NATIONAL GOVERNORS ASSOCIATION

NGA CENTER FOR BEST PRACTICES

STATE ENERGY TOOLKIT

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OVERVIEW

Governors are developing policies to promote the ongoing transformation of the energy sector into one that is more diverse, efficient, sustainable, resilient and secure. Primary areas of focus include energy efficiency, renewable energy, transportation electrification and measures that support protections against cyber and physical threats. In all these areas, governors are supporting new incentives; advancing ambitious goals; working to address concerns with affordability, equity and reliability; and developing new partnerships.

Several factors are part of this transformation. The Electric Power Research Institute (EPRI) estimates that each state can save 12% to 21% of retail sales by implementing cost-effective energy efficiency improvements. Renewable energy, alongside natural gas, has become the leading choice for new power generation. More than a dozen states have set ambitious new targets to reach 75% to 100% clean energy, some of them inclusive of nuclear power, carbon capture and storage, and potentially other fuels such as renewable natural gas. As electric vehicle ranges and model selections have increased and the recharging infrastructure expanded, transportation electrification has become more widespread. Meanwhile, states have worked to ensure that the electric grid is both smart and secure and that the system can respond to growing threats from bad actors, as well as increasingly intense storms, floods and wildfires.

The NGA Center for Best Practices State Energy Toolkit (toolkit) offers ideas to help governors respond to trends as they take action in their states. For each area — energy efficiency, renewable energy, transportation electrification, and cyber and physical protection — the toolkit offers three types of guidance:

- **An overview of the technologies and key policy trends.**
- **A summary of opportunities, challenges, and an overview of state solutions**
- **A menu of state policy solutions, spotlighting leading states.**

Additional information is available from the many resources provided in the endnotes.

Governors will be able to use this toolkit to craft approaches that meet their state's goals for advancing their energy future.

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INCREASING EFFICIENCY

Technologies and Key Policy Trends

TECHNOLOGY OVERVIEW.

Buildings account for roughly three-quarters of U.S. electricity consumption.[1] The $83 billion U.S. energy efficiency industry improves energy productivity by using traditional technologies such insulation; light-emitting diode (LED) light bulbs; ENERGY STAR appliances; and state-of-the-art measures such as data analytics, peak demand management, behavioral efficiency and smart thermostats.[2]

ECONOMICS.

There are more than 2.3 million energy efficiency jobs in the United States.[3] In 2018, the industry grew by 3.4% — faster than overall U.S. employment growth.[4] The cost of energy efficiency measures varies considerably by region and customer class, but the average cost of a kilowatt-hour saved is appropriately 5 cents per kilowatt-hour,[5] which is less than half of the average price of electricity to utility customers in the United States.[6]

KEY POLICY TRENDS

Spending on efficiency continues to increase. Ratepayer-funded utility spending on efficiency programs grew by about 20% between 2011 and 2016,[7] reaching an estimated $7.9 billion in 2017.[8] Similarly, nonutility energy service companies reported industry revenues of approximately $7.6 billion in 2017, which equates to an average annual growth rate of roughly 13% from 2015 to 2017.[9]

More than half of U.S. states have an energy efficiency resource standard (EERS). Currently, 22 states have a mandatory EERS, and four states have a voluntary (nonbinding) EERS. Two states have combined their EERS with their Renewable Portfolio Standards.[10]

Incremental electricity savings continue to grow. In 23 states, utility consumer- or ratepayer-funded efficiency programs offset at least 1% of electricity load for investor-owned utilities, with four states exceeding savings of 2% of sales, resulting in 27.5 terawatt-hours saved in 2016.[11]

"Smart" home devices continue to multiply. Americans are rapidly adopting smart thermostats, light bulbs, home energy controllers and other smart home energy devices in their homes. By 2023, 28% of U.S. homes are expected to have smart thermostats installed, and the home energy management technology sector anticipates $24 billion in hardware sales.[12] Similarly, businesses are deploying building energy management and automation systems that can use real-time data analytics to reduce energy consumption and improve system efficiency.

1 American Counsel for an Energy Efficiency Economy. (2016). Building policies. Retrieved from https://aceee.org/topics/building-policies

2 Advanced Energy Economy. (2019). *Advanced energy now 2019 market report: Global and U.S. market revenue 2011–18 and key trends in advanced energy,* p. 9. Retrieved from https://www.advancedenergynow.org/aen-2019-market-report

3 National Association of State Energy Officials & Energy Futures Initiative. (2019). *The 2019 U.S. energy and employment report.* Retrieved from https://www.usenergyjobs.org

4 Walton, R. (2019, March 7). *Efficiency leads 2019 energy job growth prospects* (Issue Brief). Retrieved from https://www.utilitydive.com/news/efficiency-leads-2019-energy-job-growth-prospects-report-finds/549968/

5 A June 2018 U.S. Department of Energy Lawrence Berkeley National Laboratory study found that the cost of a kilowatt-hour (kWh) saved, including both participant costs and program administrator costs, was appropriately 5 cents per kilowatt-hour ($0.039/kWh for residential, $0.145/kWh for low income and $0.055/kWh for commercial and industrial). Hoffman, I., Goldman, C. A., Murphy, S., Mims, N., Leventis, G., & Schwartz, L. (2018, June). *The cost of saving electricity through energy efficiency programs funded by utility customers: 2009–2015.* Retrieved from http://eta-publications.lbl.gov/sites/default/files/cose_final_report_20180619_1.pdf

6 The average price of electricity to ultimate U.S. consumers (all sectors) was 10.43 cents per kilowatt-hour as of February 2019. U.S. Energy Information Administration. (2019, July). Electric power monthly: Table 5.6.A. Average price of electricity to ultimate customers by end-use sector. Retrieved from https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

