range of reasons for focusing on clean energy, including job creation, energy security, environmental quality, business development, consumer cost reductions, and financial assistance for specific regions and population groups within a state.

Public opinion surveys suggest that people from across the political spectrum would like to see additional clean energy development. In March of this year, Gallup asked Americans which energy sources should receive more emphasis in terms of domestic production. Solar and wind were the two sources most frequently recommended for greater emphasis. Solar was the most popular choice with 76 percent of the people surveyed wanting to see it get more attention. There were some differences among Republicans, Democrats, and Independents, but solar was the top choice of all three groups. In the case of wind, 71 percent of Americans wanted it to receive greater emphasis. Although Republicans, unlike Democrats and Independents, rated natural gas development slightly higher than wind (66 percent versus 63 percent), a solid majority still favored expanded use of wind.[86] Other recent public opinion studies have shown similarly strong support for renewable energy.[87]

Although partisanship has increased in American politics in recent years, clean energy has been a topic that has been characterized by discussions, cooperation, and coalitions that span party lines and ideologies. While there are certainly some hot button issues in some states, there are still opportunities for bipartisan and nonpartisan discussion on issues related to clean energy.

State policymakers of all political persuasions should therefore continue to maintain active communication with peers from other states, regions, and parties. By participating in groups like CESA, NARUC, NASEO, NCSL, and the NGA, they can learn from each other and identify the

policy ideas that make the most sense for their state. They can also look for other opportunities to exchange information and ideas across state lines.

Lessons about the Role of the Federal Government

5. THE FEDERAL GOVERNMENT PROVIDES STATES WITH NECESSARY INFORMATION AND ANALYSIS

The federal government, especially through U.S. DOE and the national energy laboratories, has helped states develop sound policies by providing data and analysis on clean energy technologies and on policy options. The federal government usually has greater research capacity than any individual state. It also plays an essential convening and coordination role, encouraging collaboration among the states. This report highlighted a few of the many examples of the federal government's coordination efforts, including regional transmission planning processes, the SunShot Initiative, and energy storage technology partnerships.

The federal government has helped states develop sound policies by providing data and analysis on clean energy technologies and on policy options.

Now that the market penetration of clean energy technologies has increased significantly, the federal government's information sharing and convening roles are even more important for helping states set appropriate policies. For one thing, there is more data to be collected and analyzed. Furthermore, the potential economic and reliability implications of different clean energy policies are much greater in an electricity system in which clean energy makes up a significant share of the generation mix.

At a recent Senate hearing on energy policy, Senator Martin Heinrich of New Mexico emphasized the states' need for accurate data about the economic implications of distributed generation, energy storage, and other clean energy technologies, in order to avoid policies that undercut or destabilize the electricity sector. He pointed out that the states will need "to make very accurate decisions about the costs and benefits, both sides of the ledger, of those things being brought onto the grid." Secretary of Energy Ernie Moniz, who was present at the hearing, agreed that U.S. DOE, through the national labs, could and should provide such information.[88]

U.S. DOE can directly produce or fund studies that quantify the benefits and costs of adding solar and other distributed resources, and can look at specific utility rate design and regulatory models for clean energy technologies. For example, earlier this year, NREL published a useful study of one possible rate design approach, the value of solar tariff.[89] Similar analysis should be produced for other policy options, such as minimum bills and standby charges.

LBNL has analyzed some of the less obvious economic impacts of clean energy. For example, it published studies on the effects of rooftop solar installations on home values and the long-term hedge value of electricity from wind installations.[90] These types of studies have been helpful to the states and more of them should be carried out.

LBNL and NREL jointly published a survey of the costs of state renewable portfolio standards[91] and have a project underway to analyze the specific economic and environmental benefits of those policies. Because RPSs are such an important vehicle for promoting clean energy generation and have been contentious in some states, additional economic analyses will be desirable in the coming years, especially if they can overcome the limitations of the data available to the studies carried out to date.

Beyond the costs and benefits of clean energy, the federal government can help state policymakers with other issues as well. In an electricity system with increased clean energy penetration, the variable

output of solar and wind becomes a greater challenge. The states are giving more attention to this issue, and U.S. DOE should prioritize research on integrating large quantities of renewable energy into the electricity system.

In addition, the federal government should continue its important convening and coordination activities. This includes supporting analysis of the need for long-distance transmission related to wind development, enabling regional transmission planning efforts, disseminating strategies for reducing solar soft costs, facilitating federal-state cooperation on offshore wind, and helping states to implement and assess implement demonstration projects related to energy storage, fuel cells, and other emerging technologies.

6. FEDERAL FINANCIAL INCENTIVES HAVE WORKED WELL IN COMBINATION WITH STATE INCENTIVES

State clean energy incentives have been effective because they have complemented federal policies, but have not been a substitute for those policies. Without both the states and the federal government providing support for clean energy development, the pace of development would slow. Moreover, the states would be burdened with increased costs for their clean energy programs and would have greater difficulty achieving the goals set out in their RPSs and other programs.

Several key federal tax incentives could end over the next two years. The Renewable Energy Production Tax Credit, which has been subject to several pauses and restarts over its history, expired at the end of 2014, at least temporarily.[92] That incentive has been especially important for utility-scale wind projects. The Residential Renewable Energy Investment Tax Credit, which is used for rooftop solar installations, geothermal heat pumps, and other home-scale technologies, is scheduled to expire at the end of 2016. The Business Energy Investment Tax Credit, which is used for technologies installed by businesses, is scheduled to decline from 30 percent to 10 percent at the end of 2016 for most solar applications and be eliminated completely for combined-heat-and-power, wind turbines, and several other technologies.

Although it may be appropriate to alter or reduce some of these incentives, it should be recognized that there has been a partnership between the states and the federal government to support clean energy. That partnership should continue.

7. STATES' EXISTING CLEAN ENERGY PROGRAMS CAN BE IMPORTANT TO EPA'S CLEAN POWER PLAN

This report is not the place for discussion of the merits of the U.S. EPA's Clean Power Plan. But the report does show that the states have employed a wide range of policies that have stimulated the development of clean energy generation that reduces carbon emissions. If the U.S. EPA's plan is implemented, the whole suite of existing state policies and programs should be encouraged to continue as part of state compliance plans. Renewable energy generation should therefore be given considerable encouragement in the Clean Power Plan.

RPSs, in particular, have proven to be potent state policies. But they could be weakened if the final Clean Power Plan rule is not carefully constructed. The Commerce Clause of the U.S. Constitution limits state restrictions that favor in-state projects over out-of-state projects for RPS compliance. Consequently, states have supported the development of thousands of megawatts of clean energy generation capacity beyond their borders. It is in the interests of the U.S. EPA and the nation to have these interstate effects continue. If states cannot receive credit under the Clean Power Plan for the clean energy generation projects they cause to be built beyond their borders, they would be incentivized to scale back their RPSs, which would have a constraining effect on renewable energy markets. To avoid this problem and to be fair, if the RECs from a particular electricity generator in one state are used to comply with the RPS of a different state, then the state that retires the RECs should receive credit for the emission reductions associated with the generation.

The U.S. EPA should also recognize that states such as Alaska and Hawaii do not have robust transmission systems linking all statewide electric utilities via a full electric grid. If the Clean Power Plan does not allow credit for renewable energy development in remote areas off the limited central grid, these states would not receive credit for clean energy generation projects they cause to be built in rural areas and they would be incentivized to scale back their renewable energy programs. Such a scenario should be avoided.

In terms of Clean Power Plan implementation, the renewable energy tracking systems that the states have established are valuable tools. The U.S. EPA and the states should work together to explore using those tracking systems to ensure the proper accounting for renewable energy generation.[93] The tracking systems could readily be adapted to keep a record of certificates that need to be monitored as part of a state's compliance plan even though the certificates do not count toward an RPS (because the power comes from a generator whose technology is not eligible for that RPS or was built before the RPS became effective).

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Up to now, the states have been an essential pillar of clean energy growth. They have been able to play that role because governors, legislators, and state agency staff have given significant attention to clean energy as an issue. They have been willing to put in place new innovative policies and to modify them over time, as necessary. They have provided sufficient budgets to carry out those policies and to staff the agencies that oversee them. By taking a similar approach in the future, the states will continue to be a central pillar of clean energy growth.

Case Studies

CASE STUDIES

LISTED ALPHABETICALLY BY STATE OR PROGRAM

CASE STUDY 1

North Carolina Diversifies its Energy Supply with a Renewable Portfolio Standard

North Carolina has the ninth-largest population in the U.S. and is projected to continue growing over the coming decades, especially in the state's urban areas. Electricity prices are lower in North Carolina than the national average but higher than in neighboring southern states. Traditionally, the state has relied on fossil fuels and nuclear power, but in 2007 North Carolina enacted a renewable portfolio standard (RPS) that is diversifying its fuel supply and has helped to attract new businesses.

North Carolina's RPS requires investor-owned utilities to generate 12.5 percent of their power from renewable fuels by 2021, with a slightly lower standard for cooperatives and municipal utilities (10 percent by 2018). Eligible technologies include solar, landfill gas, wind, biomass, geothermal, combined heat and power (CHP), anaerobic digestion, and wave and tidal power. The law includes several small carve-outs: 0.2 percent solar by 2019, 0.2 percent energy from swine waste by 2019, and 900,000 megawatt-hours from poultry waste by 2016 (the latter two sources reflect the state's large agricultural sector). Energy efficiency technologies such as CHP can be used to meet up to 25 percent of the targets, which lowers compliance costs for power producers.

When North Carolina adopted its RPS the state had about 1,400 megawatts of hydropower and 600 megawatts of other renewables. A study prepared for the North Carolina Utilities Commission projected that biomass, including wood and agricultural wastes, would be the largest contributor to an RPS.[1] The study also noted that North Carolina's reliance on coal and nuclear power—its two largest electricity sources—exposed consumers to several types of financial risk. Both fuels produce wastes

1 "Analysis of a Renewable Portfolio Standard for the State of North Carolina," La Capra Associates Inc., December 2006, p. v, *www.ncuc.commerce.state.nc.us/reps/NCRPSReport12-06.pdf.*

that are hazardous and expensive to manage (coal ash and spent nuclear fuel respectively). And if North Carolina or the United States were to adopt a carbon tax or other carbon pollution limits, electricity from the state's coal-fired power plants would become more expensive.

"It is clear that the addition of new renewable resources and development of energy efficiency programs would help to diversify the State's resource mix and, as such, could have beneficial effects over the long-term for customers," the study observed.[2] Potential risks from coal-fired generation were illustrated in 2014 when coal ash leaked from holding ponds at several Duke Energy plants in North Carolina, contaminating the Dan River with arsenic. In February 2015, Duke Energy agreed to pay more than $100 million to settle nine criminal charges associated with the spills.[3]

Solar Surge

In the eight years since North Carolina adopted its RPS, the state's clean energy industry has grown rapidly. According to the North Carolina Sustainable Energy Association, this sector employed nearly 23,000 people at more than 1,200 firms as of early 2014 and generated $4.8 billion in annual revenues.[4] Contrary to expectations that biomass would be the largest in-state source of renewable energy supply for North Carolina's RPS, the state has become a major center for solar energy. It has about 722 megawatts of installed solar capacity, ranking fourth nationwide after California, Arizona, and New Jersey. Some of these projects provide power for large data server farms for companies like Apple and Google, which North Carolina has recruited aggressively. At the opposite extreme, a statewide incentive program called NC GreenPower, which offers production payments for grid-tied electricity, has spurred the development of many small solar projects (less than 5 kilowatts).

In the eight years since North Carolina adopted its RPS, the state's clean energy industry has grown rapidly.

"The combination of the RPS, tax credits, and reduced costs for solar technology have led to substantial solar development in North Carolina," says Sam Watson, general counsel and director at the North Carolina Utilities Commission. "The poultry and swine waste industries are not mature enough yet to provide economical waste-to-energy projects, but utilities have met their general obligation and solar targets each year, at much lower compliance costs than were originally anticipated when the RPS was adopted."[5]

Although the future of the RPS and the tax credits is uncertain, as some legislators push for their repeal, there can be no doubt that the North Carolina RPS has had a major impact on clean energy development in the state.

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2 Ibid., p. xiii.

3 Ralph Ellis, "Duke Energy Faces Charges, $102 Million in Fines Over Coal Ash Spills, CNN, Feb 21, 2015, *www.cnn.com/2015/02/20/us/duke-energy-charges.*

4 Robin Aldina et al., *North Carolina Clean Energy Industry Census 2014*, (NC Sustainable Energy Association, February 2015), p.5, *http://c.ymcdn.com/sites/www.energync.org/resource/resmgr/Docs/2014census.pdf.*

5 Unless otherwise indicated, all quotations in the case studies in this report come either from conversations or correspondence with one of the report's authors or from comments in recorded CESA webinars.

CASE STUDY 2

Oklahoma Captures the Potential of its Wind Resources

Some of the strongest winds in the U.S. blow through Oklahoma. To take advantage of this resource, the state has implemented several wind energy policies and incentives, including a ten-year tax credit based on the amount of electricity wind farms generate, a five-year property tax exemption, and streamlined regulatory siting approval. As a result of these policies and other factors, Oklahoma's wind capacity has tripled since 2011.

Wind projects in Oklahoma are providing numerous environmental and economic benefits. Because wind power requires very little water, the state has avoided the use of an estimated two billion gallons by fossil fuel power plants. Additionally, over six million metric tons of CO_2 emissions have been avoided. Economic benefits from the deployment of wind include capital investments of $7 billion. Land lease payments for wind in excess of $11 million annually provide valuable income to the state's farmers and other landowners. Wind development also creates jobs with over 4,000 direct and indirect jobs being supported in 2014.[1] Moreover, supply chain manufacturing facilities have sprung up to support wind power.

1 American Wind Energy Association, Oklahoma Wind Energy Fact Sheet, accessed, May 27, 2015, *http://awea.files.cms-plus.com/FileDownloads/pdfs/Oklahoma.pdf.*

Oklahoma Deputy Secretary of Energy Craig Sundstrom knew the state was on the right track when other states started showing interest in Oklahoma's wind policy. He points to Oklahoma's zero emission tax credit of 0.5 cents per kilowatt-hour, which is refundable if wind farms don't have enough income to claim the credit. In addition, wind farms have been exempt from local property taxes for five years. This tax exemption is unique in that it reimburses local communities for lost property tax income, ensuring that they share in the economic benefits of wind development. Although the legislature recently decided to eliminate the tax exemption to address budget shortfalls, it has had a powerful impact and the zero emission tax credit will remain in place for another five years.

Although the legislature recently decided to eliminate the tax exemption to address budget shortfalls, it has had a powerful impact and the zero emission tax credit will remain in place for another five years.

Frank Costanza, executive vice president of wind developer Tradewind Energy, believes that Oklahoma's policies have been "extraordinarily effective" in attracting wind developers. He cites the tax credit and property tax exemption as the primary reasons. These policies entice wind developers to the state and enable them to offer competitively priced electricity, and then pass the savings through to their utility customers. Wind energy development has helped keep Oklahoma's electricity costs among the lowest in the country.

Oklahoma Secretary of Energy and Environment Michael Teague notes proudly that the state's "abundant wind resources" combined with its "robust set of incentives" have meant that "Oklahoma's wind power is proven to be the best-cost resource for utilities in [five] other states to use as part of their generation portfolios for consumers."[2] Governor Mary Fallin adds that: "Today, Oklahoma's wind industry is among the strongest in the nation and is an integral part of our power grid and our economy. Wind energy is here to stay."[3]

2 Michael Teague, "Fossil-Fuel-Rich Oklahoma Digs into Wind Energy," *North American Windpower*, January 2015, *http://www.nawindpower.com/issues/NAW1501/FEAT_03_Fossil-Fuel-Rich-Oklahoma-Digs-Into-Wind-Energy.html*.

3 Mary Fallin quoted in "Oklahoma Gov. Signs Bills Reforming Wind Industry Incentives," *North American Windpower,* May 21, 2015, *www.nawindpower.com/e107_plugins/content/content.php?content.14255#utm_medium=email&utm_campaign=NAW+News+Headlines&utm_source=LNH+05-23-2015*.

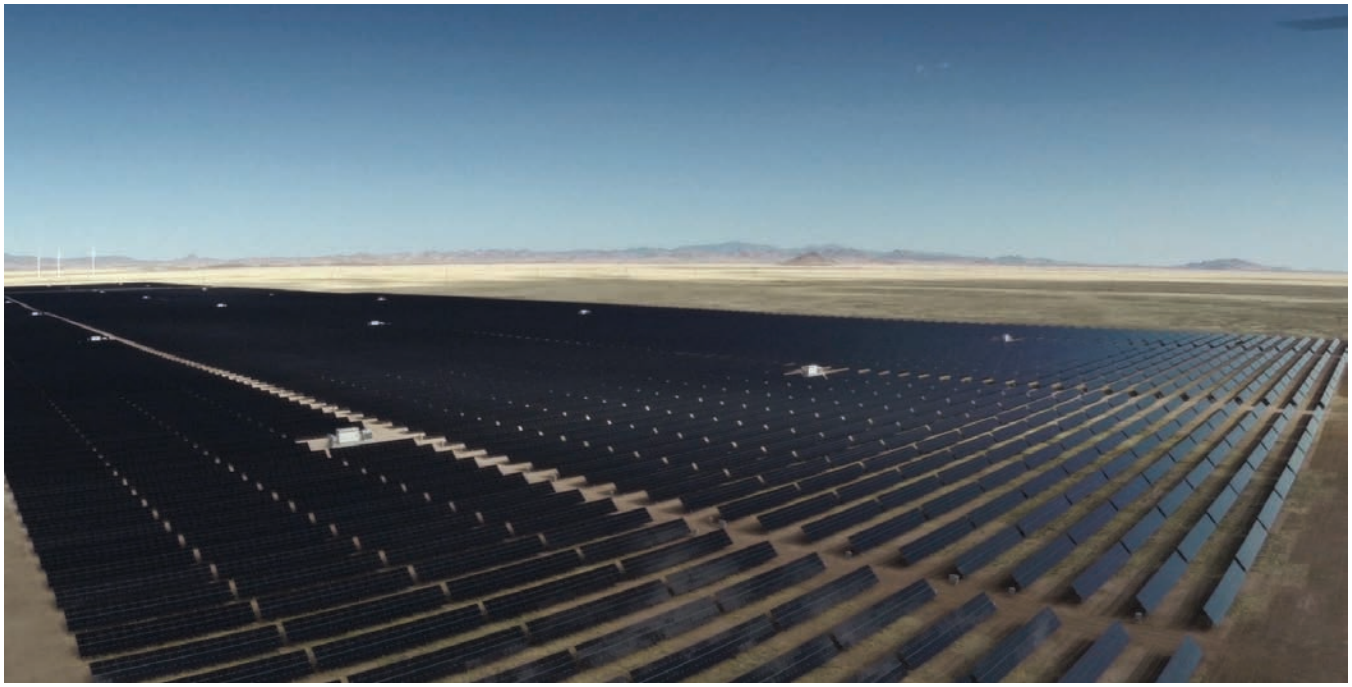
CASE STUDY 3

New Mexico Attracts Jobs and Revenues with Renewable Energy Tax Credit

New Mexico has abundant fossil fuel resources: in 2013, it ranked sixth in the nation for crude oil production, seventh for natural gas and twelfth for coal.[1] It also has some of the best solar and wind energy resources in the United States. Over the past decade, New Mexico leaders have positioned the state as a major growth area for renewable energy by developing effective policies and programs, along with financial and other incentives, including a state-level renewable energy production tax credit. These policies have attracted millions of private and federal dollars, generated construction and manufacturing jobs, and boosted state revenues from land leases for renewable energy projects. They are also helping diversify New Mexico's electricity production, thereby reducing the potential impacts if the price of fossil fuel-fired electricity increases in the future.