7 Goldman, C. A., Murphy, S., Hoffman, I., Mims Frick, N., Leventis, G., & Schwartz, L. (2018, November). *The future of U.S. electricity efficiency programs funded by utility customers: Program spending and savings projections to 2030.* Retrieved from http://eta-publications.lbl.gov/sites/default/files/future_of_ee_final_report_20181205_final.pdf

8 Bert, W., Nowak, S., Relf, G., Vaidyanathan, S., Junga, E., DiMascio, M., & Cooper, E. (2018, October). *The 2018 state energy efficiency scorecard* (Report No. U1808). Retrieved from https://aceee.org/sites/default/files/publications/researchreports/u1808.pdf

9 Stuart, E., Larsen, P. H., Carvallo, J. P., Goldman, C. A., & Gilligan, D. (2016, October). *U.S. Energy Service Company (ESCO) industry: Recent market trends.* Retrieved from https://www.naesco.org/data/industryreports/esco_recent_market_trends_30sep2016.pdf

10 Center for Climate and Energy Solutions. (2019, March). Energy efficiency standards and targets. Retrieved from https://www.c2es.org/document/energy-efficiency-standards-and-targets/

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12 Chen, O., (2018, June 20). Connected devices are driving a more grid-responsive home. *GreenTech Media.* Retrieved from https://www.greentechmedia.com/articles/read/connected-devices-driving-a-more-grid-responsive-home#gs.j3ewag

INCREASING EFFICIENCY

Opportunities, Challenges and State Solutions

OPPORTUNITIES. The least expensive kilowatt is the one not needed. Improving energy productivity is sometimes considered a no-regrets policy option because efficiency investments reduce bills for residential, commercial and industrial customers; drive domestic job creation; reduce emissions; and improve grid reliability and resiliency.

Despite major investments over the past decade, every state still has a large electric energy efficiency potential that it can use as a cost-effective energy resource.[1] For example, EPRI estimated in 2017 that energy efficiency economic potential will range from 12% in **Missouri** to 21% in **Florida** in 2035 relative to adjusted baseline sales.[2]

CHALLENGES. Despite its numerous benefits, a variety of market barriers hinder optimal deployment of energy efficiency technologies. For example, building owners are often reluctant to invest in efficiency improvements, even when they have a payback period of less than two years.[3] Transaction costs, such as difficulty identifying the best technological solution, hiring and overseeing contractors and completing the paperwork, are frequently cited as factors that discourage implementation of efficiency measures.[4] Other barriers include limited access to capital and the split incentive problem, whereby the costs and benefits of efficiency are split across different parties (such as the owner of rental property not generally realizing the benefits of reduced electric bills).[5]

In addition, energy utilities are traditionally paid based on the volume of kilowatt-hours they sell, creating a powerful disincentive to reduce sales of their product. Similarly, the market has been slow to recognize the benefits of exceeding minimum energy building codes, such as health, environmental and resilience benefits, resulting in underinvestment in appliances, lighting and other building technologies.

STATE SOLUTIONS. States have developed an array of policy interventions, often in partnership with local utilities and others, to overcome these specific challenges. State solutions include the following:

- ***Establish or strengthen EERS.*** Set long-term energy savings targets typically administered by utilities using ratepayer funds.
- ***Implement demand response programs.*** Reduce demand during peak hours, when electricity consumption is highest and most expensive.
- ***Update and enforce state building codes.*** Establish, refresh and enforce minimum energy standards for buildings, which consume 70% of a state's electricity.
- ***Expand state government-led financial incentives.*** Include state-administered energy efficiency rebates, revolving loan funds, loan-loss reserve funds, grants, tax credits and tax holidays.
- ***Lead by example.*** Conduct energy retrofits, and benchmark state government buildings.
- ***Expand weatherization and other low and moderate income (LMI) programs.*** Provide funds to supplement the chronically underfunded U.S. Department of Energy (DOE) Weatherization program or establish specific LMI efficiency targets and programs.
- ***Encourage use of smart energy management devices.*** Promote smart, internet-enabled devices, such as thermostats, light bulbs, home energy controllers and building energy management systems, through ratepayer incentives, tax rebates and similar policies.
- ***Establish and use building benchmarking and disclosure policies.*** Make a building's energy consumption more transparent through benchmarking of commercial buildings, residential home energy ratings or disclosure of annual energy consumption at the time of home listing.
- ***Decouple utility revenues from volumetric sales.*** Pay the utility for services provided rather than kilowatts/therms sold or create a lost revenue adjustment mechanism to prevent efficiency from eroding utility revenue.

INCREASING EFFICIENCY

- ***Encourage performance-based utility incentives for energy efficiency initiatives.*** Use performance-based financial incentives to reward utilities for encouraging energy efficiency and peak demand reductions.
- ***Accelerate the evolution of utility business models.*** Transition from the traditional cost-of-service model, where utilities earn revenue based on what they spend, to a new model, such as performance-based ratemaking, which compensates utilities based on their ability to meet or exceed state-established performance metrics.

1 Electric Power Research Institute. (2017, May). *State level electric energy efficiency potential estimates* (Report No. 3002009988). Retrieved from https://www.energy.gov/sites/prod/files/2017/05/f34/epri_state_level_electric_energy_efficiency_potential_estimates_0.pdf

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INCREASING EFFICIENCY

State Solutions Spotlights

Opportunities to enhance energy efficiency exist in every state. Some states describe these opportunities as accelerating energy productivity; others characterize it as ensuring energy optimization or reducing energy waste. Regardless of the nomenclature, governors have successfully pioneered a range of state policies. Those efforts have been driven by objectives such as helping reduce consumer and business utility bills, enhancing grid reliability, deferring infrastructure upgrades and promoting local job creation.