Production tax credits (PTCs) give investors an incentive to build or finance renewable energy projects. They typically are offered for a fixed period to help new industries scale up. Unlike investment tax credits, which reward investors for building a project and typically are paid up-front when the project is put into service, PTCs are paid over time and are based on the amount of electricity generated.

Offering a PTC helped New Mexico compete with other Western states for energy investments. Those states are major energy producers with excellent wind, solar, and/or geothermal resources. In



1 "New Mexico: State Profile and Energy Estimates," U.S. Energy Information Administration, accessed May 19, 2015, *www.eia.gov/state/?sid=NM*.

particular, Colorado has a well-developed green economy, a skilled labor force, and world-class research institutions that make it a regional leader in clean energy and environmental technologies. To attract investments in its clean energy sector, New Mexico needed to provide equally attractive business conditions for renewable energy companies.

Attracting Wind Developers

In 2002, New Mexico's public utility commission adopted a Renewable Portfolio Standard that required investor-owned utilities to generate 5 percent of their electricity from renewables by 2006 and 10 percent by 2011. Five years later the legislature increased New Mexico's renewable electricity targets to 15 percent of electricity by 2015 and 20 percent by 2020. Before it set those targets, New Mexico had very little renewable energy online, so the state had to scale up renewable energy production rapidly.

To attract energy developers, the state hired an international firm to produce "investment grade" maps of the state's wind resources. This data gave companies reliable information to make decisions for siting wind projects. The state then offered wind and biomass energy producers a PTC of $0.01 per kilowatt-hour against their corporate taxes. To qualify, companies had to develop at least 1 megawatt of generating capacity before January 1, 2018. (This size requirement ensured that the credit would support construction of commercial-scale projects.) Each qualifying project could earn credits for producing up to 400,000 megawatt-hours of electricity annually over its first 10 years of operation. Solar energy was later added to the state's PTC, so that solar producers can now receive credits that average $0.027 per killowat-hour for their first 200,000 megawatt-hours per year, generated over 10 years.

In the first 10 years in which New Mexico offered the production tax credit, developers built 10 wind energy projects with 794 megawatts of generating capacity and 21 solar projects with 232 megawatts of capacity. Additional projects on a waiting list of tax credits would provide another 677 megawatts of wind and 65.5 megawatts of solar (the state caps the total number of credits that can be awarded each year).

Energy Projects Generate Land Revenue

Wind and solar energy projects in New Mexico have generated approximately $2 billion in construction activity. Moreover, because many of the plants are sited on lands leased from the State Land Office, state land leases are projected to provide $574 million in revenues for the state, or about $15 million per year. Other renewable energy projects on private lands are providing supplemental income for landowners, many of whom are farmers and ranchers.

"We have a lot of ranchers who are not making enough money from grazing and farming. This is a great opportunity for them to use their land and gain some economic benefit," says Erica Velarde, clean energy program manager for New Mexico's Energy Conservation and Management Division. Today New Mexico is a recognized state leader in the renewable energy sector. In 2013, Ernst & Young ranked New Mexico sixth nationally for wind and fourth for solar in its state renewable energy attractiveness indices.[2] Six other states have enacted renewable energy production tax credits. The state may increase the number of credits available under the PTC to accommodate demand from energy companies. "Industry wants to raise the cap, and the legislature is considering it," says Velarde.

2 "United States Renewable Energy Attractiveness Indices," Ernst & Young, August 2013, *www.ey.com/Publication/vwLUAssets/United_States_renewable_energy_attractiveness_indices/$FILE/United_States_renewable_energy_attractiveness_indices.pdf*.

CASE STUDY 4

California Drives the Market for Solar Development

California has the world's eighth-largest economy and a population that is projected to grow from 39 million today to 50 million by 2050. Providing enough energy to meet the state's power needs would be a major challenge under stable conditions, but climate change will make it even more difficult. Notably, rising temperatures are projected to increase energy demand for summer cooling. And changing precipitation patterns will reduce spring snowpack in the Sierra Nevada Mountains, decreasing hydropower generation, which produced up to 15 percent of the state's electricity supply before the current multi-year drought.

Over the past several decades, California has staked out a leadership position in addressing climate change. It has one of the most ambitious renewable portfolio standards in the nation, and it has adopted a goal of cutting greenhouse gas emissions 80 percent below 1990 levels by 2050. To meet these targets, state agencies are spending billions of dollars and using many policy tools to promote clean energy development. One result is a fast-growing solar industry that currently employs about 55,000 people statewide—more than the state's five largest utilities combined. At the end of March 2015, California had more than 10,000 megawatts of installed solar generating capacity, far more than any other state.[1]

1 Joshua Hill, "California becomes First U.S. State to Surpass 10,000 MW Solar Mark," CleanTechnica website, June 16, 2015.

California has achieved these results through a sustained, long-term commitment to solar development. Measures such as ten-year frameworks with dedicated funding streams have created certainty for the industry. The state has sited utility-scale solar projects on large expanses of desert land, but also has aggressively supported residential PV projects with rebates and favorable net metering rules.

Escalating clean energy targets

California made an official commitment to fostering solar power and other renewables in 1996 as part of its legislation deregulating electric utilities. A year later, the state launched its Emerging Renewables Program, which provided rebates to homes and businesses that installed grid-connected solar PV systems under 30 kilowatts. The California Public Utilities Commission (CPUC) funded larger projects for businesses. From 1997 through 2006, more than 150 megawatts of solar generating capacity was installed through these programs.

California made an official commitment to fostering solar power and other renewables in 1996 as part of its legislation deregulating electric utilities. A year later the state launched an Emerging Renewables Program.

In 2002, the state legislature enacted a bill establishing a renewable portfolio standard goal of 20 percent by 2017, which was accelerated by subsequent legislation in 2006 to 20 percent by 2010.[2] Three years later, Governor Arnold Schwarzenegger issued an executive order calling for California to reduce its greenhouse gas emissions to 1990 levels by 2020—about 15 percent below a business-as-usual trajectory—and 80 percent below 1990 levels by 2050. Schwarzenegger also proposed a "Million Solar Roofs" initiative that would offer rebates for a decade to promote residential solar projects. In 2006, the California legislature enacted AB 32, which codified the 2020 goal into law, and SB 1, which codified the Million Solar Roofs initiative and expanded on the state's existing solar energy programs.

These targets increased the urgency of scaling up solar development. In 2007, CPUC launched a new ten-year statewide effort called the California Solar Initiative (CSI), with a $3.3 billion budget and a goal of 3,000 megawatts of new solar capacity. Various elements of the program are administrated by state agencies and utilities, as shown in Table 1.

TABLE 1
California Solar Initiative by program component, 2007–2016

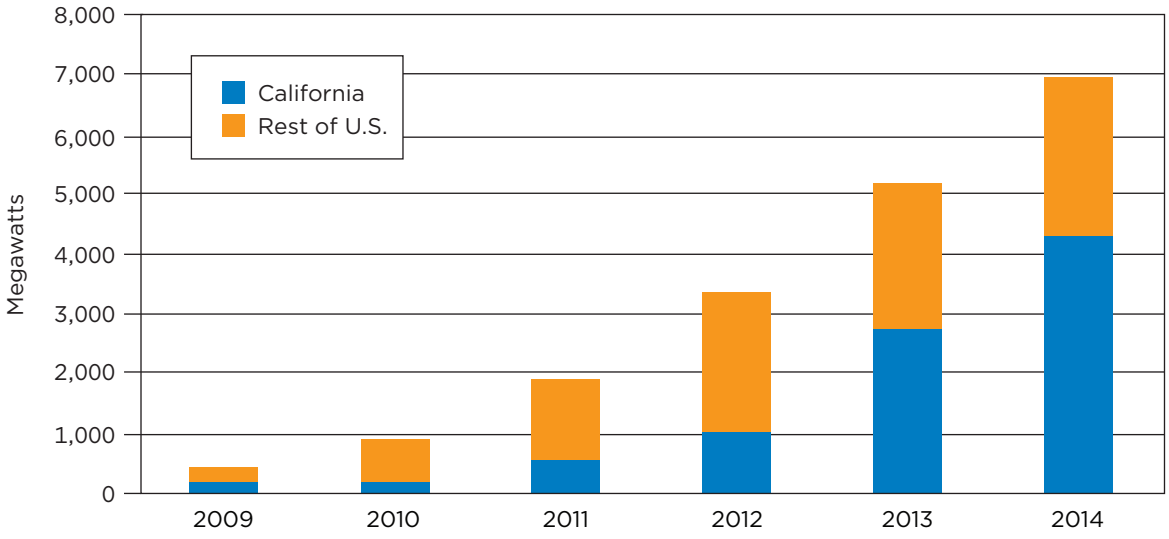
	California Solar Initiative	New Solar Homes Partnership	Various Programs
Program authority	California Public Utilities Commission	California Energy Commission	Publicly owned utilities
Budget	$2.367 billion	$400 million	$784 million
Solar goals (MW)	1,940 MW	360 MW	700 MW
Scope	All systems in investor-owned utility areas except new homes	New homes in investor-owned utility areas	All systems in publicly owned utility areas
Start date	January 2007	January 2007	January 2008

Source: Go Solar California, *www.gosolarcalifornia.ca.gov/about/gosolar/history.php.*

2 In 2011, California's renewable portfolio standard was expanded to 33 percent by 2020. Governor Edmund Brown has set a goal to further expand the requirement to 50 percent by 2030.

FIGURE 3

California and U.S. Yearly Installed Solar Capacity (MW)



Source: Solar Energy Industries Association

The largest component of the overall CPUC CSI program provided rebates to customers in the territories of the state's large utilities for installing PV and other solar generating technologies, and solar hot water systems on existing homes, commercial, agricultural, government and nonprofit buildings. Incentives were awarded based on project performance for commercial systems over 100 kilowatts and expected performance for smaller systems.

The CSI program also offered special rebate programs for low-income homeowners and for multi-family affordable housing. In 2013, the legislature authorized $108 million in new funding, setting a goal of 50 megawatts of installed capacity across both single-family and multifamily programs, and extending the programs until 2021 or until the new funding is exhausted, whichever occurs first.

Under the CSI, rebates for solar projects declined in value as the cumulative amount of installed solar generating capacity statewide increased. By early 2015, nearly all of the available rebates had been awarded, but the pace of solar development remained strong.[3] This trend indicates that the California solar market has matured: developers have reduced their costs and continue to install new solar projects without relying on state subsidies.[4] Figure 3 above shows how solar projects through the CSI, combined with utility-scale solar development in the state, account for a large share of the nation's additions to solar capacity, including the majority in 2014.

"The guiding philosophy behind all of California's renewable energy programs over the past decade has been that long-term, stable policies signal to the market and investors that renewable energy is here to stay and is going to grow. The three things that will help grow solar and reduce prices are innovation, automation, and scale, and California's approach to solar development has fostered all of those processes," says Commissioner David Hochschild of the California Energy Commission.

Facilitating sustainable growth

Large energy projects often are hard to site, and solar power is no exception—especially in California, where many environmental advocates raised concerns about the impacts of utility-scale projects on

3 "California Solar Initiative – Statewide Trigger Tracker," Go Solar California, last updated May 19, 2015, *http://csi-trigger.com*.

4 For details see Stephen Lacey, "The End of a Solar Era: The Legacy of the California Solar Initiative," *GreenTech Solar,* November 4, 2014, *www.greentechmedia.com/articles/read/the-legacy-of-the-california-solar-initiative.*

fragile desert lands. To address those concerns, the California Energy Commission, the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife launched an initiative in 2009 called the Desert Renewable Energy Conservation Plan (DRECP), which focused on 22.5 million acres in the Colorado and Mojave deserts. The plan identified areas where solar, wind, and geothermal development poses relatively little risk of significant environmental impacts, as well as areas that should be protected for habitat conservation. The goal was to help the state balance conservation and renewable energy development in the deserts.

"A lot of this land is pristine. We knew we couldn't let developers throw projects up wherever they wanted," says Kevin Barker, an adviser to California Energy Commission Chair Robert Weisenmiller.

The DRECP created a partnership between multiple state, local, and federal government agencies, environmental organizations, and renewable energy development groups that will use landscape-scale planning to designate some areas for conservation and recommend others for development.

The DRECP created a partnership between multiple state, local, and federal government agencies, environmental organizations, and renewable energy development groups that will use landscape-scale planning to designate some areas for conservation and recommend others for development. To make those decisions, participating agencies determined that they needed more information about where animals and plants existed, how vulnerable they were to climate change and development, and what could be done to protect them from the impacts of energy development. The commission developed and funded research projects on species including the California desert tortoise, desert kit fox, golden eagle, and Mohave ground squirrel, and mapped vegetation in the target areas. The draft plan and programmatic environmental analysis was released in September 2014. A public comment period closed in February 2015 and, based on comments received, the plan will be completed in phases.[5]

"This kind of proactive land use planning process can and should be replicated in other places," says Barker.

5 For details see: "Public Input Drives Next Steps for Desert Renewable Energy Conservation Plan," News Release, March 10, 2015, *www.drecp.org/documents/docs/2015-03-10_DRECP_Path_Forward_News_Release.pdf* . The draft plan can also be viewed on the DRECP website, *www.drecp.org.*

CASE STUDY 5

Minnesota Tackles the Value of Solar

In 1983, Minnesota became the first state to require net metering for distributed generation. More than three decades later, many other states have joined Minnesota in requiring utilities to pay retail rates for the solar power they purchase from customers. The rooftop solar PV market is growing across the country, thanks in part to net metering. But as greater quantities of solar electricity penetrate the grid, some utility companies and energy analysts are questioning whether net metering will still make sense in the future.

The concerned utilities argue that solar electricity produced by distributed generation reduces the revenue needed to cover a utility's fixed costs of operation. They claim that net metering gives those using solar power unfairly large payments for the electricity they generate. On the flip side, advocates of solar point out that distributed solar power is more valuable than conventional power. It has a multitude of environmental benefits, it can decrease the need for power plant upgrades, and it can reduce demand stress on the grid.

Minnesota's legislature realized that the state's public utilities commission and utilities were hard pressed to accurately value solar's contributions without a formal, comprehensive, inclusive evaluation of solar. Accordingly, Minnesota set a national precedent again by enacting a bill directing its Department of Commerce (DOC) to derive a methodology that could be used by utilities to implement a value of solar (VOS) tariff.

Over several months, the DOC held hearings with all stakeholders—utilities, environmentalists, citizens, and others. This stakeholder process was critical, according to Lise Trudeau of the DOC, because it created a transparent and open-minded atmosphere from which the methodology evolved.

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Using the insights they gleaned from the hearings, the DOC staff was able to value solar power. They used avoided costs as the building blocks of the valuation. The largest avoided costs were fuel, environmental impacts, and generation capacity. The U.S. EPA-derived "social cost of carbon" was used to estimate economic damage caused by CO_2 emissions.

The DOC's goal was not to advocate for any particular position. It was simply to enable an equitable way of accounting for the value of solar. Utilities are not required to adopt the value of solar tariff; they may continue to use net metering.

As defined by Minnesota, VOS differs from net metering not only in an accounting sense, but in a physical sense as well. VOS customers have two meters: one tracking the electricity they consume and another tracking the solar electricity they produce. Customers pay for consumption at the going retail rate but earn a credit based on the VOS rate. A 25-year contract locks in the value of the solar credit. If the solar system produces more electricity in a year than the customer consumes, it is forfeited to the utility. In addition, the solar renewable energy certificates belong to the utility.

The VOS concept is still a work in progress. The utilities and the state are still figuring out when it does or does not make sense to use VOS. But Minnesota's exploration of the concept has informed and enriched a national discussion on solar electricity rate design.