Examples of state policies include the following:

- Establish or strengthening energy efficiency resource standard (EERS).
- Implement demand response programs.
- Update and enforcing state building codes.
- Expand state government-led financial incentives.
- Lead by example using state government buildings.
- Expand weatherization and other low and moderate income (LMI) programs.
- Encouraging use of smart energy management devices.
- Establish and use building benchmarking and disclosure policies.
- Decouple utility revenue from volumetric sales.
- Encourage performance-based utility incentives for energy efficiency initiatives.
- Accelerate the evolution of utility business models.

ESTABLISHING OR STRENGTHEN EERS. Twenty-seven states have created energy efficiency targets. These long-term EERSs are typically binding on the state's utilities, which administer a range of ratepayer-funded incentives and programs to reduce residential, commercial and industrial consumption. Collectively, these programs saved an estimated 242 million megawatt-hours (MWh) in 2017, which is equivalent to 6.4% of overall U.S. electricity consumption.[1]

Traditionally, states have established incremental energy savings targets in the range of 1% to 1.5% annually (e.g., **Nevada** at 1.15%, **Arkansas** at 1.2% and **Colorado** at 1.6%). Recently, however, seven states have raised their annual incremental savings targets to 2% or more (e.g., **Maryland** at 2%, **New Jersey** at 2% electric and 0.75% gas, and **New York** at 3%),[2] while others established requirements that utilities or third-party administrators achieve "all cost-effective" energy efficiency as determined by the state's public utility commission (PUC).[3] Sixteen states also have EERS policies in place for natural gas.[4] Consider the following state spotlights:

State spotlight: Arizona. **Arizona** established incremental savings targets at 1.25% of sales in 2011, ramping up to 2.5% in 2016 through 2020 for cumulative electricity savings of 22% of retail sales, 2% of which may come from peak demand reductions.[5] Co-ops must meet 75% of targets. For natural gas, Arizona established a target of approximately 0.6% incremental savings per year (for cumulative savings of 6% by 2020). Although not quite achieving these ambitious goals to date, Arizona reached more than 1 million MWh of incremental savings in 2017, making it a top 10 state in terms of percentage of retail sales saved.

State spotlight: Nevada. In Nevada, 2017 legislation established utility energy savings goals for NV Energy, allowed program approval if the portfolio of programs is cost-effective, captured nonenergy benefits in a cost-benefit analysis and required a minimum spending level for low-income efficiency programs.[6]

State spotlight: Vermont. **Vermont** is one of nine states to establish an independent implementation entity, a so-called "efficiency utility," to administer their state's programs.[7] Vermont led the nation in net incremental efficiency savings in 2017 of 3.33% of retail electricity sales and was a top-10 state for natural gas and other fuel savings.[8] Vermont also spent more than any other state on efficiency, exceeding 8% of retail electricity expenditures.[9]

INCREASING EFFICIENCY

IMPLEMENT DEMAND RESPONSE PROGRAMS. Demand response programs complement energy efficiency by focusing on reducing consumption during peak hours, when demand is highest and most expensive. In addition to the cost savings, demand response programs can help avoid outages and offset the need for aging, inefficient peak power generation. Consider the following state spotlights:

State spotlight: Maryland. As part of the EmPower Maryland law, Maryland investor-owned utilities provide rebates to customers who reduce their energy use during a handful of peak demand events each year. The program reduces summer peak demand, lowers electricity costs, reduces wholesale market prices and enhances the reliability of Maryland's grid. Baltimore Gas and Electric Company, for example, has a program that typically reduces peak demand by more than 300 MW each year — about the size of an average coal-fired power plant — and has provided more than $40 million in customer rebates and $400 million in wholesale market savings.[10]

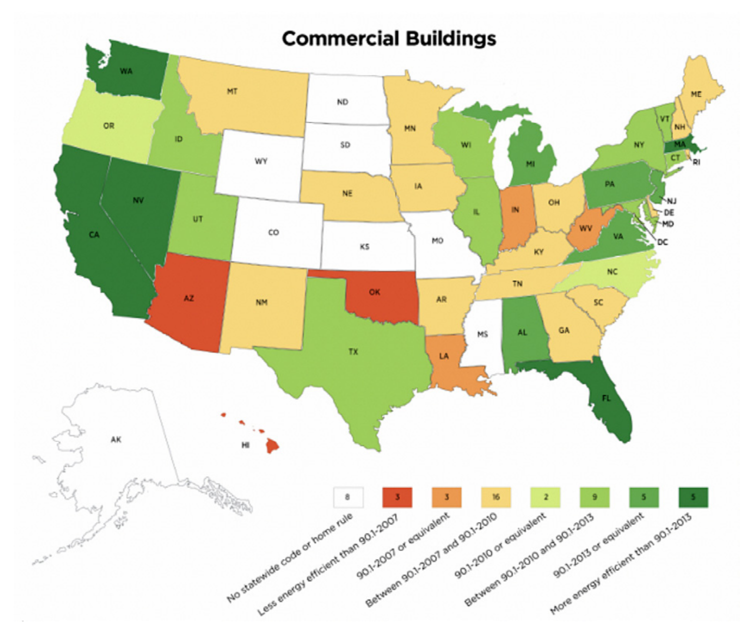

FIGURE 1: Status of state energy code adoption

Source: U.S. Department of Energy. (2018, December). Status of state energy code adoption. Retrieved from https://www.energycodes.gov/status-state-energy-code-adoption

State spotlight: New Mexico. Public Service Company of **New Mexico**'s Peak Saver program helps large commercial electric customers reduce their electricity consumption during peak demand days, typically the hottest days of the year.[11] Participants receive an annual incentive based on the amount of electricity managed during the program.