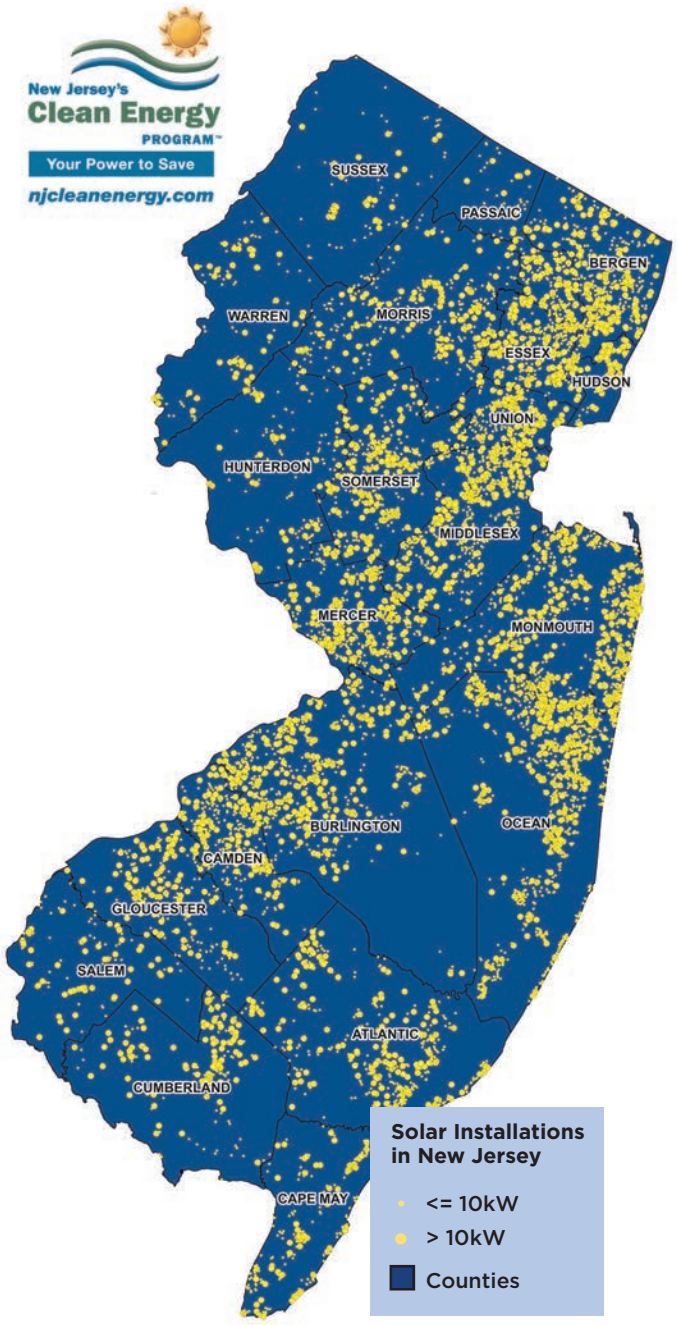
CASE STUDY 6

New Jersey Drives Solar Development with SRECs

New Jersey is densely developed and has modest solar resources compared to states like California and Arizona, which have large swaths of desert land. But New Jersey has used public policy aggressively to develop more than 1,400 megawatts of installed solar capacity, ranking it third in the United States. The key elements of New Jersey's solar energy policy are a strong solar set-aside (or carve-out) within the state's renewable portfolio standard, and a market-based trading system for solar renewable energy certificates (SRECs)[1] that enables electricity suppliers to meet their RPS solar requirement.

New Jersey's RPS calls for generating just over 20 percent of electricity from renewables by 2021, with a requirement of 4.1 percent solar electricity by 2028. In 2014, the solar requirement was 2.05 percent. The state's SREC trading system, which was launched in 2004, was the first system created specifically for trading solar electricity credits. It generates a REC for each megawatt-hour of solar electricity from facilities connected to the electric distribution system in New Jersey. SREC creation, tracking, and retirement is accounted for through the regional PJM-EIS Generation Tracking System. Facilities can receive SRECs for 15 years once they connect to the grid.

Utilities and third-party electricity suppliers show that they are meeting yearly solar goals by retiring SRECs or paying a fee called the Solar Alternative Compliance Payment (SACP). The SACP, which is effectively a ceiling on the SREC prices and on compliance costs passed on to ratepayers, is established by law and is set high enough to create demand for SRECs and help support a market. In 2015, the SACP is $331 per megawatt-hour. SRECs can be banked for four years after the year in which they are issued.



1 A renewable energy certificate represents the property rights to the environmental and other non-power qualities of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source.

New Jersey also has interconnection and net metering policies that make it easy for homeowners and businesses to connect solar systems to the grid, to offset purchased electricity at retail rates, and to sell any excess at wholesale rates. The state requires all utilities and electricity suppliers to offer net metering and does not limit the aggregate statewide capacity that can be net metered. Many types and sizes of systems are eligible. The state encourages solar development on unproductive land, including brownfields and landfills, and on flat-roofed commercial buildings such as warehouses and distribution centers. This approach makes effective use of New Jersey's limited amount of open space.

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These policies have fostered a fast-growing solar industry in New Jersey. When the state launched its Clean Energy Program in 2001 to promote renewable energy development, it had a total of six solar installations. By the end of March 2015, it had 34,669 solar installations with a total capacity of 1,469 megawatts, and more than 7,700 additional projects in the pipeline. Almost 80 percent of the state's installed solar capacity comes from so-called "behind the meter" systems— i.e., smaller systems that are designed to produce power mainly for use onsite in a home, office building, or other commercial facility.[2]

Managing the SREC market

Although New Jersey's solar energy industry has grown rapidly, the market for SRECs has not always worked smoothly. For the first four years of trading, starting in 2008, while the SACP was fixed at $300 per SREC, spot market prices averaged $200. A key component of the state's transition away from rebates to reliance on SRECs to motivate solar investment was raising the SACP to $711 in 2008. Contemporaneous with the change in the SACP schedule, the New Jersey legislature increased the solar requirements, making an already short SREC market even shorter. As a result, SREC spot market prices rose above $600. In 2011-2012, falling solar technology prices, changes to the federal investment tax credit, and high SREC values led to a surge in solar projects. That caused the price of SRECs to plunge from $670 to $225. The drop in SREC values threatened to cause a prolonged contraction in new project starts.

In response to this problem, in 2012 the New Jersey legislature enacted a law that restructured the SREC market to reduce volatility. The law doubled the solar requirement to 2.05 percent in 2013, extended the solar target to 4.1 percent in 2028, changed the vintage period for SRECSs from three years to five years, restricted development of large-scale solar on farm land, and encouraged development on brownfields and landfills.[3]

"The SREC market has supported the industry and public policy in New Jersey," says Todd Hranicka, director for solar energy at PSE&G, the state's largest publicly owned utility. Hranicka worked for a solar construction firm in New Jersey prior to joining PSE&G in 2012. "New Jersey is a very densely developed state and has high electricity costs, but promoting solar power on sites like rooftops and landfills is a way for the state to meet its renewable needs and provide ratepayers some relief."

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2 "Solar Market FAQs," New Jersey's Clean Energy Program, accessed May 19, 2015, *www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs.*

3 "Solar Market Development Volatility in New Jersey," Meister Consultants Group and Sustainable Energy Advantage LLC, May 2014, *http://nj.gov/bpu/pdf/announcements/2014/solar-market-volatility.pdf.*

CASE STUDY 7

States Spur Solarize Successes

States have been using group purchasing and special marketing initiatives to bring down the cost of solar. A wide range of campaigns, each called Solarize, have been launched with leadership from state agencies in Oregon, Massachusetts, Connecticut, and other states. Solarize initiatives combine four components:

1. *Community-Driven Outreach:* These methods may include peer-to-peer interactions, social media campaigns, town meetings, and booths at community events.
2. *Competitively Selected Installers:* Through a competitive bidding process, the targeted community selects an installer or installers to service the area throughout the duration of the Solarize campaign. This reduces installers' customer acquisition and screening costs and saves the consumer from the effort of shopping around for a reputable, price-competitive installer.
3. *Discount, Tiered Pricing:* Pre-negotiated discounts increase as more people sign up within a target community (i.e., the more people who go solar under a Solarize campaign, the lower the price or overall cost savings for everyone who participates in the community).
4. *Limited Time Offer:* Solarize campaigns are limited-time offers. This motivates customers to act quickly, or risk missing the window of opportunity to install solar PV at a reduced rate.

Significant cost savings result from coordinated education, promotion, and outreach efforts by town volunteers, and in some cases assistance from professional marketing organizations, along with

discounted pricing, which takes advantage of reduced customer acquisition costs. These savings are passed along to homeowners and create a compelling reason to sign up for Solarize.

Oregon Starts the Ball Rolling

The first Solarize campaign began in southeast Portland, Oregon in 2009 when residents sought to increase their solar purchasing power by banding together. Through a local neighborhood coalition, Southeast Uplift, the residents reached out to Energy Trust of Oregon for advice on how to get started. Energy Trust, an independent nonprofit empowered by the State of Oregon to deliver cash incentives and services to help utility customers invest in energy efficiency and renewables, worked with Southeast Uplift to develop and pilot a solar volume purchasing program, which it dubbed "Solarize Portland."

The initial Solarize campaign successfully reduced the financial and logistical barriers of going solar, with over 115 southeast Portland residents signing installation contracts during the first six months of the program. Together with several subsequent campaigns, Solarize was responsible for increasing the amount of installed solar in Portland by more than 400 percent over three years. The campaigns helped lay the foundation for a strong and durable solar market in Oregon. The results were so impressive that the idea spread elsewhere, creating jobs, lowering energy bills for residents, and decreasing the carbon footprint of participating communities.

Massachusetts and Connecticut Hop on Board

Solarize Massachusetts (Solarize Mass) was launched in 2011 when the Massachusetts Clean Energy Center partnered with the Green Communities Division of the Massachusetts Department of Energy Resources to pilot a program in four communities, resulting in 829 kW of new solar. The success of Solarize Mass led to many subsequent rounds of the program. Now in its fourth year, Solarize Mass has led to more than 2,400 residents and business owners signing contracts for small-scale solar electricity systems. Through active Solarize marketing and educational outreach, thousands of people have learned about the economic and environmental benefits of solar electricity. Almost every community participating in Solarize Mass has more than doubled its number of residential-scale solar projects and has seen the rate of adoption increase relative to the rate prior to participating. In addition, the average number of systems and the average capacity contracted per community has continued to increase in every round.

The Connecticut Green Bank, formerly CEFIA, began Solarize Connecticut in May of 2012, choosing four towns from its pre-existing Clean Energy Communities Program. The Green Bank partnered with SmartPower, a non-profit marketing firm with experience conducting community energy campaigns, for the development of promotional materials, recruitment of municipalities, management of town websites and social media, and coordination of local community outreach campaigns.

Phase I of Solarize Connecticut, which ran from August 2012 until January 2013, was a marked success, with approximately 280 signed contracts, and more than 2.2 megawatts of installed capacity—all generated from four towns. The Solarize Connecticut program has just finished Phase 5. In total, Solarize Connecticut has conducted 38 campaigns in 49 municipalities. The Connecticut Green Bank is now launching six Solarize U campaigns for homeowners associated with participating universities.

The successful Solarize marketing approach has spread to many other parts of the country. Sometimes, as in the case of Rhode Island and New York, state or quasi-state agencies have played a crucial role in initiating the program. In other places, community groups, grassroots organizations, or solar businesses have been the key instigators. But the Solarize model would not have been developed as fully or spread as widely without the initial work performed by state programs in Oregon, Massachusetts, and Connecticut.

CASE STUDY 8

Wisconsin Helps Farmers Turn a Liability into an Asset

Dairy farmers in Wisconsin, like those elsewhere, face a weighty problem from the large quantities of manure produced by their cows. A 1,400-pound cow produces more than 100 pounds of manure each day, meaning that a 500-cow farm needs to deal with more than 10,000 tons of manure annually. The State of Wisconsin's Focus on Energy Renewable Energy Program promoted and popularized a solution—biogas digester systems—that simultaneously generated renewable energy, improved farm conditions, reduced pollution, and improved the farms' profitability.

Biogas digester systems collect the gases that are produced when bacteria break down organic materials such as manure or food waste. The resulting gas is typically about 60 to 80 percent methane and can be burned to produce heat or generate electricity. Because the methane is captured and systematically combusted to produce electricity rather than released into the atmosphere, significant greenhouse gas emissions are avoided. Processing manure in biogas digesters also eliminates odors and pathogens that could otherwise pollute local air and water supplies. The material that remains after the process is complete can be sold as organic fertilizer, compost, or animal bedding.

Although biogas digesters are a logical solution to the manure problem, Focus on Energy had to overcome many barriers to their adoption by farmers. For one thing, there are large initial costs for the equipment. Focus on Energy therefore provided cash-back incentives. The agency also worked with

members of the Wisconsin agriculture community to secure 32 digester grants from the U.S. Department of Agriculture's Renewable Energy/Energy Efficiency Program.

Economic incentives alone would not have been enough to get farmers to adopt the biogas digestion technology. As Don Wichert, Focus on Energy's program director at the time, recalls, "Unsurprisingly, farmers were hesitant to embrace this unfamiliar technology. After all, their experience and expertise was in farming, not in managing an electricity generating facility. We needed to make them comfortable with the technology and to prove that it really would be an effective solution for them."

Focus on Energy monitored three biogas systems using a scientifically reviewed protocol developed by the U.S. Environmental Protection Agency to provide a standard method of evaluating digester biogas system performance.

Focus on Energy mounted a multi-faceted education and outreach campaign. It co-sponsored an annual conference on biogas digesters for five years and funded a casebook to document farmers' experiences and biogas digester performance data. Wichert notes, "Because we knew that the most credible and convincing advocates for the technology would be farmers' peers, we created many opportunities for farmers to hear from and talk with the early adopters."

Focus on Energy monitored three biogas systems using a scientifically reviewed protocol developed by the U.S. Environmental Protection Agency to provide a standard method of evaluating digester biogas system performance. The agency also worked closely with Wisconsin utilities to make it easier to interconnect biogas systems to the utility grid and to institute higher rates for electricity produced from biogas.

In one resulting project, Crave Brothers Dairy in Waterloo, Wisconsin added a biogas digester system to handle the 26,000 gallons of manure produced daily by its cows. A company specializing in waste management, Clear Horizons, was responsible for installing and managing the system. A couple of years after initial installation, the system was expanded, so that it now has a 633 kilowatt capacity. It produces enough electricity to power the farm, its cheese factory, and 300 area homes.[1]

Charles Crave, one of the four brothers who manages the dairy, notes that: "When you're handling many millions of gallons of manure, any way to handle that risk is helpful. What is in this for us is manure management, odor reduction, and a chance to move the operation forward using modern technology."[2]

Through the efforts of Wisconsin's program, biogas digesters have become a common feature of the agricultural landscape in the state. Moreover, energy agencies and farmers in other states learned from Wisconsin's program and applied the lessons learned.

1 "Sustainable Story: Crave Brothers Dairy Farm Anaerobic Manure Digester," Crave Brothers web page, accessed May 11, 2015, *http://cravecheese.com/dairy-farm.php?Sustainable-Story-3.*

2 Quoted in "Crave Brothers Dairy Farm/Clear Horizons LLC," US EPA's AgStar Program web page, accessed May 11, 2015, *http://epa.gov/agstar/projects/profiles/cravebrothersdairyfarmclearhorizonsl.html.*

CASE STUDY 9

Oregon Expands Opportunities for Small Hydropower

Oregon is well endowed with hydropower resources, which provide about half of the state's electricity. Most of this energy comes from large dams on the Columbia and Willamette rivers. Large-scale hydropower has a long and controversial history in the Pacific Northwest. It provides abundant inexpensive electricity, but major dams have damaged habitat and blocked fish from migrating upstream.

Since 2007, Energy Trust of Oregon has promoted a different kind of hydropower: small, environmentally friendly projects. These projects install generating equipment in places where water is already dammed or diverted, such as agricultural irrigation pipelines. Adding hydropower where water is already in use for another purpose typically does not cause additional environmental impacts. And it provides small-scale local power sources that keep revenues in local communities.

Locations for new, run-of river hydropower projects in Oregon are limited by the state's 1987 *Instream Water Right Act*, which declared that instream uses of water (such as recreation and maintenance of fish habitat) were beneficial uses and allowed natural resource agencies to apply for those rights.[1] The Northwest Power and Conservation Council has identified other locations as Protected Areas off limits to hydro development. The combination of the law and regulation "essentially took

1 "Backgrounder: Instream Water Rights," Oregon Department of Fish and Wildlife, *www.dfw.state.or.us/fish/water/docs/BKGWaterRights.pdf.*

natural streams off the table," says Jed Jorgensen, a renewable energy program manager at Energy Trust of Oregon. "Hydropower work now is mostly limited to existing non-powered dams; streams where there are no fish issues, which is a very small subset; and places where water already is in use for another purpose, such as municipal supply pipes and irrigation canals."

After studying these options, Energy Trust focused on conduit projects, which install generating equipment inside an existing conduit, such as an irrigation ditch or municipal water line. Hydropower projects, even small ones, must go through complex state and federal permitting processes that can be daunting for new developers, so Energy Trust published permitting guides. It also provided technical and financial support to developers for project research and permitting, and published a separate guide to the utility interconnection process.

Hydropower projects, even small ones, must go through complex state and federal permitting processes that can be daunting for new developers, so Energy Trust published permitting guides.

Energy Trust has completed 13 small hydropower projects since 2007, ranging in size from 4 kilowatts to 5 megawatts. These projects are generating approximately 27 million kilowatt-hours of electricity annually. Now the organization is scaling up its work with irrigation districts, the majority of which still move water through leaky open ditches. Irrigation modernization projects replace open canals with pressurized pipe, often saving energy as well as water and allowing for hydropower in many cases. In the arid West where water is very valuable, the water savings from the piping process is an important piece of financing the cost of the pipe. "Irrigation districts have hundreds of miles of canals that move tremendous volumes of water. Piping is very expensive, and most districts don't have the operating budget to go out and buy it all by themselves," says Jorgensen. Energy Trust is developing project assessment tools and hopes to have assessed up to a dozen potential sites by the end of 2016.

Based on its experience, Energy Trust provided comments to the Federal Energy Regulatory Commission on simplifying and streamlining permitting for conduit hydropower projects. Not long after that, the *Hydropower Regulatory Efficiency Act*, enacted by Congress in 2013, simplified the permitting process for conduit hydropower projects.

CASE STUDY 10

New Hampshire Promotes Better Wood Heating

New Hampshire's location in northern New England means that the winters are long and cold. Heating costs are high and can be crushing for many households, especially because many parts of the state do not have access to cheap energy from natural gas. For affordable heating, many residents turn to the same resource that has been keeping homes in the state warm for centuries: wood.

Wood is abundant in New Hampshire, but older wood stoves are frequently highly polluting and inefficient, and require significant fuel storage space. New Hampshire policymakers have therefore taken several steps so that residents can purchase new equipment using improved biomass heating technologies that address these issues.

Helping Residents and Businesses Switch to Wood Pellets

The New Hampshire Public Utilities Commission created a Residential Wood-Pellet Boiler and Furnace Rebate Program. It offers rebates of 30 percent (up to $6,000) for high-efficiency, bulk-fed, wood-pellet central heating boilers and furnaces.[1] The pellets are made from compacted sawdust

1 The average cost for a wood pellet boiler or furnace which provides central heating is approximately $20,000.

and other industrial waste byproducts left over from lumber, manufacturing, construction, and woodworking industries. Since lumber and woodworking companies are abundant in New Hampshire, wood pellets present a plentiful local fuel source. Wood pellet boilers are highly efficient, inexpensive, and compact, making them an excellent modern alternative to wood, propane, or oil. When wood pellet fuel is delivered in bulk, which New Hampshire's program was specifically designed to facilitate, wood pellet boiler systems offer the same convenience as oil heating systems. To date, the residential program has dispersed close to $1.5 million in rebates to almost 300 participants, with an applicant investment of close to $4.2 million.