UPDATE AND ENFORCE BUILDING ENERGY CODES. Improved technologies and building methods have enabled significantly more effective energy codes, which could save consumers an estimated $126 billion between 2010 and 2040 and avoid the equivalent of 177 million passenger vehicles driven for one year in greenhouse gases (see Figure 1).[12]

To capitalize on these improvements, states need to periodically incorporate the latest version of these codes, which are usually developed by independent groups such as the International Energy Conservation Code or the American Society of Heating, Refrigerating and Air-Conditioning Engineers. Tools are available to help states estimate the energy and carbon savings of updating energy codes.[13] Educating builders and ensuring code compliance have also proven to be effective long-term strategies. Consider the following state spotlights:

State spotlight: Massachusetts. In 2016, **Massachusetts** updated its base and stretch energy codes for both commercial and residential buildings. More than 180 Massachusetts towns have adopted the code.[14] Department of Energy (DOE) estimated that the energy cost savings from these updates will be nearly $144 million annually by 2030.[15]

State spotlight: Rhode Island. Gov. Gina Raimondo's Executive Order 15-17 requires, among other things, the **Rhode Island** Office of Energy Resources to establish a voluntary stretch building code.[16] The code is intended to support the sustainable energy goals described in the Resilient Rhode Island Act of 2014 to cut emissions by 45% by 2035 and 80% by 2050. Available in February 2018, the residential stretch

INCREASING EFFICIENCY

code was based on DOE's Zero Energy Ready Homes program, and the commercial stretch code was based on the International Green Construction Code.[17]

State spotlight: Texas. Under **Texas** state law, a division of Texas A&M University has six months to compare the stringency of the current Texas Building Energy Performance Standards with newly published codes and provide recommendations to the Texas State Energy Conservation Office, which can adopt the code subject to legislative oversight. Texas currently has adopted the 2015 International Code Council Residential and Commercial Standards.[18]

EXPAND STATE GOVERNMENT-LED FINANCIAL INCENTIVES. Many state governments offer a suite of financial incentives that complement ratepayer-funded utility programs. State energy offices, for example, offer rebates, loans or grants, particularly for low-income, nonprofit and other underserved communities. Some states also offer income tax credits or sales tax holidays for eligible efficiency investments. Consider the following state spotlights:

State spotlight: Colorado. Colorado's Residential Energy Upgrade loan program offers long-term, low-interest loans to homeowners seeking energy efficiency improvements such as air sealing, insulation, windows, lighting and appliances. As the program's sponsor, the Colorado Energy Office authorizes contractors to participate, and the contractors then work directly with the homeowner to install upgrades.[19]

State spotlight: Florida. The Florida Department of Agriculture and Consumer Services offers farmers free energy audits to determine the potential for energy efficiency and other measures. Eligible agricultural producers can receive up to $25,000 for implementing recommended measures.[20]

State spotlight: Mississippi. The **Mississippi** Development Authority operates a leasing program for energy-efficient equipment that public entities and nonprofit hospitals can use to lease efficiency equipment and services for up to 15 years from the authority using a third-party financier. The state also offers an efficiency revolving loan program, an alternative fuel school bus and municipal motor vehicle loan program and a state sales tax exemption for electricity used in manufacturing.[21]

State Spotlight: Tennessee. Tennessee's Pathway Lending Energy Efficiency and Renewable Energy Loan Program issued 29 loans to businesses and nonprofits in 2018, resulting in more than 12,800 MWh of annual energy savings and $1.4 million in estimated monetary savings due to utility reductions. This Program was started in 2010 and is funded through loan capital provided by the Tennessee Department of Environment and Conservation, the Tennessee Valley Authority, and Pathway Lending. The State of Tennessee also launched the Energy Efficient Schools Initiative (EESI) in 2008, leveraging excess lottery funds to support energy savings projects in K-12 schools statewide. In FY2018, EESI approved nine loans expected to achieve more than 17,600 MWh, or $7.2 million, in annual energy savings.[22]

LEAD BY EXAMPLE. Many states have adopted programs to lead by example, conducting energy audits and benchmarking state government buildings to help lower energy use, lower costs and demonstrate new technologies. Energy savings for new and existing state facilities can be regularly tracked and the saving targets periodically reviewed. An increasing number of states are also benchmarking public sector buildings to help prioritize the most cost-effective efficiency projects. Consider the following state spotlights:

State spotlight: Kentucky. The **Kentucky** Division of Facility Efficiency, which is part of the Kentucky Finance and Administration Cabinet, operates an innovative state building dashboard called the Commonwealth Energy Management and Control System Kentucky Energy Savings Dashboard to better track and manage energy consumption in state facilities (see Figure 2). The state tracks energy consumption for 801 buildings in the system, representing more than 16 million square feet and annual utility costs of more than $32 million. Through this tool and a robust lead-by-example program, the state had reduced energy costs by 8.9% as of August 2019 and is on track to meet its goal of a 25% reduction by 2025.[23]

INCREASING EFFICIENCY

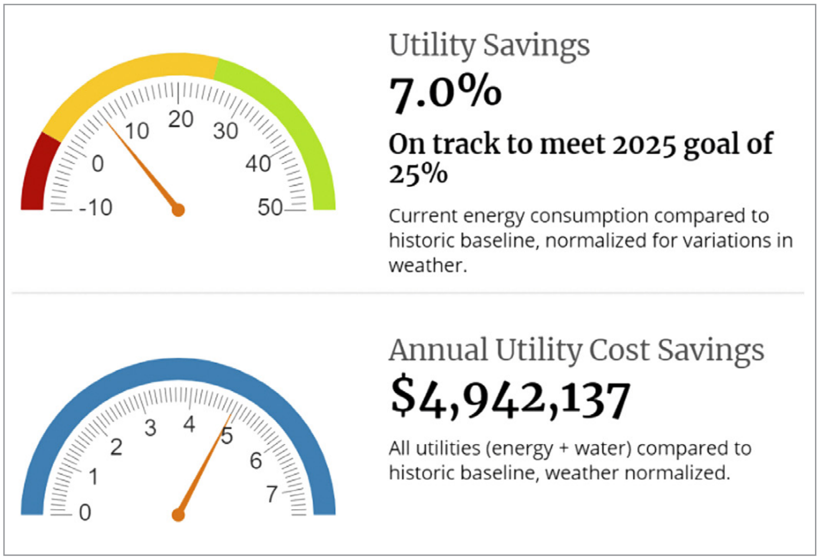

Figure 2: Kentucky Energy Savings Dashboard

Source: Commonwealth Energy Management and Control System. (n.d.). Kentucky Energy Savings Dashboard. Retrieved from http://kyenergydashboard.ky.gov/Home