Wood pellet boilers are highly efficient, inexpensive, and compact, making them an excellent modern alternative to wood, propane, or oil.

The Public Utilities Commission also created a rebate program for commercial applications. The Commercial and Industrial Bulk Fuel-Fed Wood Pellet Central Heating Systems Rebate Program offers a rebate payment of 30 percent of the cost of equipment and installation, to a maximum of $50,000. An additional incentive of up to $5,000 or 30 percent of the system cost is offered if thermal storage is included. To date, a total of $383,000 has been dispersed to 20 non-residential projects,[2] with an additional $.5 million in process or reserved. The average non-residential rebate has been just over $20,000.[3]

RPS Carve-Out

To better promote wide-scale market growth and technological development of biomass thermal technologies, New Hampshire became the first state to add a carve-out for renewable thermal technologies to its Renewable Portfolio Standard. This carve-out requires utilities to produce or otherwise support a minimum amount of renewable thermal energy each year.

"This is an important step forward in efforts to gain equal consideration for thermal energy," said Joseph Seymour, Executive Director of the Biomass Thermal Energy Council, an industry trade association. "With little happening on energy policy in Washington, efforts must focus on state policy to achieve a more fuel and technology neutral incentive structure for renewable energy. New Hampshire has led the way in showing the nation that it is possible to enhance state RPS programs by adding thermal energy."[4]

Impacts beyond New Hampshire

States across the country are looking at New Hampshire as a leader and a model for supporting renewable thermal technologies. For example, other states, such as Maryland, have explored adding renewable thermal requirements to their RPS.

2 Projects include municipal and nonprofit buildings as well as commercial and industrial projects.

3 Correspondence from the New Hampshire Public Utilities Commission, Sustainable Energy Division, May 26, 2015.

4 Quoted in Jennifer Runyon, "New Hampshire Sets Renewable Thermal Energy Carve Out," *Renewable Energy World*, June 26, 2012, *www.renewableenergyworld.com/rea/news/article/2012/06/hew-hampshire-sets-thermal-renewable-energy-carve-out* .

CASE STUDY 11

Maryland Seizes the Opportunity to Develop Offshore Wind

As Maryland's population grows, so do its energy needs. In fact, PJM Interconnection, the regional transmission organization that coordinates the movement of wholesale electricity, has warned that the state could soon face rolling blackouts. To address the need for more electric power generation while safeguarding public health and the environment, the state turned to renewable energy. In 2008, Maryland revised its RPS, raising the state's RPS goal from 7 percent to 22 percent by 2020. An assessment of renewable technologies revealed that the only in-state renewable resource able to meet a significant portion of the RPS goal was offshore wind. A flurry of offshore wind planning activity followed, involving several state agencies, nonprofits, and universities.

In 2009, the state analyzed its offshore wind potential. The Maryland Energy Administration (MEA) recommended that the state allocate resources to help developers overcome high capital costs and that it address its regulatory framework related to offshore wind. MEA collected information from wind developers interested in constructing an offshore wind project off its coast. MEA, the Maryland Department of Natural Resources, and the Nature Conservancy began marine spatial planning, including the creation of support tools to understand the characteristics of Maryland's offshore resources and potential conflicts. In conjunction with these efforts, MEA engaged in broad stakeholder outreach to gain early feedback.

An offshore wind farm in Denmark.

Making the Case for Offshore Wind

As it became apparent that the most scalable renewable resource lay in Maryland's offshore waters, political momentum was needed to support policy development. Armed with data compiled by the U.S. Department of Energy, the University of Maryland, and consultants, MEA worked to gain the Governor's support to further ocean energy planning and analysis. A federal Bureau of Ocean Energy Management task force was formed at the state's request in early 2010; later that year, BOEM and MEA released a request for information for offshore wind development to gauge industry interest in commercial development on the outer continental shelf.

It took three years before an offshore bill passed in the legislature. Governor Martin O'Malley's Administration and MEA worked with legislators to craft the *Maryland Offshore Wind Energy Act of 2013*. The legislation created an offshore wind carve-out in the state's RPS of up to 2.5 percent of total retail electricity sales in the state. The carve-out will create Offshore Wind Renewable Energy Credits (ORECs)—tradable certificates that utilities can use to comply with the legislation. Consumer safeguards in the legislation ensure that the impact on electricity rates will not exceed $1.58 per month for the average residential customer and that the price of ORECs will not exceed $190 per megawatt-hour. The Act has encouraged developers and manufacturers to invest in offshore wind, the supply chain, and associated infrastructure.

A critical voice in moving the offshore wind bill through the legislature was the Business Network for Offshore Wind, a Maryland business coalition that has since been proactive in providing leadership and support for the fledgling offshore wind industry. It works closely with state government to build a local offshore wind supply chain and develop a skilled offshore wind workforce. Last November, with financial support from MEA and others, the Business Network organized a three-day international offshore partnering forum at which European and American businesses, government agencies, technical experts, universities, and advocates gathered to address the needs in local services and products for projects off the coast of Maryland. According to Ross Tyler, MEA's offshore wind advisor, "Maryland has been saying from the start that having a partnership with local stakeholders and transferring technical knowledge from Europe are essential."

Wind in Its Sails

With the passage of the Act, MEA partnered with academic institutions, other government agencies, and the business community to commission environmental and geophysical studies, evaluate local supply chain opportunities, survey Maryland's existing infrastructure, and look at the economic and workforce development opportunities. MEA has led three overseas delegations, the largest of which contained 28 participants, including a consortium of four Maryland companies and several state senators. While overseas the group made presentations to turbine manufacturers and has a formal MOU with the country of Denmark to partner on technology, best practices, and deployment. Ross Tyler notes that the presence of the senators carried substantial weight and signified Maryland's commitment to growing the industry. MEA was the only state presenting at the last European Wind Energy Association's annual offshore wind event in Copenhagen.

Maryland's proactive efforts in building European partnerships, establishing a domestic supply chain, and passing enabling legislation seem to be paying off. With the recent federal sale of a wind lease area to US Wind Inc., to develop a major project in the Wind Energy Area off the Maryland coast, Maryland now has the wind in its sails to develop one of the first U.S. commercial-sized offshore wind projects.

CASE STUDY 12

Midwestern States Track Renewable Power Generation

In the early 2000s, many Midwestern states were considering ways to promote clean energy development, reduce greenhouse gas emissions, and maximize the region's economic opportunities in energy. State officials along with utility executives, environmental advocacy groups, energy project developers, and other stakeholders supported making investments in advanced energy options. Most states in the region adopted mandatory renewable energy portfolio standards or voluntary targets.

To help states verify that utilities were meeting these goals, officials and energy producers widely agreed that the region needed a system to track renewable energy generation. Learning from tracking systems recently established elsewhere in the country, Midwesterners hoped that such a system would also support trading of renewable energy credits (RECs), which would reduce compliance costs for utilities. Thanks to a grant from U.S. DOE, stakeholders worked with the Great Plains Institute of Minnesota, the Izaak Walton League, and the Center for Resource Solutions to draft standards for a web-based regional accounting system for RECs. After circulating an RFP to seek proposals for technology partners, in 2007, the state of Wisconsin contracted with APX, a company that designed systems for managing environmental markets, to design a Midwest Renewable Energy Tracking System (M-RETS). The system launched that year with Wisconsin, Iowa, Minnesota, and North Dakota. It then quickly added the province of Manitoba, as well as Illinois, Indiana, Montana, Ohio, and South Dakota.

Today, generators in states covered by the MISO South regional transmission organization are also able to track projects in M-RETS. In 2014, M-RETS issued 72 million RECs, each representing the environmental attributes of a megawatt-hour of renewable energy generation, and it registered transfers of nearly 30 million RECs. About 70 percent of the total activity overseen by M-RETS is driven by mandatory state RPS requirements, but companies in the region also are engaging in voluntary REC exchanges. For example, some utilities buy RECs in order to offer customers the option of paying slightly higher rates to support renewable energy generation.

Each state in the M-RETS footprint has its own list of fuels that qualify as renewable, ranging from solar and wind to waste heat recovery and various types of biomass. M-RETS does not determine eligibility for individual state programs, but its RECs connote that each megawatt-hour of electricity qualifies as renewable in the state where it was generated. The data and reports in M-RETS are then used by compliance and voluntary program administrators to determine compliance with program parameters. "That builds trust among REC purchasers that someone is verifying the information," says Eric Schroeder, chief administrative officer of the Great Plains Institute and treasurer of M-RETS. "The sole focus is on tracking renewable generation correctly and serving the states."

Representative and Adaptable

The states played crucial roles in getting M-RETS started and remain active in its governance, with Brian Rounds of the South Dakota Public Utilities Commission currently serving as M-RETS' Board President. Nevertheless, unlike other energy tracking systems, M-RETS is an independent nonprofit organization with board members who represent many interests, including utilities, renewable energy marketers, and environmental advocacy groups, as well as state and provincial regulators. "We're the only REC tracking system that is not part of any other organization, which makes us unique from our peers which are housed within state government or an ISO or RTO," says M-RETS executive director Amy Fredregill.[1] "We have very high stakeholder engagement, and when new trends bubble up, we pull lots of organizations together to make sure we're meeting their needs."

One such trend is growing adoption of solar energy nationwide in response to falling costs for solar PV systems. Many of these new systems are residential or small-scale community systems. "M-RETS wasn't originally designed to work with small projects and distributed generators because our roots were in providing compliance services for state RPSs, but as the industry changes, we're finding ways to track those projects and welcome them into our systems," says Fredregill.

A larger prospective issue for the Midwest is the U.S. EPA's Clean Power Plan, which sets state-specific targets for cutting carbon emissions from the electric power sector 30 percent below 2005 levels by 2030. Under the EPA's proposed plan, states can choose their own methods for reaching their assigned goals. Strategies include improving power plant efficiency, using low-emitting sources more frequently, expanding renewable generating capacity, and increasing demand-side energy efficiency.

"Everyone is talking about what to do about the Clean Power Plan," says Fredregill. "We're considering whether M-RETS should track emissions from all types of generation, calculate carbon emissions, or track energy efficiency or other services that states may need to report on carbon reduction. We've created a process along with our consultants to discuss possible changes, and the states and our stakeholders are centrally involved."

1 Independent system operators (ISOs) are organization formed at the direction or recommendation of the Federal Energy Regulatory Commission to coordinate, control, and monitor state or regional electric power systems.

CASE STUDY 13

Texas Expands Wind Energy by Building Transmission First

Texas has over 12,000 megawatts of installed wind energy generating capacity—much more than the next state (California), and nearly one-fifth of total U.S. wind capacity. The state spurred this development by spending $7 billion to build transmission lines connecting remote high-wind resource areas of the state with more heavily populated areas. By doing so, Texas attracted wind developers and made it easier to integrate large quantities of wind energy into the grid.

In 1999, Texas adopted a renewable energy portfolio standard that set a target of 5,000 megawatts of new renewable generation by 2015 and 10,000 megawatts by 2025. To meet these targets, the state had to overcome a classic chicken-and-egg problem. Its best wind resources were in west Texas and the Panhandle, but wind developers were unlikely to build generation in those rural zones, where there was little local energy demand and no transmission system to move electricity to load centers. Transmission companies had no incentive to build power lines to areas where there were no electricity generating facilities.

In 2005, the Texas legislature instructed the state public utility commission to identify Competitive Renewable Energy Zones (CREZs) where wind generation should be built. In 2008, the commission designated five zones and outlined about 2,400 miles of transmission upgrades that would be needed

to deliver electricity from wind projects in those zones to Texas consumers. Texas state law allowed the costs of approved transmission projects to be passed on to all ratepayers across the electricity load. The state started building the transmission links in 2009 and completed them early in 2014.[1]

This state strategy gave developers confidence that they would be able to develop and deliver their power to the market. In 2005, Texas had less than 2,000 megawatts of wind generating capacity; over the next decade it added more than 10,000 megawatts.

David Power, deputy director of Public Citizen of Texas, which lobbied for the creation of the CREZs, applauds the state's actions: "It took forethought. You needed leaders who were willing to think beyond the next election cycle. Wind companies said, 'If you build it, we will come,' and they were required to put up bond money so that they would have some skin in the game."

In 2005, Texas had less than 2,000 megawatts of wind generating capacity; over the next decade it added more than 10,000 megawatts.

Better Transmission Improves Power Markets

The CREZ investments eased congestion in the Texas grid that threatened to stifle the state's growing wind industry. As new wind projects came online in the CREZs, they sometimes produced more power than the existing transmission lines could carry. When that happened, grid managers had to order wind projects to reduce their output. This practice, known as curtailment, was equivalent to throwing away energy. In 2009, the Electric Reliability Council of Texas (ERCOT), which manages the state's grid, curtailed more than 17 percent of potential wind energy production. By 2012, however, new transmission lines reduced curtailment to 3.7 percent.[2]

Curtailments caused another problem for wind generators: negative electricity prices. When wind farms produced substantial quantities of electricity but were unable to send it to high-demand areas, regional prices for electricity in West Texas sometimes would fall below zero. Wind plants still had an incentive to generate power because they received tax credits for producing the electricity, but negative prices were a clear sign that the market was working poorly. In 2011 and 2012, electricity prices in the region repeatedly dropped below zero, sometimes falling as low as minus $50 per megawatt-hour. By mid-2013, transmission expansions virtually eliminated such incidents.[3]

By 2014, Texas had already surpassed its 2025 RPS target for wind generating capacity. At peak output, wind farms can produce enough electricity to meet nearly 29 percent of the state's electricity load. Other regions, including the Midcontinent Independent System Operator and the Southwest Power Pool, are emulating Texas by expanding their transmission systems to accommodate new wind generation.

The CREZs have also benefitted rural parts of Texas by stimulating energy projects and providing the opportunity for farmers to lease their land. "It's probably the largest rural economic development initiative that Texas has ever undertaken," says Power. "Now it's generating about $40 million a year in rural lease payments. Texas is going through a major multi-year drought, so those long-term contracts are valuable income that farmers and ranchers can count on."

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1 For additional information about the CREZ transmission upgrades and their impacts, see Jacquelin Cochran et al., *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience* (Golden: National Renewable Energy Laboratory, April 2012), pp. 110–119, *www.nrel.gov/docs/fy12osti/53732.pdf.*

2 Michael Goggin, "Plummeting Curtailment, More Low-Cost Wind: CREZ Transmission Policy Already Reaping Big Returns," American Wind Energy Association, September 6, 2013, *www.awea.org/Membership/Content.aspx?ItemNumber=5635%20.*

3 "Fewer Wind Curtailments and Negative Power Prices Seen in Texas After Major Grid Expansion," U.S. Energy Information Administration, June 24, 2014, *www.eia.gov/todayinenergy/detail.cfm?id=16831.*

CASE STUDY 14

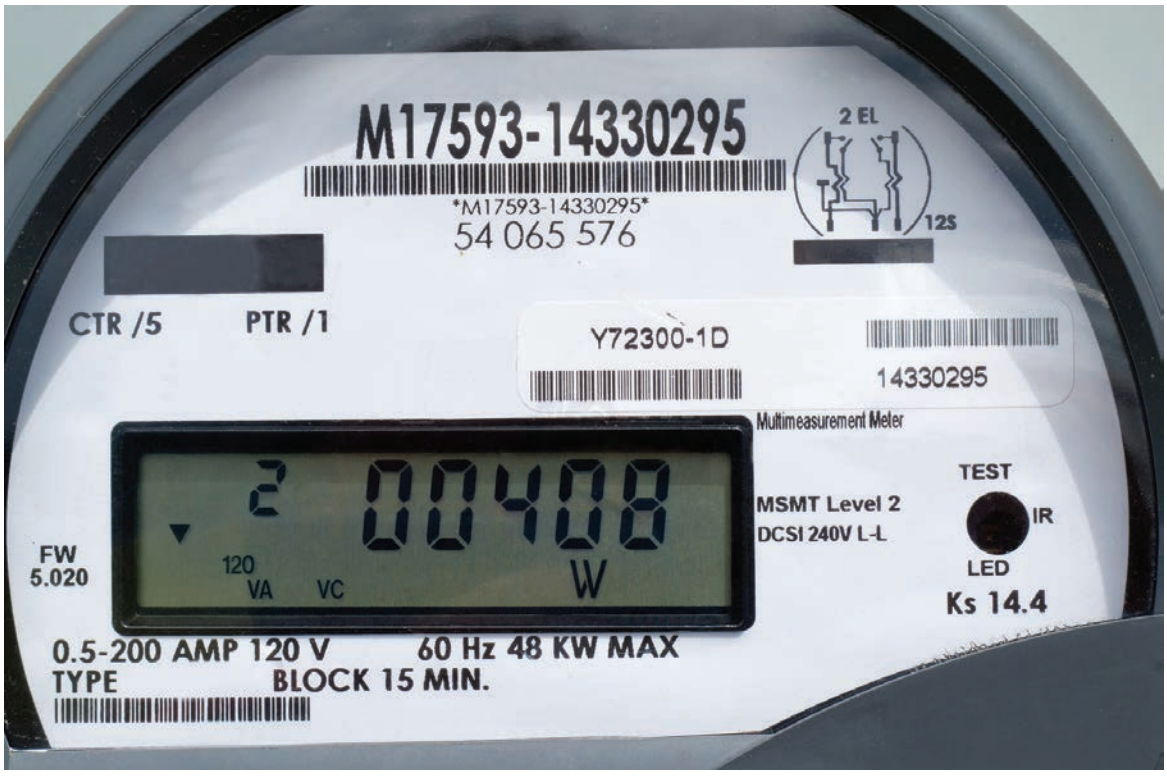
Illinois Implements Ambitious Grid Modernization Policy

When Illinois was faced with a deteriorating energy infrastructure, it went beyond just refurbishing and replacing cables, manholes, and telephone poles. It instead leveraged those improvements by enhancing its infrastructure with digital technology in a very broad-based and significant fashion. The goal was to create a grid that would support technologies such as distributed energy resources and advanced metering.

Recognizing the need for significant investments in the grid, Illinois' *Energy Infrastructure Modernization Act of 2011* introduced regulatory reform measures to benefit utilities that voluntarily undertook prudent, long-term infrastructure investments. The Act addressed regulatory reforms, reliability performance metrics, infrastructure modernization, and smart grid improvements. The utilities eligible to participate are those serving more than one million customers in Illinois.

Increasing Incentives for Grid Upgrades

To incentivize grid modernization efforts, Illinois switched to performance-based ratemaking for utility rates. Prior to this legislation, Illinois used traditional cost-of-service ratemaking to set the rates charged to utility customers. This kind of ratemaking allows utilities to earn a reasonable return on



prudent investments. It's widely thought that this kind of cost-of-service ratemaking doesn't give utilities sufficient incentive to improve and innovate. By contrast, performance-based ratemaking sets rates based on goals the utility is expected to achieve.

Illinois wanted to encourage utilities to upgrade the grid and invest in "smart grid" technology, which the U.S. Department of Energy's Office of Electricity Delivery & Energy Reliability defines as "a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries."[1] The smart grid allows the use of a variety of generation and storage options. Utilities and consumers can use it to optimize electricity usage.

Computer-based remote control and automation systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. The smart grid allows the use of a variety of generation and storage options.

The results of the Act have been impressive. According to the *2014 Grid Modernization Index* produced by the GridWise Alliance, an industry coalition advocating for modernizing the nation's electric system, Illinois moved up seven places since 2013 to place third in a ranking of grid modernization policies and activities.[2]

Dick Munson, director of Midwest Clean Energy at the Environmental Defense Fund, says the Illinois law has been quite successful from an environmental perspective, "It's opened up opportunities to do a variety of clean energy projects." Munson notes that some people have been surprised to see these kinds of activities coming from a state known for relying on coal and nuclear resources.

Under the terms of the Act, Commonwealth Edison, the state's largest electric utility, is expected to spend $2.6 billion over 10 years, half on improving infrastructure and the rest on digitizing the system with new technology. The company has been implementing distribution automation, a smart grid feature referred to as "self-healing," which detects distribution problems and automatically re-routes power. It is also replacing about four million traditional residential and business electric meters with smart meters.

Evaluation, measurement, and verification measures that track the benefits of the grid modernization have been cooperatively developed by ComEd and other stakeholders. Metrics measure the effect of the smart grid improvements on energy savings, demand-side management, and the use of smart energy devices. Utilities can assess how the smart grid is being used and where there are opportunities for improvement. Munson credits metrics as a key component of a regular feedback mechanism that keeps the program on track.

Becky Harrison, CEO of the GridWise Alliance, notes that the success of the type of comprehensive grid modernization policy that Illinois is attempting to implement depends on a state's ability to "connect the dots." This is important for the future of clean energy, because adding an abundance of renewable energy resources to the grid requires an infrastructure capable of managing those resources. Understanding the effects policy will have on the entire system is critical to long-term success.

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1 "Smart Grid," US Department of Energy Office of Electricity Delivery & Energy Reliability, accessed March 27, 2015, *http://energy.gov/oe/services/technology-development/smart-grid*.

2 GridWise Alliance and Smart Grid Policy Center, *2014 Grid Modernization Index (GMI)* (Washington: GridWise Alliance, November 2014), p. 10, *http://www.gridwise.org/uploads/reports/GWA_14_GridModernizationIndex_11_17_14Final.pdf*.

CASE STUDY 15

Alaska Helps Remote Communities Shift to Renewables

Energy is a major concern in rural Alaska. Households in many regions spend over 20 percent of their annual income on heat and electricity. In some communities, more than half of average household income goes toward home heat and electricity. Although many of these homes consume very little electricity, electric rates and fuel costs are high, and the cold climate means that lots of energy is required to heat even energy-efficient homes. Numerous small and remote Alaskan communities run on stand-alone electric grids and rely heavily on diesel fuel generators. Because Alaska does not have a statewide highway system, fuel is barged from Seattle to regional distribution centers, then delivered locally by air or boat. Winter weather can make deliveries impossible, so rural communities have to store 8 to 13 months' worth of fuel onsite in tank farms to avoid fuel shortages.

Alaska is investing in renewable energy projects to provide remote communities with more secure and lower-cost energy. One notable example is the City of Kodiak on the Gulf of Alaska. Before 2008, Kodiak produced about 60 percent of its electricity from hydro and the balance from diesel fuel. Today Kodiak generates more than 99 percent of its power from hydro and wind energy, thanks to grants from the Alaska Renewable Energy Fund.

The Renewable Energy Fund, administered by the Alaska Energy Authority (AEA), was created in 2008. Its goal is to help the state generate 50 percent of its electricity from renewable sources by

Energy storage batteries in Kodiak, Alaska.

2025. The fund awards about $25 million yearly to utilities, independent power producers, local governments and tribal councils. AEA evaluates proposals, then recommends projects to the state legislature for funding. AEA focuses on projects that it judges will deliver significant public benefits and that are located in high-cost areas.[1]

Kodiak's Transition to Renewable Energy

About 14,000 people live on Kodiak Island, which is home to Alaska's biggest fishing port and the largest Coast Guard base in the United States. Kodiak Electric Association (KEA), a local cooperative, operates the island's microgrid. In 2007, KEA's board set a goal of generating 95 percent of its electricity from renewable sources by 2020. By 2014 it had already surpassed that goal, producing more than 99 percent of its power from wind and hydropower supported by a battery energy storage system.

The Renewable Energy Fund awarded a total of $16 million to Kodiak to install six 1.5 megawatt wind turbines; add a third 10-megawatt turbine to its existing hydropower facility; and a three-megawatt battery storage system, which eliminates the need to curtail generation from Kodiak's wind turbines and provides spinning reserve capacity in combination with the island's hydropower facility. In 2014, Kodiak installed the newest phase of its renewable upgrades: two one-megawatt flywheels to power a new electric crane at the busy port of Kodiak, replacing a diesel crane.[2]

"Without the Alaska Energy Authority, we could not have done it nearly this fast," says Darron Scott, president and CEO of the Kodiak Electric Association. "These have been very cost-effective projects for our community, but without the help and support and financing, it would have been too hard on our balance sheet to do all of this so quickly."

Multiple Benefits

Displacing diesel fuel with renewable power has produced multiple benefits for Kodiak. Scott estimates that the island has avoided use of 6.9 million gallons of diesel fuel at roughly $3.50 per gallon since 2009. Kodiak residents paid approximately 2.5 percent less for electricity in January 2015 than they did in January 2001, without any adjustments for inflation. And because the island's diesel generators now are used mainly for backup, residents are insulated for the long term against oil price spikes.

By virtually eliminating diesel generation, KEA has also avoided about 77,000 tons of greenhouse gas emissions, 2.2 million tons of NOx, 86 tons of carbon monoxide, 47 tons of particulate matter and 43 tons of volatile organic compounds.

AEA hopes to replicate Kodiak's success in other remote communities. "It's incredible how much Alaskans have learned since this program started," says Sean Skaling, AEA's program development and project evaluation director. "We've really dialed in on what works and what doesn't, and we're still learning."

In summarizing the achievements of the Kodiak project, Alaska Senator Lisa Murkowski remarks that: "Both the Alaska Energy Authority and the Kodiak Electric Association are putting into practice five principles that I believe are in our national interest. And those are to make energy abundant, affordable, clean, diverse, and secure."[3]

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1 For more information see "Renewable Energy Fund," Alaska Energy Authority web page, accessed May 20, 2015, *www.akenergyauthority.org/Programs/RenewableEnergyFund*.

2 Clean Energy States Alliance, *2014 State Leadership in Clean Energy Awards: Outstanding Programs Found Here*. (Montpelier: Clean Energy States Alliance, November 2014), pp. 3-4, *www.cesa.org/assets/2014-Files/SLICE-2014/CESA-SLICE-2014-Report.pdf*.

3 Lisa Murkowski quoted in Laurie Guavara-Stone, "Second Largest Island in U.S. Goes 100% Renewable," *EcoWatch*, May 20, 2015, *https://ecowatch.com/2015/05/20/kodiak-island-renewable-energy*.

CASE STUDY 16

Rhode Island Makes Solar Work for the Distribution System

How does a utility cope with peak loads that are stressing its distribution system? It constructs a new substation feeder. Or does it?

In 2014, as state legislators were considering a four-fold expansion of the state's distributed generation program, the Rhode Island Office of Energy Resources (OER) and National Grid (the state's major investor-owned utility) were busily investigating how distributed renewable energy could benefit system reliability. They identified the Rhode Island communities of Tiverton and Little Compton as places to test the proposition that distributed, solar PV generation could defer or potentially eliminate grid upgrades and enhance reliability.

A study determined that solar could provide 250 kilowatts of summer peak load needs and potentially contribute to the deferral of $2.9 million in electric distribution upgrades.[1] The next step was for OER and National Grid to take a real-life look at PV deployment and how to maximize its benefits to the grid and to system owners in the two towns.

1 Francis Cummings et al., *Solar PV for Distributed Grid Support: The Rhode Island System Reliability Procurement Solar Distributed Generation Pilot Project* (Boston: Peregrine Energy Group, June 2014), *www.energy.ri.gov/documents/SRP/RI-SRP-PV_Report_Peregrine-team_07-16-2014.pdf.*

The hourly electricity load in Rhode Island's test areas is highest in the late afternoon. Because panels facing southwest and west generate electricity during this time period of peak demand, they offer advantages for the distribution system. Even though the total amount of electricity generated by a typical south-facing array is greater on an annual basis, its solar generation drops off significantly in the late afternoon when the electrical load is high. In recent years, some electricity system analysts have called for using west-facing and southwest-facing solar panels to address this capacity problem.

Rhode Island's nascent but ambitious project of cooperating with utilities to target areas that could benefit from distributed solar generation could easily be replicated in other locations.

Because less electricity is produced, the concept of orienting panels to the west would normally not be an easy sell to potential solar customers who want to maximize the amount of electricity they can produce to reap all of the financial benefits of their system. To address this concern, OER, Commerce Rhode Island, and the nonprofit SmartPower partnered to pilot a Solarize program that offered an extra incentive to homeowners who install westerly-oriented panels in the two test communities. The one-time rebate incentive is designed to offset the lower elecrticity production of the panels.

Data acquisition systems (DAS) are another integral part of this solar program. A DAS collects measurements at both the inverter and the electric service meter. It reports PV production data and tracks in-home energy usage. DAS will allow OER to monitor and ultimately evaluate the actual generation that the solar systems contribute during periods of peak demand.

On the policy side, the 2014 legislation removed a three-percent aggregate statewide limit on net metering which would have impeded the adoption of solar. The bill also addressed an accounting issue that has historically deterred some utilities from more fully embracing renewable energy: Contracts between utilities and solar developers have now been replaced by tariffs, which provide an income stream to developers without creating a balance sheet liability for the utility.

Rhode Island's nascent but ambitious project of cooperating with utilities to target areas that could benefit from distributed solar generation could easily be replicated in other locations. "This pilot will help us better understand the benefits of solar beyond cost-savings to the project owner—including potential system-wide savings for all ratepayers by deferring, or possibly eliminating, the need for investment in costly utility infrastructure to meet growing energy demand," Shauna Beland, chief of program development at OER, commented. "If the pilot bears fruit, it could open the door for grid planners to tap solar as an exciting new tool in the toolbox of solutions to address electric distribution system investment needs."

CASE STUDY 17

California's Energy Storage Mandate Paves the Way for More Renewable Energy

California is aggressively incorporating renewables into its electricity portfolio in order to meet its current RPS goal of deriving 33 percent of its electricity from renewables by 2020. But as California's electricity has become greener, managing larger amounts of electricity from variable renewable energy resources such as solar and wind power has become more challenging.

Although solar panels generate electricity during the day when more power is needed, peak solar generating hours do not match perfectly with utilities' power needs. Additional electricity is often required during times of peak demand in the late afternoon and early evening. At midday, solar systems may generate more electricity than is needed along with the output from baseload power plants, which have to run continuously. This mismatch of electricity supply and demand wastes electricity and causes problems for financially leveraged renewable facilities that depend on a guaranteed market for their power when it is generated.

Energy storage technologies can capture the excess power PV panels produce at certain times and then release it when the power is needed. Batteries, flywheels, molten salt, compressed air, and pumped hydro can all be used to store energy, thereby balancing energy supply with demand while

increasing the use of renewable energy, reducing greenhouse gas emissions, and contributing to grid resiliency and flexibility. Energy storage can also provide ancillary services (e.g., frequency regulation, voltage control), and eliminate the need for upgrades to transmission and distribution capacity. During short power outages, stored energy can provide back-up power.

To speed the commercialization and use of energy storage, California legislators in 2010 passed a law directing the California Public Utilities Commission (CPUC) to open a proceeding to determine appropriate targets, if any, for each load-serving entity to procure viable and cost-effective energy storage systems. Their underlying strategy was to encourage large-scale investment in energy storage to jumpstart the market. In response, the CPUC required three investor-owned utilities (PG&E, SCE, and SDG&E) to procure 1.3 gigawatts of storage capacity by 2020.

Barriers to Investment in Energy Storage

The CPUC found that, in order to set realistic but ambitious energy storage targets, it was necessary to identify and overcome institutional and economic barriers such as inadequate market rules and technology limitations. With inputs from industry and the utilities, the CPUC adopted a framework and plan for developing policies and guidelines for energy storage. It adopted an energy storage "end-use" framework, which identified 20 types of storage that varied in their applications and use in different market segments or grid domains (e.g., customer, transmission/distribution, generation, California Independent System Operator (ISO)). Since this is an evolving area, market rules are in the process of being developed and defined. The CPUC, California Energy Commission, and the California ISO also jointly produced an Energy Storage Roadmap that identified actions needed to help create a sound market for energy storage resources. The roadmap focuses on actions that address three areas: expanding revenue opportunities; reducing costs of integrating and connecting to the grid; and streamlining and defining policies and processes to increase certainty.

In combination with private industry initiatives, California has become a hotbed for energy storage technology, furthering market development while stimulating the economy.

To support the energy storage mandate, California has made a substantial investment in research related to energy storage, primarily through the California Energy Commission. In combination with private industry initiatives, California has become a hotbed for energy storage technology, furthering market development while stimulating the economy.

An example of the transformational role that energy storage can play in power markets is Southern California Edison's use of it to offset the closing of the San Onofre nuclear power plant. The energy storage mandate required the utility to provide 50 megawatts of energy storage, but it instead signed contracts with 11 companies for over 200 megawatts, both in grid-scale and behind-the-meter storage. Energy storage and renewable energy generation were able supply electricity to make up some of the power lost due to the closing of the San Onofre facility.

California's carefully crafted plan is successfully and expeditiously developing the state's energy storage market. The technology improvements developed as a result of the mandate will surely spread to other parts of the entire country, making the use of energy storage more widespread and less expensive.

CASE STUDY 18

Vermont Reduces Costs for Residents to Install Solar

Since the price of PV panels has dropped precipitously in recent years, non-hardware "soft" costs now account for the majority of the total installed price of a residential system. These costs include customer acquisition, financing, and installation expenses. Other contributors to soft costs, particularly for residential systems, are expenses associated with system permitting and interconnection to the power grid. For a typical five-kilowatt residential PV system in the U.S., the cost of permitting, inspection, and interconnection is nearly a thousand dollars.[1]

While many jurisdictions have worked to simplify permitting and interconnection processes, Vermont has taken a particularly streamlined approach to address the issue. The state has instituted a 10-day expedited solar registration process for small PV installations, up to 15 kilowatts. Unlike other states where solar permitting occurs through individual municipal building departments, all net-metered permitting in Vermont is granted by the Vermont Public Service Board, a single centralized entity. Vermont law states that: "With respect to a solar net metering system of 15 kilowatts or less, the

1 A 2013 National Renewable Energy Laboratory study found that on average $0.19 per watt of a residential solar installation is directly associated with permitting, inspection, and interconnection. Barry Friedman et al., *Benchmarking Non-Hardware Balance-of-System (Soft) Costs for U.S. Photovoltaic Systems, Using a Bottom-Up Approach and Installer Survey—Second Edition* (Golden: National Renewable Energy Laboratory, October 2013), p. 11, *http://www.nrel.gov/docs/fy14osti/60412.pdf.*

Board shall provide that the system may be installed ten days after the customer's submission to the Board and the interconnecting electric company of a completed registration form and certification of compliance with the applicable interconnection requirements."[2]

While many jurisdictions have worked to simplify permitting and interconnection processes, Vermont has taken a particularly streamlined approach to address the issue. The state has instituted a 10-day expedited solar registration process for small PV installations.

Registration[3] for any new grid-tied PV system in Vermont is complete when the Public Service Board issues a Certificate of Public Good for its installation. To receive the certificate, an applicant simply submits a registration form and interconnection certification to the Board, the applicant's electric utility company, and the Public Service Department. Unless the utility company raises a concern about the installation within 10 days and provides recommendations for how the applicant can resolve the interconnection issue, a Certificate of Public Good for the installation is automatically "deemed granted" and installation can begin.

Vermont's 10-day registration process for small-scale PV installations meaningfully streamlines permitting and interconnection approval in a least four ways:

1. It uses a one-page, downloadable application form that can be submitted to all three registration entities.
2. No individual or entity other than the applicant's utility company can make objections and the only grounds for objection are interconnection issues.
3. It establishes a presumption in favor of granting interconnection approval and places the burden on the utility to halt system registration.
4. It allows an applicant to self-certify that an installation will comply with interconnection rules.

Andrew Perchlik, director of Vermont's Clean Energy Development Fund, notes, "Vermont's process makes it very easy to obtain permission to install solar PV systems 15 kilowatts or less. It is one of the many ways that the state is sending a message to its citizens that it welcomes solar development." Through net metering, expedited permitting, and a simple interconnection approval process for small-scale PV installations, Vermont is lighting the way on solar.

2 30 V.S.A. § 219a(c)(1).

3 When the bill prescribing Vermont's solar permitting and interconnection process was being molded in 2011, solar proponents argued that permitting and interconnection approval for small solar PV systems should be no more onerous than registering a car. Thus, the bill used the nomenclature "registration" to liken the PV permitting and interconnection approval process to other routine government registration processes like registering an automobile.