EXPAND WEATHERIZATION AND OTHER LMI PROGRAMS. Low-income families, on average, spend 7.2% of their income on utilities — nearly three times the amount that higher income households pay (2.3%).[27] To supplement the federally funded DOE Weatherization Assistance Program, some states budget additional taxpayer funds. Others set specific LMI targets for ratepayer-funded utility programs, often applying a more relaxed cost-effectiveness test. Consider the following state spotlights:

State spotlight: Illinois. The 2016 Future Energy Jobs Act effectively doubled the required annual amount of utility investment in low-income energy efficiency programs in **Illinois**.[28] Illinois excludes low-income measures from the requirement to meet the "total resource cost" test in recognition that such programs typically have higher implementation costs and would otherwise be deemed ineligible.[29]

State spotlight: New Mexico. Legislation championed by Gov. Michelle Lujan Grisham in 2019 provides $20 million in direct spending on energy upgrades at all 29 state buildings in Santa Fe. An additional $12 million was secured from the New Mexico Finance Authority by issuing bonds to pay for building efficiency improvements.[24]

State spotlight: Oregon. Under a 2017 executive order, all **Oregon** state agencies are required to adopt targets to reduce their energy consumption, and all new state buildings permitted after 2021 are required to achieve carbon-neutral operations. The order also directs the Oregon Department of Energy to report and track all state-owned building energy use to guide energy conservation efforts and to follow the most recent energy building standards.[25]

State spotlight: Rhode Island. Since 2017, Rhode Island's Office of Energy Resources has recognized 23 state government agencies, municipalities and state colleges and universities at its annual Lead by Example Energy Awards ceremony. Under a 2015 executive order, state agencies are required to reduce their energy consumption by 10% by fiscal year 2019 from a 2014 baseline.[26]

State spotlight: New York. New York established an Energy Affordability Policy intended to limit energy costs for low-income residents to no more than 6% of household income. The effort enables EmPower New York to provide income-eligible customers with a range of no-cost energy efficiency solutions, including home energy assessments and replacement of old appliances, and a Clean Energy Fund to invest in programs that specifically benefit LMI customers.[30]

State spotlight: Pennsylvania. In 2015, the **Pennsylvania** PUC approved Phase III of its Act 129 efficiency program, which, among other things, increased the state's commitment to energy efficiency in low-income households. As a result, the utilities have agreed to increase their spending by almost $200 million over the next five years.

ENCOURAGE USE OF SMART ENERGY MANAGEMENT DEVICES. Consumers have far greater control over their energy consumption than ever before because of the growing adoption of internet-

INCREASING EFFICIENCY

enabled smart devices, such as thermostats, light bulbs, home energy controllers and building energy management systems. States can encourage use of these devices through ratepayer incentives, tax rebates and similar policies. For example, Massachusetts and Vermont offer residential customers rebate incentives to purchase smart thermostats, which can help customers reduce energy consumption and enable them to participate in utility demand response programs.[31,32]

ESTABLISH AND USE BUILDING BENCHMARKING AND DISCLOSURE POLICIES. Many states and cities are using the power of the market by requiring energy benchmarking of commercial buildings to help potential tenants consider energy consumption in their decision making. To add similar sunlight to the residential real estate markets, a growing number of local governments are requiring homeowners to disclose their annual energy consumption or home energy rating at the time of listing. Sixteen states have energy benchmarking policies or voluntary programs.[33] **California** and New Jersey have policies in place that mandate energy benchmarking for commercial and public buildings.[34]

DECOUPLE UTILITY REVENUE FROM VOLUMETRIC SALES. Electric and gas utilities traditionally earn their revenue based on the volume of electricity or natural gas they sell, which creates a powerful disincentive to engage in efficiency. Thirty states have addressed this barrier by either decoupling (paying the electricity utility for the services provided rather than the kilowatts sold) or creating a lost revenue adjustment mechanism.[35] Similarly, 28 states have decoupled or created a lost revenue adjustment mechanism for natural gas.[36]

ENCOURAGE PERFORMANCE-BASED UTILITY INCENTIVES FOR ENERGY EFFICIENCY INITIATIVES. Twenty-six states use performance-based incentives to reward utilities for encouraging energy efficiency.[37] For example, utilities in **Georgia** can recover a higher rate on their energy efficiency investments when the program or project achieves at least 50% of projected energy savings.[38]

ACCELERATE THE EVOLUTION OF UTILITY BUSINESS MODELS. Many states and utilities are reevaluating the traditional utility business model in light of higher customer performance expectations, stagnating utility revenues and grid modernization needs.[39] Moving away from the traditional cost-of-service model (where utilities earn revenue based on what they spend), performance-based ratemaking compensates utilities based on their ability to meet or exceed state-established metrics, such as affordability, reliability and low carbon intensity. As of January 2019, at least 10 states had started or completed at least one aspect of a utility business model reform proceeding.[40]

1 Bert, W., Nowak, S., Relf, G., Vaidyanathan, S., Junga, E., DiMascio, M., & Cooper, E. (2018, October). *The 2018 state energy efficiency scorecard* (Report No. U1808). Retrieved from https://aceee.org/sites/default/files/publications/researchreports/u1808.pdf