CASE STUDY 19

The Connecticut Green Bank's Financial Innovation Makes Building Improvements Possible

One of the biggest barriers preventing building owners from committing to comprehensive energy efficiency upgrades or installing clean energy technologies is the high upfront cost. If businesses and other commercial building owners want to finance these projects, they often have difficulty accessing capital or securing a line of credit. And, even when successful, the interest rates may be too high to make the projects viable. To address these problems, the finance experts at the Connecticut Green Bank, a state-created agency, developed a commercial clean energy finance program that is as effective as it is innovative.

Providing Financing to Drive Clean Energy Investments

The Connecticut Green Bank helps qualifying commercial property owners make clean energy improvements by offering the state's Commercial Property Assessed Clean Energy (C-PACE) program. The program was started in 2013, after legislation was passed enabling its creation and empowering the Green Bank to administer, design, and assist in financing the program. Cities and towns are able to opt in as a C-PACE municipality through an agreement with the Green Bank.

The program allows commercial property owners in participating municipalities to access financing that covers 100 percent of the upfront cost of energy efficiency and clean energy improvements. The

Crest Mechanical in Hartford, CT installed a 55 kW PV system using $145,000 in C-PACE financing; it will reduce its energy costs by $418,000 over the life of the upgrades.

properties must be non-residential, with the exception of multi-family dwellings of five units or more. Energy audits, construction costs, and any required verification costs can be wrapped into the C-PACE financing.

One of the key benefits of this program is that it is mandated to be cash-flow positive for the building owner. The estimated energy savings, which are measured and verified according to technical underwriting standards, must be projected to exceed the repayment charges over the term of the loan. Using the money saved by the energy improvements, the building owners repay the C-PACE financing through a "benefit" assessment on their municipal property tax bill. An accompanying lien, spanning up to two decades, is placed on the property.

C-PACE offers other benefits to building owners: as a benefit assessment repaid through the property tax bill, C-PACE is an operating expense. That means owners can finance improvements without tapping into business capital and lines of credit. With solar energy improvements, the building owner can own a PV system outright and benefit from its full value, including any tax credits and renewable energy credits (RECs).

In addition to solar projects, qualifying C-PACE upgrades include high-efficiency lighting; heating, ventilation, and air conditioning improvements and controls; windows; variable-speed drives on motors, fans, and pumps; high-efficiency boilers, chillers, furnaces, and water heating systems; fuel cells, and energy-management systems.

As Genevieve Sherman, the Green Bank's Acting Director of Commercial and Industrial Programs, proudly observes: "C-PACE is a home run. Building owners pay no money down, realize immediate cash-flow savings, increase asset value, and retain tenants. The ability to spread payments over as many as 20 years allows deeper energy upgrades, involving multiple measures with greater benefits."

The Program's Impressive Results

The C-PACE program has already approved over 90 projects and has leveraged its limited public dollars to attract private investment. More than seven megawatts of clean energy have been or are in the process of being installed, and 110 Connecticut cities and towns have signed up to participate. Over 90 percent of the state's commercial and industrial properties can access C-PACE financing and more than 200 contractors have been trained to provide energy improvements through the program.

The Connecticut Green Bank currently funds the C-PACE program off of its balance sheet, originating projects directly. However, private capital still drives the program: in May 2014, the Green Bank aggregated C-PACE projects from its balance sheet and securitized them into a bond offering. This securitization—the first ever structured for commercial PACE transactions—demonstrated the investment community's confidence in the C-PACE program as a whole, and specifically in the program's underwriting standards as supported by the security of the tax lien on each property. Going forward, private capital will play an even more prominent role in the program, as the Green Bank raises a private capital warehouse to use in originating projects, again with the goal of bundling into a future securitization. This strategy will provide yet more confidence to the market that C-PACE is an attractive, growing asset class, which should result in further reductions in the cost of capital and even better pricing for customers.

Bryan Garcia, president of the Connecticut Green Bank, sums things up: "In just two years, we've seen the securitization of C-PACE transactions and allocated more than $65 million in capital, enabling property owners to make valuable building improvements and control their energy costs. C-PACE is a sustainable model for financing clean energy upgrades in the commercial and industrial sector."

CASE STUDY 20

States Use CESA to Identify and Share Best Practices

In the late-1990s, several Northeast states and California deregulated their electric utility industry. As part of the deregulation process, state legislatures mandated small charges on ratepayers' electric bills to create public benefit funds, which would be used to develop clean energy resources in their states. After the different state funds were created, their directors soon realized that they would benefit from sharing experiences with other states that had similar, newly created clean energy funds and missions. With support from several private foundations, the nonprofit Clean Energy Group worked with these fund directors in 1998 to create an informal consortium to share information and carry out joint research activities.

As Lew Milford, Clean Energy Group's president, recalls, "Everything was new. These public benefit funds, established with the purpose of advancing clean and renewable energy generation, didn't exist before. States had to figure out how to create effective programs to incentivize the deployment of clean energy technologies in their states. They were breaking new ground with every program they created. It made sense for them to share ideas on the best programs to establish and how to implement them."

In October 2002, representatives from 12 states met to formally establish the Clean Energy States Alliance (CESA) as a member-supported organization to be managed by Clean Energy Group. Through CESA, states could combine efforts to create more effective strategies, programs, and finance tools.

More than a decade later, CESA now includes 15 states plus the District of Columbia. Its mission remains the same—to help the states learn from each other and to carry out group projects that advance their mutual interests.

The 2014 winners of the State Leadership in Clean Energy awards.

Former Chair, Peter West of Energy Trust of Oregon, who has been actively involved since the first meeting in 2002, notes, "CESA has long been the place to incubate the "idea"—and then follow those ideas through program design and implementation strategies, with an eye to how the policy and financing experiments at the state and local level can be leveraged regionally and nationally to accelerate the clean energy economy."

CESA's staff provides information on best practices and practical advice to state clean energy agencies, as shown in the 2014 reports, *Planning and Implementing a Solarize Initiative: A Guide for State Program Managers* and the *2014 State Leadership in Clean Energy Awards: Outstanding Programs Found Here.*[1] CESA and its members have advanced multi-state efforts to promote solar, wind, fuel cells, renewable thermal, and other clean technologies.

Much of CESA's value rests with the information exchanges among the members at meetings, through webinars, and more informally. They share lessons learned, new program strategies, and challenges they are facing. This enables the states to more quickly advance clean energy at a lower cost.

But much of the organization's value rests with the information exchanges among the members at meetings, through webinars, and more informally. They share lessons learned, new program strategies, and challenges they are facing. This enables the states to more quickly advance clean energy at a lower cost.

CESA Board President Andrew Brydges of the Connecticut Green Bank notes that: "In this rapidly growing and evolving industry, CESA provides ongoing and valuable opportunities to learn about, collaborate on, and implement strategies that help expand clean energy adoption, while using ratepayer funds efficiently and effectively."

1 Nate Hausman and Nellie Condee, *Planning and Implementing a Solarize Initiative: A Guide for State Program Managers* (Montpelier: Clean Energy States Alliance, September 2014), *www.cesa.org/assets/2014-Files/Solarize/CESA-Solarize-Guide-September-2014-lowres.pdf*; and Clean Energy States Alliance, *2014 State Leadership in Clean Energy Awards: Outstanding Programs Found Here.* (Montpelier: Clean Energy States Alliance, November 2014), *www.cesa.org/assets/2014-Files/SLICE-2014/CESA-SLICE-2014-Report.pdf*

CASE STUDY 21

Northeast States Create Cap-and-Trade Program for Greenhouse Gas Emissions

Northeast states have worked together for several decades to address air quality issues and, more recently, climate change. The Regional Greenhouse Gas Initiative (RGGI), the first mandatory cap-and-trade program regulating greenhouse gases in the United States, is the long-term result of these efforts. RGGI was initiated in 2003 when Republican Governor George Pataki of New York invited his counterparts in 11 states from Maine to Maryland to join in developing a regional cap-and-trade program to reduce carbon dioxide (CO2) emissions from electric power plants. All of the New England states agreed, along with Delaware and New Jersey. State officials sought to show that regulating greenhouse gas emissions would not harm consumers or the economy if a system was designed properly, and to create a model for federal action.

RGGI was designed to stabilize CO_2 emissions starting in 2009 and then to cut total emissions 10 percent by 2019. Like the cap-and-trade system for sulfur dioxide (SO_2) emissions that Congress enacted in amendments to the Clean Air Act in 1992, RGGI set a cap on yearly CO_2 emissions from fossil fuel generation in participating states (initially, 165 million tons). All power producers covered by RGGI were required to possess enough allowances to cover their actual emissions. An allowance is a permission to emit one ton of CO_2. However, instead of giving allowances to regulated entities at the start of the program, most of the RGGI allowances were auctioned off. This approach generated revenues that the RGGI states could use to advance clean energy programs.

When RGGI's analysts set the initial emissions cap in 2005, they projected that emissions would rise between that year and 2009. Instead, emissions fell sharply during that time because of the national economic recession and retirements of old coal-fired plants. This meant that initially, the RGGI cap did not cause any generators to make emission reductions. Nonetheless, the program still had positive impacts, notably:

- The existence of a cap put a price on carbon emissions, which traded for about $2 to $3.50 per ton through 2012 (prices were low because allowances were abundant);
- Through 2014, RGGI emission allowance auctions generated more than $1.8 billion, which the states used mainly to promote energy efficiency and renewable energy; and
- State officials gained experience with emissions trading and carbon markets.[1]

In 2013, the RGGI states overhauled the program to reflect market conditions. Starting in 2014, the regional CO_2 cap was lowered 45 percent, from 165 million tons to 91 million tons, and will decline by 2.5 percent yearly from 2015 to 2020. This shift increased auction prices to approximately $5 per ton, indicating that the new cap would force covered electricity generators to reduce emissions. To contain costs, the program will make extra allowances available if prices reach certain thresholds ($6/ton in 2015, $8/ton in 2016, and $10/ton in 2017, increasing 2.5 percent yearly thereafter.)[2]

Creating a Model

The energy and environmental regulators who developed the RGGI framework, with extensive input from stakeholders, sought to design a program that would create an efficient market for CO_2 emissions and advance the broader goals of slowing climate change and advancing clean energy. Many RGGI features reflected these goals. For example, more than 90 percent of emission allowances were auctioned instead of giving them directly to regulated entities (an approach used in some other cap-and-trade programs). Auctioning most of the RGGI allowances captures the value of those allowances and makes it available to use for public benefits, such as funding energy efficiency upgrades and paying for site reuse studies on communities where coal-fired power plants are shutting down.

The new RGGI limits "lock in the CO_2 pollution reductions achieved to date from power plants across the region, while also providing a path forward for additional emission reductions," said Janet Coit, director of the Rhode Island Department of Environmental Management, when the lower cap was announced. "The program will also continue to encourage job creation by local businesses focusing on energy efficiency, and will continue to help prevent many millions of dollars from being sent out of the region in the form of fuel payments."

RGGI also could offer member states a good structure for reaching state CO_2 reduction targets cost-effectively under the U.S. EPA's Clean Power Program. "Trading programs, like RGGI, can provide a simple, transparent, and verifiable system for compliance that allows states to work within the existing regional nature of the electricity grid," RGGI states asserted when they commented on EPA's proposed rule in late 2014.[3]

1 Jonathan L. Ramseur, "The Regional Greenhouse Gas Initiative: Lessons Learned and Issues for Policy Makers," Congressional Research Service, November 14, 2014, *https://www.fas.org/sgp/crs/misc/R41836.pdf.*

2 "RGGI States Propose Lowering Regional CO2 Emissions Cap 45%, Implementing a More Flexible Cost-Control Mechanism," Regional Greenhouse Gas Initiative, Inc., February 7, 2013, *https://www.rggi.org/docs/PressReleases/PR130207_ModelRule.pdf.*

3 "RGGI States Comments Support EPA Proposed Clean Power Plan," Regional Greenhouse Gas Initiative, Inc., November 7, 2014, *https://www.rggi.org/docs/PressReleases/PR110714_RGGI_Comments_CPP.pdf.*

CASE STUDY 22

Manufacturing a Clean Energy Industry in Nevada

In September 2014, Governor Brian Sandoval signed legislation designed to encourage Tesla Motors to build a massive new battery factory in Nevada.

Despite heavy competition from wealthier neighboring states, Nevada was able to present Tesla with a compelling, and ultimately winning, offer: a $1.2 billion incentive package. Although this represents a large financial commitment on the part of the state, the benefits from the manufacturing facility to the state are expected to be substantial. An independent analysis by the Governor's office estimates that the Tesla deal will generate $100 billion in statewide economic impact over 20 years and create an estimated 20,000 jobs.

"This is some of the most important legislation that's hit the state in perhaps our history," said Sandoval at the legislation signing ceremony. "We have changed the trajectory of this state, perhaps forever."[1]

The legislation supports worker training and education, to ensure that Nevada residents are prepared for the job opportunities. Tesla's agreement with the state requires the company to make two major contributions to education: 1) $1 million to the University of Nevada at Las Vegas for battery-related research, and 2) $37.5 million to improve k-12 education. Tesla must also invest a minimum of $3.5 billion in manufacturing equipment and other property in the state.

The Tesla factory will be huge in size, and the technology that the factory will produce is equally monumental. "It's worth highlighting the sheer scale of the Gigafactory and why we even call it the Gigafactory," Tesla CEO Elon Musk said during the official project announcement in September 2014. "It's not just the biggest lithium-ion factory in the world, but it's bigger than the sum of all lithium-ion factories in the world."[2]

The Gigafactory will allow Tesla to build economies of scale, driving down the costs of

1 "Nevada Governor Signs Tesla Factory Incentives into Law," available at *http://thehill.com/policy/energy-environment/217526-nevada-governor-signs-tesla-factory-incentives-into-law* (September 2014).

2 Construction is Ramping Up at Tesla's Nevada Gigafactory Site," available at *http://www.rgj.com/story/money/business/2014/11/15/union-questions-tesla-gigfactory-contracting-construction-schedule/19111337* (November 2014).

their products through large-scale manufacturing. The Gigafactory will also add diversity to the battery plant's product mix: Tesla, best known for its electric cars, will also be producing batteries for residential and commercial energy applications. The Tesla Gigafactory is expected to further reduce system costs, likely leading to increasing demand for the product over the coming years.

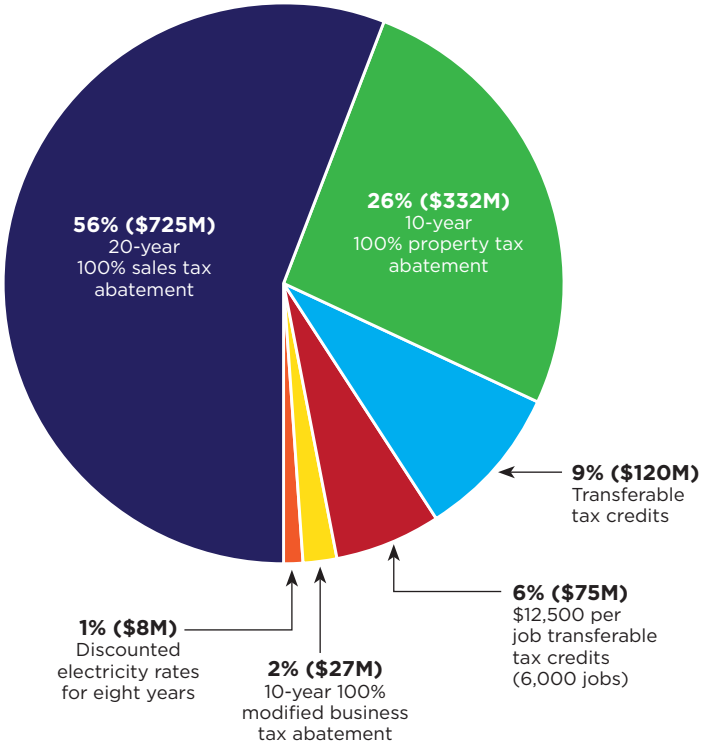
Stationary battery technologies are poised to be a game-changer in the clean energy market, with the potential to greatly disrupt traditional fossil-fuel power sources and significantly strengthen solar markets. PV combined with battery storage systems, such as Tesla's newly announced Powerwall Home Battery, can provide a continuous, uninterrupted power supply—even during extended power outages. Solar+storage systems give homeowners the flexibility to own and operate their own personal power plant, enabling greater independence from the main electric grid, in addition to increased reliability.

Tesla's deal with the state is contingent on performance. A quarterly job audit will be performed, and if at least half of the workers are not from Nevada, as agreed upon, all of the subsidies are off the table and benefits received must be repaid with interest.

"What this can do for the region.... It will allow every underemployed person to reach full employment," said Governor Sandoval's economic development director Steve Hill. "It will lift up everyone in the region. Property values will go up. The prosperity of the region will be materially changed."[3]

FIGURE 5

Breaking Down the $1.2 Billion[6]



The region is primed for growth. With sunshine and skiing both in ample supply, the region has great appeal. Excitement about the company is driving up interest in science and engineering among Nevada students, and is attracting interest from other companies who want to come to the area.

"I am grateful that Elon Musk and Tesla saw the promise in Nevada. These 21st century pioneers, fueled with innovation and desire, are emboldened by the promise of Nevada to change the world. Nevada is ready to lead," stated Governor Brian Sandoval.[4]

"We're going to build this awesome factory that's truly going to be a wonder to behold," Musk said. "It's going to take battery manufacturing to a whole new level. I don't think there's anyone in Nevada who will regret this incentive package. It's going to pay for itself by an order of magnitude or more."[5]

3 Ibid.

4 "Nevada Selected as Official Site for Tesla Battery Gigafactory," available at *http://www.teslamotors.com/blog/nevada-selected-official-site-tesla-battery-gigafactory* (September 2014).

5 "2014: Tesla to Build Giant 'Gigafactory' Near Reno," available at *http://www.mercurynews.com/business/ci_26470220/reno-tesla-motors-nevada-gigafactory-battery* (September 2014).

6 "Inside Nevada's $1.25 Billion Tesla Tax Deal," available at *http://www.rgj.com/story/news/2014/09/04/nevada-strikes-billion-tax-break-deal-tesla/15096777* (September 2014).

CASE STUDY 23

Alaska Captures Clean Energy in Rivers

River hydrokinetic energy has great potential, but it is still very much in the developmental stage. Alaska is taking steps that will speed the commercialization of the technology in that state and nationwide.

The term "hydrokinetic energy" refers to the production of electricity from water in motion—river flows, tidal currents, and ocean waves. An immersed turbine or similar device converts the energy of the moving water into electricity. The hydrokinetic energy resource is free as well as usually dependable and predictable. In addition, the process emits no greenhouse gases.

The Alaska Center for Energy and Power (ACEP) at the University of Alaska has become a key location for research and industry support for hydrokinetic energy. The Alaska Energy Authority works with ACEP to focus on various technologies that can lower the cost of energy while developing economic opportunities. ACEP Director Gwen Holdmann appreciates the benefits of partnering with the state: "A long history of collaboration has helped us maintain a diversified funding base, ensuring the program's sustainability."

Researchers from the Alaska Hydrokinetic Research Center and Oceana testing in-river devices.

Alaska has approximately 40 percent of all the river energy in the United States, so ACEP created the Alaska Hydrokinetic Energy Research Center and is paying considerable attention to hydrokinetics. Research is underway at the research center's test site on the Tanana River to determine whether river hydrokinetics is an economically feasible and environmentally sustainable energy source. Some of the hurdles are engineering issues, such as coping with debris both on and under the river surface and mitigating equipment damage from sediment and ice. Other challenges are environmental—notably, evaluating the impacts on river hydrology and plant and animal species.

The Tanana site offers important time-saving and cost-saving advantages, because all the necessary permits required for river testing are already in place. The companies do not need to go through the cumbersome process of acquiring permits before they can begin testing.

Researchers and company representatives from across the U.S. regularly visit the Tanana site, bringing new technology application ideas and hardware to test. The site offers important time-saving and cost-saving advantages, because all the necessary permits required for river testing are already in place. The companies do not need to go through the cumbersome process of acquiring permits before they can begin testing. And all the monitoring equipment is in place so that companies can easily "plug and play." Moreover, as Research Professor Jeremy Kasper notes, if "technology works well in the Tanana, it will most likely succeed in other areas around the state. Most rivers in the lower 48 will likely be easier to work in since water levels tend to fluctuate less on dammed rivers."

Holdmann thinks of ACEP as "an honest broker of information; someone to work on the issues industry might not even be thinking of today. We are working on figuring out how to make hydrokinetics work in real-world applications, and we would be very happy to be a resource to other states as they consider hydrokinetic energy."

CASE STUDY 24

NYSERDA Incubators Hatch Promising Clean Energy Technologies

The New York State Energy Research and Development Authority's (NYSERDA) mission is to "advance innovative energy solutions." NYSERDA's Clean Energy Business Incubator Program fits that mission well by helping start-up firms speed up their growth and secure funding.

NYSERDA has established six "incubators" across New York State. Five of them are affiliated with a university that provides a variety of resources, including technical expertise and mentoring in all aspects of running a business. NYSERDA's business-like approach requires incubators to meet pre-defined milestones. Start-ups receive funding based on a "pay for performance" standard with the goal of creating meaningful economic growth. Occupancy in the incubator is limited to three years. Prospective recipients must demonstrate that their clean energy concepts are sound and likely to be successful.

NYSERDA Program Manager Jeff Peterson observes that the path to commercialization for clean energy has potential pitfalls and requires readiness from both a technological and a business

standpoint. The incubator program has evolved as NYSERDA has sought, as Peterson says, "to support the business, not just the product development."

Accordingly, the incubator concept does more than just address the technical aspect of a nascent clean technology company. The program also offers assistance in manufacturing, marketing, financing, and networking, but it doesn't work in isolation in helping to grow the number of successful clean energy start-up companies in the state. Distinct from the incubators, NYSERDA has established Proof-of-Concept Centers for connecting inventors and scientists to entrepreneurs and investors. An entrepreneur-in-residence program places experienced managers on temporary assignments in early-state companies that could benefit from executive-level assistance.

The incubator concept does more than just address the technical aspect of a nascent clean technology company. The program also offers assistance in manufacturing, marketing, financing, and networking.

Bill Jones, director of the Venture Creations incubator at the Rochester Institute of Technology, credits NYSERDA funding for enabling incubator clients to focus on developing their clean energy products and technologies rather than on fundraising. After completing their R&D and pilot project stages, incubator-bred businesses can more easily achieve commercialization. Jones notes proudly that Venture Creations is "graduating really good clean energy companies."

One of those companies, ClearCove Systems, has developed an innovative wastewater treatment system process that uses less energy and yields a sludge byproduct with a high energy content. Company President Gary Miller describes his company's mission enthusiastically: "It's not wastewater; it's energy. When we talk about ourselves as a company we are a renewable energy company. We harvest the highest value fuel for energy creation that you can in wastewater."[1]

NYSERDA grants enabled ClearCove to demonstrate its technology. Bridging the gap from prototypes to commercial-scale installations is often a deal breaker for clean energy companies. After seeing the results of a demonstration project at the Ithaca Area Wastewater Treatment Facility, Chief Operator Daniel Ramer was sold: "I think I'm one of the people ready to become a guinea pig."[2]

NYSERDA's Clean Energy Business Incubator Program is proving the value of its business development strategy as early-stage companies compete to enter New York's incubators. Informed selection of incubator sites and rigorous standards for incubator participants are advancing clean energy technologies that have potential to be deployed well beyond the state's borders.

1 Gary Miller quoted in Kerry Feltner, "Firm Eyes Shift in Wastewater Industry," *Rochester Business Journal,* January 9, 2015, p. 1, *http://clearcovesystems.com/wp-content/uploads/2015/01/RBJ-010915.pdf.*

2 Daniel Ramer quoted in Ibid, p. 2.

CASE STUDY 25

Massachusetts Builds a Clean Energy Cluster

It is not surprising that Massachusetts has a large collection of clean energy companies. After all, the state is home to major research universities with focuses on energy, it has an active venture capital community, and many early cutting-edge energy technologies were developed in the state. At of 2014, the clean energy industry, broadly defined, had over 88,000 employees working in nearly 6,000 companies.[1]

Along with Massachusetts' universities and venture capital infrastructure, a main reason for the emergence of such a large clean energy industry cluster is the active role of state government, especially the Massachusetts Clean Energy Center (MassCEC). That agency has pursued a broad-ranging, multi-faceted, integrated approach to building the industry.

1 BW Research Partnership, *2014 Massachusetts Clean Energy Industry Report* (Boston: Massachusetts Clean Energy Center, 2014), p. 1, http://images.masscec.com/reports/Web%20Optimized%202014%20Report%20Final.pdf

To help start-ups get off the ground, MassCEC has helped entrepreneurs, researchers, and investors to forge connections. It has provided funding and leadership for an annual week of events that includes sessions on industry trends, information about financing for companies, and opportunities for early-stage companies to pitch their business plans to potential investors.

The AmplifyMass program offers matching funding to companies and research teams that receive awards from ARPA-E (the Advanced Research Projects Agency—Energy), which is the part of the U.S. Department of Energy charged with supporting early-stage energy technology innovations with breakthrough potential. Without support from MassCEC, many ARPA-E awardees would have difficulty raising the necessary matching funding.

Each year, MassCEC publishes a clean energy industry report that counts the number of companies; classifies them by type and technology; and points out trends.

Through the InnovateMass program, early-stage companies can compete for awards of up to $150,000 to bring innovative technologies closer to commercialization. MassCEC has also provided support to business incubators.

One of MassCEC's most creative and impactful programs is the Massachusetts Clean Energy Internship program. Since 2011, it has placed 1,194 paid interns in 262 companies. This strategy not only strengthens the workforce by providing young people with useful skills and work experience, but it helps the clean energy businesses in the state find qualified employees. Because MassCEC pays some or all of the interns' salary, small companies are able to get work assistance they would otherwise not be able to afford. More than 50 interns have gained permanent positions at their host com-panies, while many more are now working elsewhere in the Massachusetts clean energy industry.[2]

The business community recognizes the importance of MassCEC's many programs in growing the clean energy industry. Peter Rothstein, president of the region's most influential industry trade group, the New England Clean Energy Council, notes that, "MassCEC programs have supported this growth with initiatives focused on R&D and startups, as well as creative and effective programs that have accelerated demand and market growth, all contributing to Massachusetts' leadership in energy efficiency, solar, and innovation."

Each year, MassCEC publishes a clean energy industry report that counts the number of companies and jobs; classifies them by type and technology; and points out trends. Not only does this analysis enable MassCEC to see if it is making progress, but it provides the business community and investors with valuable information about the shape and size of the clean energy industry cluster. In the most recent report, MassCEC was pleased to point out that the state's businesses expected to exceed 100,000 workers in 2015.[3]

2 Clean Energy States Alliance, *State Leadership in Clean Energy Awards: Outstanding Programs Found Here* (Montpelier: Clean Energy States Alliance, November 2014), pp. 11-12, *www.cesa.org/assets/2014-Files/SLICE-2014/CESA-SLICE-2014-Report.pdf.*

3 BW Research, *2014 Industry Report*, p. 1.

CASE STUDY 26

California's Solar Equipment List Saves Time and Money

California's commitment to solar energy development has created a large market for solar energy technologies of all sizes. In Senate Bill 1 (SB 1), enacted in 2006, the state legislature directed the California Energy Commission to establish criteria for which PV equipment would be eligible for rebates under the state's solar electric incentive programs, along with conditions for those incentives and rating standards for solar incentive programs. Today the commission's list (*http://www.gosolarcalifornia.ca.gov/equipment/index.php*) includes information on thousands of models of PV modules, inverters, and other solar equipment, far more than other databases. The National Renewable Energy Laboratory (NREL) calls it "the most robust source of [performance and safety] information for PV equipment in the United States," and "the *de facto* national eligible equipment list."[1]

Ensuring High Quality and Performance

SB 1 provided California state energy agencies with $3.3 billion over 10 years to support 3,000 megawatts of solar projects. To support this goal, the bill laid out specific expectations that projects had to meet in order to qualify for ratepayer-funded incentives, including the following:

1 NREL, "Transitioning the California Energy Commission Eligible Equipment List to a National Platform," October 2013, p. 4.

- High-quality solar energy systems with maximum performance to promote the highest energy production per ratepayer dollar
- Optimal system performance during periods of peak demand.

In December 2007, the California Energy Commission established eligibility criteria, conditions for incentives, and ratings standards. All major components of solar energy systems (PV modules, inverters, and meters) had to be chosen from eligible equipment lists. To have their equipment included on the lists, manufacturers had to provide certification from a nationally recognized testing laboratory that the components met safety standards in the National Electrical Code. They also had to have the components tested once by an accredited test laboratory to verify performance in the field. The Energy Commission verified information provided by manufacturers.

In 2007, the California Energy Commission established eligibility criteria, conditions for incentives, and ratings standards. All major components of solar energy systems (PV modules, inverters, and meters) had to be chosen from eligible equipment lists.

Less than a decade later, numerous organizations are using the California list for diverse purposes. Fifteen states in addition to California that have solar PV incentive programs refer to the approved equipment list to calculate upfront incentives, project future costs for performance-based incentives, and/or determine whether the PV equipment is eligible for tax credits. Together with California, these states represent 70 percent of the U.S. solar market.[2]

Other stakeholders that use the list include utilities, building designers and engineers, and project developers. Two federally funded solar PV performance models—NREL's System Advisor Model (SAM) and Clean Power Research's PowerClerk software—estimate the expected performance of specific PV systems in designated locations based on underlying data from the California list. These tools are used by software developers, utilities, and energy agencies nationwide. The California Energy Commission provides the data free of charge.

2 Ibid., p. 4. NREL reports that the following states refer to the California list: Colorado, Connecticut, Georgia, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Mexico, New York, Oregon, Pennsylvania, Texas, Utah, and Wisconsin. Vermont also uses this list.

CASE STUDY 27

State Advisory Council Increases Confidence in Small Wind Turbines

The year 2011 was a bad one for manufacturers of small wind turbines. Incidents across the United States raised questions about the quality of these systems. For example, at one site in New Jersey, a 10-kilowatt Xzeres turbine caught fire both at the nacelle at the top of the turbine and at the control unit located in the residence's garage. At another site, three turbine blades separated from the rotor of an Enertech turbine. In California, the DyoCore company was accused of overrating the performance of its turbines to qualify for a heftier California Clean Energy Commission subsidy. Events like this generated bad publicity that undercut consumer confidence and led some states to suspend their incentive programs for small wind turbines.

Regardless of whether these incidents were a result of a manufacturing flaw or an installation error, the damage was done—the technology was seen as unreliable and consumer confidence was shaken. Further investigations by some of the states indicated that many installed turbines were not performing up to manufacturers' claims. Corrective action was clearly needed to preserve a future market for disbursed, small-scale wind turbines.

States Pool Resources to Develop Best Practices and an Equipment List

States and utilities that offered incentive programs to support small, distributed wind decided to pool their resources to address the turbine performance and reliability issues. The group, which initially consisted of California, New York, Oregon, and Wisconsin, concluded that maintaining individual lists of turbines that qualified for financial incentives was neither cost-effective nor an efficient way to foster a market for reliable turbines. Moreover, these independent state-approved turbine lists were not based on third party information about the performance and reliability of various turbines.

The states therefore decided to form the Interstate Turbine Advisory Council (ITAC), which would be managed by the Clean Energy States Alliance. ITAC members established eligibility criteria for distributed wind turbines and set conditions that manufacturers had to meet to qualify for incentives. The goal was to create a set of requirements to ensure that consumers, utilities, and taxpayer-funded incentive programs support safe and reliable wind turbines. At the same time, an existing effort by the American Wind Energy Association (AWEA) to certify small wind turbines, the AWEA 9.1 standard, was gaining momentum and third-party testing was becoming more widespread.

ITAC created a set of eligibility requirements for distributed wind turbines. For small turbines with a rotor swept area of less than 200 square meters, ITAC accepts the AWEA small wind turbine standard and required third party-verified performance ratings and acoustic information. For medium-size wind turbines, which were not covered by the AWEA standard, ITAC's eligibility requirements include performance tests, operational history milestones, or design evaluation. These review criteria for medium-size turbines were developed with the help of the Distributed Wind Energy Association and are serving as an interim standard until an international standard is developed and formally adopted.

Energy Trust of Oregon, one of the founding members of ITAC, initially had limited experience with varied turbines and manufacturers because Oregon had a relatively modest market for small wind turbines. Chris Dearth, program director at Energy Trust, calls collaboration with colleagues across the country through ITAC invaluable. He says, "It has been extremely helpful to not only share information, but to also benefit from the market power provided by a multi-state collaboration to leverage improved industry performance."

The ITAC Unified List currently features nine small wind turbines and four medium wind turbines. Nine incentive programs across the United States support and use the Unified List.[1]

The ITAC listing criteria evaluate manufacturer business practices and consider, among other things, the strength and length of the turbine warranty, the manufacturer's customer service record, and requirements for installer training. These additional review criteria add value to the ITAC list beyond certification, because even a certified turbine will not necessarily perform well if it is installed at a poor site or if the manufacturer fails to honor its warranty or provide maintenance services. ITAC collects consumer testimonials and shares turbine information from across the nation. Some state programs collect performance data from installations that they have supported; some make site visits before and after installations; and some maintain lists of qualified turbine installers. Together, the ITAC eligibility requirements and the additional ITAC-member installation information help create an equipment standards list that safeguard consumers as well as ratepayer and taxpayer funds.

1 Current ITAC participating organizations are the Energy Trust of Oregon, Maryland Energy Commission, Massachusetts Clean Energy Center, Minnesota Department of Commerce, New Jersey Clean Energy Program, NV Energy, NYSERDA, PG&E, and Vermont Clean Energy Development Fund.

CASE STUDY 28

NYSERDA Supports CHP Buyers and Streamlines the Market

For more than a decade the New York State Energy Research and Development Authority (NYSERDA) has promoted combined heat and power (CHP), also known as cogeneration, as an efficient and reliable energy technology. CHP systems produce electricity from an engine or generator and capture heat generated during this process for separate uses, such as space heating. By recycling the leftover heat, they can produce energy more efficiently than if the electricity and heat were produced separately. Modern CHP systems typically use natural gas, so they have low emissions. Many kinds of facilities use CHP systems, including hospitals, apartment buildings, and large commercial office buildings.

NYSERDA's interest in CHP emerged in part from a desire to make the state's electric grid more reliable. Events such as a region-wide outage across the Northeast in 2003 and local blackouts during Hurricane Sandy in 2012 have painfully highlighted the need for secure power sources. Because CHP units generate electricity on-site, they can keep at least part of a facility operating during power outages.

From 2000 through 2012, NYSERDA funded several dozen CHP demonstration projects to test different sizes and types of systems. The agency found that, while many types were available, choosing the right components and sizing the system correctly for a specific building was a complex process. Buyers typically had to hire consulting engineers to guide their decisions, and systems had to be extensively adapted on site. The process was time-consuming, and poor decisions could result in buying mismatched equipment.

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To reduce these hurdles, NYSERDA launched a CHP Acceleration Program in 2012. The agency developed a catalog of modular, pre-packaged CHP systems, all of which it vetted for quality, reliability, and durability.[1] "We wanted cookie-cutter replication of well-proven designs that many customers could follow," says Dana Levy, NYSERDA's program manager for technical development and onsite power applications. Every item had to be capable of operating independently during grid power outages, come with a five-year service plan, and have a bumper-to-bumper warranty.

Initially the catalog included 36 systems from eight vendors; later it was expanded to 141 systems from 13 vendors. The systems ranged in size from 50 kilowatts to 1.3 megawatts—typical sizes for small to medium-sized buildings.

For each system in the catalog, NYSERDA specified the rebate that it would offer to purchasers (typically about 40 percent of the project cost). Customers who chose these systems and whose projects fit within standardized sizing guidelines for common building types received streamlined reviews from NYSERDA. The agency held trade shows where potential customers could meet vendors and compare CHP systems. It also required vendors to take full responsibility for ensuring that systems were installed correctly and performed properly. This approach made vendors key members of design teams early in the process, reducing the chance of buyers choosing components that were incompatible or poorly designed for the space where they would be installed.

In the first 18 months of the CHP Acceleration program, NYSERDA received 29 project applications—a much higher participation rate than its previous demonstration programs. The agency expects its $60 million program budget to leverage $90 million in private investments and reduce New York's peak electric load by 37.5 megawatts. The program has also streamlined the market for CHP systems by reducing the time required to choose and install them. NYSERDA's endorsement makes customers more confident in these systems and gives approved vendors a marketing edge.

"We have transformed the way that deals are occurring in the marketplace," says Levy. "Healthy comparison shopping is happening, and we're seeing long-term partnerships, as opposed to a focus just on making sales."