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3 The seven states that require all cost-effective efficiency are California, Connecticut, Maine, Massachusetts, Rhode Island, Vermont and Washington. American Council for an Energy-Efficient Economy. (2017, January). *State energy efficiency resource standards (EERS)* (Policy Brief). Retrieved from https://aceee.org/sites/default/files/state-eers-0117.pdf

4 The 16 states are Arizona, Arkansas, California, Colorado, Connecticut, Illinois, Iowa, Maine, Massachusetts, Minnesota, Michigan, New Hampshire, New York, Oregon, Rhode Island and Wisconsin. American Council for an Energy-Efficient Economy. (2017, January). *State energy efficiency resource standards (EERS)* (Policy Brief). Retrieved from https://aceee.org/sites/default/files/state-eers-0117.pdf

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7 States that have established nonutility administration of efficiency programs include Delaware, the District of Columbia, Hawaii, Maine, New Jersey, New York, Oregon, Vermont and Wisconsin. Bert, W., Nowak, S., Relf, G., Vaidyanathan, S., Junga, E., DiMascio, M., & Cooper, E. (2018, October). *The 2018 state energy efficiency scorecard* (Report No. U1808). Retrieved from https://aceee.org/sites/default/files/publications/researchreports/u1808.pdf

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INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

Technologies and Key Policy Trends

TECHNOLOGY OVERVIEW.

Recent growth in the use of clean energy is fundamentally reshaping the U. S. electricity system. Some of the most pronounced changes involve the increased use of utility-scale renewables, which now account for over 75 percent of all renewables.[1] Generation from utility-scale wind and solar generation are now less expensive than coal fired generation in many parts of the nation.[2] Solar costs have dropped by more than 70 percent over the last decade with utility-scale prices ranging from 2.8 to 4.5 cents per kwh.[3] Similarly, the cost of on-shore utility-scale wind generation has fallen 69 percent since 2009, and 7 percent in 2018 alone, with utility-scale prices below 2 cents per kwh in some regions.[4] Even without soon-to-expire federal tax credits, renewable energy costs are lower than the marginal cost of conventional energy technologies under a variety of future scenarios.[5]

Meanwhile, nuclear power remained steady at 19 percent of the U.S. generation mix in 2018. Commercial scale use of carbon capture and storage (CCS) technology is still limited for power plants, with the Petra Nova plant being the only one in U.S operation, but technology development efforts continue alongside efforts to expand the carbon dioxide pipeline system.[6]

Technological innovations are occurring on the customer side of the meter as well. These "behind the meter" distributed energy resources include residential and commercial solar power, battery storage, fuel cells, electric vehicle charging, combined heat and power systems, microgrids, demand response technologies, and other energy management strategies. Electric vehicle charging and the opportunity for automotive batteries to serve as distributed storage is also a part of this transformation.

ECONOMICS.

Renewable energy (both utility scale and distributed) has emerged as an engine of economic growth. The solar industry employs 242,000 Americans, more than double the number in 2012, investing $17 billion in the U.S. in 2018.[7] Similarly, the wind industry employees 114,000 Americans, with over 500 factories in 42 states.[8] Five classes of distributed energy resources — distributed solar, small-scale combined heat and power, residential smart thermostats, electric vehicles and battery energy storage — contributed 46.4 GWs of impact on the U.S. summer peak in 2017, a figure that's expected to exceed 100 GWs by 2023.[9] The nuclear industry encompasses some 72,000 jobs in the U.S., across the utility, professional services and manufacturing sectors.[10]

KEY POLICY TRENDS

States' renewable energy ambitions soar. Twelve states and territories in recent years have raised their renewable energy standards to 50 percent or greater.[11] **California**, **Hawaii**, **Nevada**, **New Mexico**, **Puerto Rico**, and **Washington** have set a 100 percent clean energy goal.[12]

Governors leading efforts to address climate change. Twenty-five Governors have pledged that their state will reduce carbon emissions by at least 26 percent below 2005 levels by 2025.[13] Together, states making this non-binding commitment comprise over 55 percent of the U.S. population.[14]

Natural gas and renewables booming, coal generation continues to drop . The shale gas boom led natural gas power production to grow to 35 percent of the U.S. electricity mix in 2018, with renewables growing 5 percent to almost 18 percent.[15] At the same time, coal's percentage of the U.S. electricity generation mix fell to 27 percent, the lowest since World War II, with 13 GWs of coal capacity retiring in 2018.[16] In response to these changing economic circumstances, some states are increasingly considering incentives and other financial support to help coal communities.[17]

Incentives to continue nuclear generation expanding. While nuclear power remained steady at 19 percent of the U.S. generation mix in 2018, economic competition has forced many nuclear power plants to announce early retirements.[18] **New York**, **Connecticut**, **New Jersey** and **Illinois** have enacted incentives to

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

support nuclear power, while **Ohio** and **Pennsylvania** are considering similar measures.[19]

Embrace of renewables by corporations and electric utilities growing. Corporate America's appetite for renewables has grown steadily in recent years, with over 175 major companies committed to purchasing 100 percent renewable power.[20] Changing economics and customer demand has led several major investor owned electric utilities to embrace renewables, including **Minnesota**-based Xcel Energy, which has pledged to be carbon-free in all eight states in which it operates by 2050,[21] Northern Indiana Public Service Company, which plans to retire all of its coal fleet in the next decade,[22] **Ohio**-based AEP, which pledged to cut its CO2 emissions 80 percent by 2050,[23] and **Michigan**-based Consumers Energy, which pledged zero coal use and a 90 percent reduction in carbon emissions by 2040.[24]

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INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

Opportunities, Challenges and State Solutions

OPPORTUNITIES. The electricity system pioneered by Thomas Edison over 125 years ago is undergoing a fundamental transformation. Driven by technological innovations, growing consumer engagement, and heightened environmental awareness, the U.S. electricity system is evolving into a dynamic network with a decline in traditional generation sources and a rise in a more diverse array of utility-scale renewables and distributed energy resources.

Among the benefits attributed to utility-scale renewable technologies and distributed energy resources are energy cost savings, deferred infrastructure upgrades, enhanced system resilience and reliability, power quality benefits, and improved environmental performance.[1] Some states are also looking to continue the use of nuclear power as a reliable, emissions-free resource and interested in the opportunities for carbon capture and storage for coal generation.

CHALLENGES. Wind and solar technologies are variable resources since the wind does not always blow and the sun does not always shine. Integrating these variable resources onto the grid requires significant planning and the use of controllable generation, such as natural gas, hydropower and battery storage, that can ramp up or down quickly as supply and demand fluctuate.

Similar care must be taken to effectively integrate distributed energy resources onto the grid. Among the unique challenges posed by distributed energy resources are the need for more robust distribution system planning, privacy concerns related to third-party access to consumer energy data through mobile energy-conservation applications and cyber-security concerns.[2]

Existing nuclear generation faces economic challenges while the technologies associated with carbon capture and storage or utilization are cost prohibitive and call for additional infrastructure developments to achieve scale.

STATE SOLUTIONS. As discussed below, states have developed a wide array of policies to promote utility-scale renewables and distributed energy resources. Some are also developing incentives to support continued operation of nuclear plants. State solutions include:

- ***Establishing and/or Strengthening Renewable Portfolio Standards (RPS)*** – specifying that a certain percentage of the electricity provided by utilities come from renewable or clean energy resources which could include zero emission resources like nuclear power or carbon capture utilization and storage.
- ***Encouraging Distributed Solar Generation*** – updating state "net metering" policies and/or adopting alternative "value of solar" rates to accelerate residential and commercial solar projects without shifting the costs of maintaining the electricity grid to other customers.
- ***Encouraging Community Solar*** – promoting solar facilities shared by multiple community subscribers who receive credit on their electric bills for their share of the power produced.
- ***Accelerating Adoption of Battery Storage Technologies*** – establishing state storage targets, integrating storage with existing programs (such as RPS or clean peak standards), and incorporating storage into utility integrated resource planning and similar exercises.
- ***Promoting Off-Shore Wind Resources*** – establishing offshore wind procurement targets, RPS "carve outs," and/or favorable tax incentives.
- ***Addressing Transmission Constraints and Siting Requirements for Land-Based Wind Farms*** – expedite the often decade-long transmission permitting process while balancing environmental and procurement protections and adopt model state siting ordinances and/or reasonable setback requirements to ensure safety without hindering growth.
- ***Expanding Clean Energy Funding and Financing*** – innovative efforts to leverage public funds with private capital including Property Assessed Clean Energy (PACE) programs and green banks.

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

- ***Adopting Greenhouse Gas Reduction Targets*** – setting greenhouse gas emission targets to address climate change.
- ***Expanding Corporate Access to Renewables*** – to meet growing corporate demand for renewables, many states are working to develop green power tariffs and reconsidering perceived barriers such as prohibitions on power purchase agreements, solar array size restrictions, onerous wind setback requirements, and prohibitions on companies obtaining electricity from the generator of their choice.
- ***Revisiting Hydropower –*** encouraging relicensing, upgrades at existing projects, and developing non-powered existing dams, new pumped storage projects, and conduit hydro projects.
- ***Supporting Continued Nuclear Generation*** – creating nuclear procurement targets and zero emissions credits (ZEC) Programs, using state mandated power purchase agreements (PPAs), including nuclear in state energy plans.

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INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

State Solutions Spotlights

The U.S. electricity system is experiencing a fundamental transformation as a result of the rapid maturation of clean energy resources like wind and solar, advanced battery storage and other distributed energy technologies. These technologies are increasingly cost-competitive, are less susceptible to fuel price fluctuations, offer customers greater control of their energy choices, and typically involve lower or no emissions, including greenhouse gases, than most traditional sources.

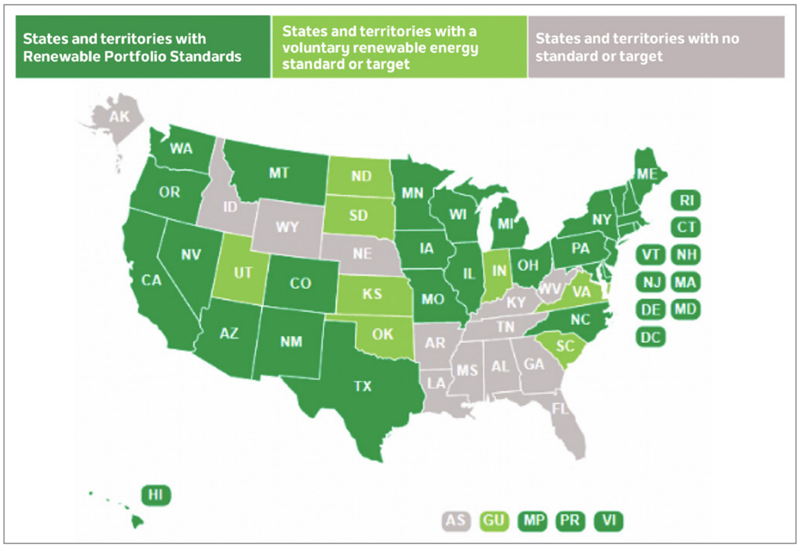

FIGURE 1: 2019 State RPSs and goals

Source: National Conference of State Legislatures. (2019, February 1). State renewable portfolio standards and goals. Retrieved from http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

Governors have successfully pioneered a range of state policies to promote clean and distribute electricity technologies. State solutions include:

- Establishing and/or Strengthening Renewable Portfolio Standards (RPS)
- Encouraging Distributed Solar Generation
- Encouraging Community Solar
- Accelerating Adoption of Battery Storage Technologies
- Promoting Off-Shore Wind Resources
- Addressing Transmission Constraints and Siting Requirements for Land-Based Wind Farms Encouraging Distributed Solar Generation
- Expanding Clean Energy Funding and Financing
- Adopting Greenhouse Gas Reduction Targets
- Expanding Corporate Access to Renewables
- Revisiting Hydropower

ESTABLISHING AND/OR STRENGTHENING RENEWABLE PORTFOLIO STANDARDS (RPS).