NYSERDA officials would like to see other states adopt its catalog and expand it into a national list of approved CHP equipment. The agency is already consulting with several other states that are interested in building on New York's success.

1 For more information and the current version of the CHP catalog, see *www.nyserda.ny.gov/PON2568*.

CASE STUDY 29

Washington, DC Bridges the Solar Gap

The District of Columbia has enjoyed 15 years of strong economic growth. But prosperity is spread unevenly across the nation's capital. Calling Washington "an increasingly two-class town," the *New York Times Magazine* reported in 2013 that about one-third of the city's households earned less than $60,000 a year, while nearly half made more than $100,000 a year.[1] At the same time, high housing and energy costs make Washington, DC one of the nation's most expensive places to live.[2]

The District has adopted a strong green agenda, including a renewable portfolio standard with an overall goal of 20 percent renewable electricity and a 2.5 percent carve-out for solar power by 2023. The city is densely developed, so distributed solar will be an important component of this target. But when the District of Columbia Sustainable Energy Utility (DCSEU)—an entity created by D.C. Council legislation in 2008 to promote energy efficiency, clean energy, and economic development through financial incentives, technical assistance, and information-sharing—surveyed existing solar

1 Annie Lowrey, "Washington's Economic Boom, Financed by You," *New York Times Magazine,* January 10, 2013, *www.nytimes.com/2013/01/13/magazine/washingtons-economic-boom-financed-by-you.html*.

2 Dana Hedgpeth, "It's More Expensive to Live in D.C. than New York, Study Says," *Washington Post*, October 13, 2014, *www.washingtonpost.com/blogs/local/wp/2014/10/13/its-more-expensive-to-live-in-d-c-than-new-york-study-says*.

installations in the city, it found that almost no residents in low-income wards had access to solar power. Because these households spent nearly twice as large a fraction of their total incomes on energy than the national average, solar power could save them significant amounts of money.[3]

Small-Scale Solar

In 2012, the DCSEU launched a Small-Scale Solar Initiative with a goal of installing solar photovoltaic arrays on 20 homes belonging to low-income owners in Wards 7 and 8, where fewer than one dozen homes had solar power. The DCSEU identified qualified participants and educated them about solar power, working with community leaders and nonprofits. The systems were installed at no cost to homeowners. Financing came through a combination of federal investment tax credits, renewable energy credits (owned by contractors who installed the systems), and additional funding provided by DCSEU.[4] More than 80 systems were installed in 2012.

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Once the program gained residents' confidence, demand increased. To date the DCSEU has installed solar PV systems on more than 100 homes in Wards 5, 7 and 8. The systems provide residents with zero-cost electricity and save each household about $500 yearly.[5] The DCSEU also is working with the National Housing Trust to install solar PV and hot water systems on a number of multifamily affordable buildings in the District, with plans to add solar to more than 20 buildings in the next several years.[6]

Expanding Opportunity

In early 2015, the DCSEU and the District Department of the Environment (DDOE), which administers the DCSEU's contract, launched a new program called Solar Advantage Plus. It offers rebates to income-qualified residents to install PV systems in single-family homes. Modeled on the DCSEU's 2012 efforts as well as California's Single-Family Solar Affordable Homes (SASH) program, Solar Advantage provides rebates of $2.50 per watt AC with a maximum of $10,000 per system and is designed to cover the full cost of installation. Systems must be installed and operational by September 30, 2015.

Now DDOE and other agencies are developing plans to coordinate a number of programs targeted toward low-income households, including support for solarization, to meet multiple policy goals. "We want to expand solar as broadly as possible to reap all of the benefits," says DDOE policy analyst Emil King. Washington, DC mayor Muriel Bowser, elected in November 2014, has proposed a series of initiatives aimed at creating "Pathways to the Middle Class," and DDOE views solar power as one way to advance that agenda by reducing the amount of money that residents spend on energy. "The focus will be on meeting the needs of households that have low incomes and high energy burdens," King says.

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3 George L. Nichols and Stanley L. Greschner, "Successful Solar Incentive Programs Grow Solar Penetration Within Low-Income Communities #203," February 2013, p. 6, *http://communitypowernetwork.com/node/9486*.

4 Ibid., pp. 7–8.

5 "Here Comes the Sun," DC Sustainable Energy Utility, accessed May 26, 2015, *https://www.dcseu.com/for-my-home/success-stories/success-story-list/here-comes-the-sun*.

6 "Setting a New Standard for Multifamily Solar Energy," DC Sustainable Energy Utility, accessed May 26, 2015, *https://www.dcseu.com/for-my-business/success-stories/success-story-list/setting-a-new-standard-for-multifamily-solar-energy*.

CASE STUDY 30

Hawaii Uses Clean Energy Finance Innovations to Meet Customer Needs

Along with its fabled beaches, the Hawaiian Islands are graced with many renewable energy resources. It is sunny all year long, onshore breezes are nearly continuous, and the volcanic islands also have good geothermal resources. Yet the state's electric system remains almost 90 percent reliant on imported fossil fuels. Because of its energy dependence and its remote location, Hawaii has the highest electricity rates in the nation.

To tackle this problem, Hawaii crafted a unique new clean energy finance initiative, the Green Energy Market Securitization (GEMS) program. GEMS aims to provide an expanded range of Hawaiian consumers with access to lower-cost clean energy. For the first time, it links a sophisticated utility bond structure with utility-facilitated "on-bill" financing.

Initially, the program is supporting distributed PV installations and associated grid-interconnect and/or storage systems for several classes of underserved Hawaiian Electric customers. While the distributed PV market has exploded across Hawaii in the last several years, it has mainly reached homeowners with strong credit scores and successful commercial organizations. The GEMS program has found an innovative way to serve nonprofits, renters, and homeowners who can't afford the significant upfront costs of typical PV financing programs.

A Unique Bond Structure

GEMS can serve these classes of customers because of its unique structure. It was launched with funding from $150 million of state-issued "rate-reduction" bonds, which securitize inflows generated by a fee charged to utility consumers over time. The bonds were developed to allow for an extended recovery period for long-lived assets at an AAA bond credit rating (higher than the state's regular bond credit rating).

Hawaiian Electric customers served by the GEMS program will receive loans to purchase new distributed PV systems and repay the loans through a monthly charge on their electric utility bills. This form of payment is highly secure, since customers risk losing their electricity service if they fail to pay their bills. Default rates are typically less than 0.1 percent, compared to a typical default rate of 4-5 percent on loans paid off in installments.

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Homeowners' monthly repayments are based on the size of the systems they install. The systems are designed to optimize the likelihood that they will produce monthly energy savings larger than the owners' monthly repayment charges.

In addition to loan repayments from PV system purchasers, all Hawaiian Electric customers pay a small fee on their electric bill to support the GEMS program. The fee has been initially set at just $1.29/month for residential consumers. It is adjusted semi-annually, based on overall program performance and realized financing costs.

The bonds were issued in late-2014 and provided the GEMS program with a very attractively priced source of capital, with an interest rate averaging just 2.99 percent. The newly created Hawaii Green Infrastructure Authority will administer the funds. The Authority has contracted with Pacific Rim Bank, which is now handling outreach about the program to PV installers and developers statewide.

GEMS Will Soon Add a Community Solar Program

The initial GEMS program to support distributed solar installations for not-for-profit organizations was launched in March 2015. A new program, based on the community solar model of aggregated-distributed PV ownership, is set to roll out in June. It is intended to serve renters and homeowners with either suboptimal locations for solar installations or relatively low credit scores.

GEMS' goals are as ambitious as its design is innovative. The program's managers hope to provide support to as many as 30,000 Hawaiian consumers for more than 44 megawatts of new PV generation capacity.

In 2014, the International Financing Review awarded GEMS its "North American Structured Finance Issue" of the year award, calling the program an "innovative solution that is now expected to be replicated elsewhere." Within Hawaii, the GEMS model could be widely utilized across a variety of clean energy technologies over time. The structural originality and programmatic flexibility of GEMS' combination of bond financing with on–bill repayment has significant potential for nation-wide replicability.

CASE STUDY 31

Colorado Solar Gardens Expand Access to Renewable Electricity

As the cost of producing solar electricity has fallen dramatically over the past decade, more Americans have become interested in meeting some or all of their electric power needs from the sun. But many potential customers cannot access the benefits of solar, either because they cannot afford the upfront costs, they own homes that are poorly sited for solar, or rent their homes and thus do not control decisions about long-term building changes.

Utilities, cities, and community groups in an increasing number of states are exploring an alternative model, known as community solar or shared solar projects. These projects allow customers to buy or lease shares in a shared solar system that is sited in a suitable location. Colorado created a leading example of this approach with its *2010 Community Solar Gardens Act*, which directed the state's investor-owned utilities to build community solar projects across the state.

"We were hearing from customers who wanted access to solar but had shady roofs, or lived in multifamily buildings, or rented, or lived in areas where there were no solar installation services," says Tom Plant, a senior policy advisor for the Center for a New Energy Economy at Colorado State University. Plant served in the Colorado legislature from 1998–2006 and directed the Governor's Energy Office under Gov. Bill Ritter from 2006–2010. "The market wasn't open to them, so we wanted to create a mechanism that would let them participate."

Community solar projects can be designed and operated in many different ways. Colorado's law allows residents, commercial entities, low-income utility customers and agricultural producers to invest in solar gardens. With limited exceptions, participants must be located in the same county as the project. Each solar garden must have at least 10 members. Individual shares must be at least one kilowatt, and the maximum size for a project is two megawatts.

Solar gardens are owned by subscriber organizations, whose sole purpose is to own and operate community solar gardens. Utilities are required to purchase their power. For the first three years, the total output that each utility had to purchase was capped at six megawatts. ("Utilities wanted caps to make sure the solar gardens wouldn't overwhelm their systems," says Plant.) In 2014, the Colorado Public Utility Commission determined minimum and maximum purchases that utilities would be required to make.

Shareholders receive credit on their electric bills in proportion to the size of their share in a solar garden. This approach is known as virtual net metering, since customers are credited on their home electric bills for generation that occurs somewhere else. "We didn't know whether the utilities could automate a virtual net metering structure, but it turned out not to be difficult for them," says Plant. Customers can keep their share of ownership in a solar garden if they move to another home within the same county, or can sell their share at any time.

Shareholders receive credit on their electric bills in proportion to the size of their share in a solar garden.

To ensure that low-income residents would have access to solar power, the Colorado Public Utility Commission reserved five percent of shares in each solar garden for subscribers with incomes at or below 185 percent of the federal poverty limit, and exempted them from the one kilowatt minimum share. In a twist on this approach, one of Colorado's newest solar gardens (scheduled for completion in mid-2015) is a 25-kilowatt array in Grand Junction that will exclusively serve six to 10 low-income families, offsetting up to 90 percent of their electricity costs. The local utility, Grand Valley Power, is providing land, interconnection, and philanthropic support for the project and has contracted with GRID Alternatives, the nation's largest non-profit solar installer, to build it.[1]

Colorado's solar gardens are extremely popular: when Xcel Energy opened its initial offering in 2012, it received three times as many applications as it could fill within 30 minutes.[2] The state's utilities have found that community solar projects offer advantages for them. "Utilities like this kind of program because it looks more like standard utility-scale development and is easier for them to manage than numerous smaller systems," says Plant. "They charge for grid integration and similar things, so it's structured similarly to a standard power purchase agreement."

The solar gardens also have lower upfront costs than installing rooftop systems. "You don't have to do a site visit—you can sign people up online, which drives down marketing costs," says Plant. "There also are economies of scale on interconnection—you're just dealing with one site and one permit."

Minnesota, California, Massachusetts and other states are also developing community solar projects. Minnesota passed a community solar law in 2013, and California issued regulations in January 2015 that require the state's three largest utilities to contract for 600 megawatts of new solar capacity. "A number of our customers simply can't go solar on their own," said Jonathan Marshall, a spokesman for Pacific Gas & Electric Co. "This is a tremendous opportunity for them to get to 100 percent solar if they want it."[3]

1 Kelly Pickerel, "New Colorado Community Solar Garden to Exclusively Serve Low-Income Customers," *Solar Power World*, April 26, 2015, *www.solarpowerworldonline.com/2015/03/new-colorado-community-solar-garden-to-exclusively-serve-low-income-customers.*

2 Mark Jaffe, "Demand High for Xcel's Solar Garden Program in Colorado," *Denver Post*, August 16, 2012, *www.denverpost.com/ci_21322815/demand-high-xcels-solar-garden-program-colorado.*

3 Steve Karnowski, "Community Solar Gardens Springing Up All Over," *Portland Press Herald*, March 8, 2015, *www.pressherald.com/2015/03/08/community-solar-gardens-springing-up-all-over.*

ENDNOTES

Chapter 1

1 Clean Energy States Alliance (CESA), a nonprofit 501(c)(3) organization, is a network of states and municipalities working together to promote renewable energy, energy efficiency, and a strong clean energy economy. CESA's mission is to support state leadership, policies, and programs to accelerate the nation's adoption of clean energy technologies. See *www.cesa.org*.

Chapter 2

2 U.S. Energy Information Administration (EIA) reports that the average residential utility customer used 10,908 kilowatt-hours of electricity in 2013. There are significant differences in electricity use between homes that heat with electricity and those that do not. A typical residence that does not have electric heat uses about 7,200 kilowatt-hours annually. For our calculations, we used the US EIA average including the households with electric heat. "Frequently Asked Questions," U.S. EIA, last updated February 20, 2015, accessed April 20, 2015, *www.eia. gov/tools/faqs/faq.cfm?id=97&t=3*.

3 EIA projections in this paragraph come from U.S. Energy Information Administration, *Annual Energy Outlook 2000 with Projections to 2020* (Washington: Energy Information Administration, December 1999), *http://www.eia.gov/ forecasts/archive/aeo00/pdf/0383%282000%29.pdf*. Generation numbers come from U.S. Energy Information Administration, *Monthly Energy Review March 2015* (Washington: Energy Information Administration, March 2015), Table 7.2a, *http://www.eia.gov/totalenergy/data/monthly/archive/00351503.pdf*.

4 Generation numbers come from EIA, *Monthly Energy Review March 2015*, Table 7.2a.

5 Ibid, Table 7.2a

6 EIA, *Annual Energy Outlook 2000,* p. 72; Galen Barbose, *Renewables Portfolio Standards in the United States: A Status Update* (Berkeley: Lawrence Berkeley National Laboratory, presented during Clean Energy States Alliance webinar, November 6, 2014), p. 14, *http://emp.lbl.gov/sites/all/files/2014%20CESA%20Webinar.pdf*.

7 New legislation in Kansas in Spring 2015 will convert the state's RPS to a voluntary goal.

8 Barbose, *Renewables Portfolio Standards*, p. 8.

9 To understand the Constitutional issues, see Carolyn Elefant and Ed Holt, *The Commerce Clause and Implications for State Renewable Portfolio Standards* (Montpelier: Clean Energy States Alliance, March 2011), *http://www.cleanenergystates.org/assets/Uploads/CEG-Commerce-Clause-paper-031111-Final.pdf*.

10 PacifiCorp, *Renewable Portfolio Standard Oregon Implementation Plan 2013-2017* (Portland: PacifiCorp, January 2012), Table 2, p.4, *http://www.oregon.gov/energy/RENEW/RPS/docs/OR_RPS_Implementation_Plan_2013-2017.pdf*; Minnkota Power Cooperative compliance submission letter to the Minnesota Public Utilities Commission, May 22, 2012; Massachusetts Department of Energy Resources, "RPS Class 1 Renewable Generation Units," table updated April 15, 2015, available at: *http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/qualified-generation-units.html*.

11 Barbose, *Renewables Portfolio Standards,* p. 9.

12 The eligible technologies in Utah include not just renewables, but also certain fossil fuel technologies and nuclear energy. Information about the different states' tax credits comes from the Database of State Incentives for Renewables & Efficiency (DSIRE). This database, which is funded by US DOE and managed by the North Carolina Clean Energy Technology Center, includes all of the states' different clean energy incentives. See *www.dsireusa.org*.

13 The National Renewable Energy Laboratory has analyzed how a bundle of state policies supports solar development. See D. Steward and E. Doris, *The Effect of State Policy Suites on the Development of Solar Markets* (Golden: National Renewable Energy Laboratory, November 2014), *http://www.nrel.gov/docs/fy15osti/62506.pdf*.

14 There was 18.3 gigawatts of installed PV capacity, 8.7 gigawatts of it in California. GTM Research and Solar Energy Industries Association, *U.S. Solar Market Insight Report: 2014 Year in Review, Executive Summary* (Washington: Solar Energy Industries Association, March 2015), pp. 3, 8, *http://www.seia.org/research-resources/solar-market-insight-report-2014-q4*.

15 "Net Metering," Solar Energy Industries Association, accessed April 23, 2015, *www.seia.org/policy/distributed-solar/net-metering*.

16 Interstate Renewable Energy Council and Vote Solar, *Freeing the Grid 2014: Best Practices in State Net Metering Policies and Interconnection Procedures* (Latham, NY: Interstate Renewable Energy Council, November 2014), p. 7, *http://www.slideshare.net/VoteSolar/ftg-2014-finalreport*.

17 Barbose, *Renewable Portfolio Standards*, p. 10.

18 For a thorough overview of the role of solar in state RPSs, see Ryan Wiser et al., *Supporting Solar Power in Renewables Portfolio Standards: Experience from the United States* (Berkeley: Lawrence Berkeley National Laboratory, October 2010), *http://eetd.lbl.gov/sites/all/files/publications/report-lbnl-3984e.pdf*.

19 Andrea Sarzynski et al., "The Impact of State Financial Incentives on Market Deployment of Solar Technology," *Energy Policy* (Volume 46, May 2012), p. 556.

20 Ibid., p. 555.

21 Details on these various tax provisions can be found in the DSIRE database, *www.dsireusa.org*.

22 The 10 states are Arizona, California, Colorado, Delaware, Hawaii, Massachusetts, Nevada, New Jersey, New Mexico, and North Carolina. Jordan Schneider and Rob Sargent, *Lighting the Way: The Top Ten States that Helped Drive America's Solar Energy Boom in 2013* (Washington: Envi-ronment America Research & Policy Center, August 2014), pp. 4, 6-7, *http://environmentamericacenter.org/sites/environment/files/reports/EA_Lightingtheway_scrn.pdf*.

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