Twenty-nine states, D.C. and three territories have adopted Renewable Portfolio Standards (RPS), which require that a specified percentage of the electricity provided by utilities come from renewable or clean energy resources.[1] In some states, these resources may include zero carbon technologies such as carbon capture and storage, or nuclear energy. An additional eight states and one territory have set voluntary clean energy goals. First adopted by **Iowa** in 1983 under a voluntary approach, these requirements have proven effective in diversifying a state's electricity generation mix, encouraging domestic energy production and stimulating local job creation.

While most state targets are between 10 and 45 percent, twelve states and territories —**California, Hawaii, Massachusetts, Maryland, Nevada, New Mexico, New Jersey, New York, Oregon, Puerto Rico, Vermont,** and **Washington** state have requirements of 50 percent or greater.[2] Five of these states and territories - **California**, **Hawaii**, **Puerto Rico**, **Nevada**, and **New Mexico** have set 100 percent clean energy goals.[3]

State Spotlight: California. In September 2018, California enacted AB100, requiring that 100 percent of retail electricity sales come from zero-carbon technologies by 2045.[4] More specifically, 60 percent of

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

sales must be from eligible clean resources by 2030, while the 2045 100 percent goal includes zero carbon resources as well.

State Spotlight: New Mexico. The New Mexico Energy Transition Act, adopted in March 2019, increases New Mexico's RPS to 50 percent renewables by 2030, 80 percent renewables by 2040 and 100 percent renewables by 2045.[5] The action follows an Executive Order issued by Governor Michelle Lujan Grisham earlier in the year.[6]

State Spotlight: New York. To complement their existing 50 percent RPS requirement, in 2016 New York added a "Clean Energy Standard" to compensate nuclear plants under a long-term contract that expires in 2029.[7] Illinois and New Jersey have subsequently adopted similar "Zero Emission Credit" approaches to support nuclear power. Governor Cuomo endorsed a 100 percent RPS requirement during his 2018 gubernatorial campaign.[8]

ADOPTING GREENHOUSE GAS REDUCTION TARGETS. Over the past decade, twenty-nine have adopted specific greenhouse gas reduction targets to address climate change.[9] More recently, over the past year, a bipartisan group of twenty-five Governors have pledged that their state will reduce carbon emissions by at least 45 percent below 2005 levels by 2030.[10] Together, states making this non-binding commitment make up 55 percent of the U.S. population.[11]

State Spotlight: Maryland. The Maryland Greenhouse Gas Reduction Act of 2009 requires the State to achieve a 25 percent reduction in Statewide greenhouse gas (GHG) emissions from 2006 levels by 2020.[12] In 2016, Maryland extended their goal to 40 percent reduction by 2030[13],[14]. Through 2016, Maryland had the largest percentage decrease in greenhouse gas emissions of any state, dropping 30 percent or 24 million metric tons.[15] Governor Hogan has since accelerated Maryland's greenhouse gas reductions efforts, joining the U.S. Climate Alliance – a bipartisan coalition of governors committed to achieving reductions as outlined in the 2015 Paris agreement – and outlining a strategy for Maryland to reach 100 percent clean electricity by 2040.[16]

State Spotlight: New Mexico. In 2019, New Mexico Governor Lujan Grisham issued an executive order to reduce greenhouse gas emissions in the state 45 percent by 2030 as compared to 2005 levels. The order also directed the Energy, Minerals and Natural Resources Department and the Environment Department to work to increase New Mexico's renewable portfolio standards and create a Climate Change Task Force to create a strategy to address climate change for all of New Mexico[17].

EXPANDING CLEAN ENERGY FUNDING AND FINANCING. To stimulate private investment in clean energy projects (both renewables and energy efficiency), numerous states have launched innovative efforts to leverage public funds with private capital. Popular efforts include Property Assessed Clean Energy (PACE) programs and green banks.

State Spotlight: Connecticut. The Connecticut Green Bank is a quasi-public organization created as the nation's first green bank in 2011. With funding from a system benefits charge and Regional Greenhouse Gas Initiative (RGGI) auction proceeds, the bank administers a statewide PACE program and offers an array of energy efficiency and clean energy financing options - including products for low-income households. Through 2018, the bank has mobilized over $1.5 billion of investment dollars, with every dollar of public ratepayer money bringing in $6 of private capital and helping to generate over $75 million in state tax revenue.[18]

State Spotlight: Missouri. Missouri's Property Assessed Clean Energy program, enacted in 2010, allows local governments to raise money to fund renewable or efficiency projects through a voluntary special assessment on a business or homeowner's property tax bill.[19] The projects funded to date include solar panels on a Scottish Rite Temple in Kansas City and Greenworks Lending for commercial transactions.[20] At least twenty states have created PACE programs, primarily in the commercial sector.[21]

State Spotlight: New York. New York's Green Bank, established in 2013, combines funds from ratepayers and RGGI to leverage private clean energy capital. With commitments now totaling over $522 million in support of up to $1.7 billion in clean energy

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

investments, recent projects include loans to support community and residential solar.[22]

ENCOURAGING COMMUNITY SOLAR. Community solar has emerged as an affordable way for renters, homeowners and businesses to enjoy the benefits of solar power regardless of whether their building is conducive to hosting a solar array. Community solar typically refers to a solar facility shared by multiple community subscribers who receive credit on their electric bills for their share of the power produced.[23] Nineteen states have enacted policies and programs to promote community solar, with 43 states having at least one community solar project on-line.[24]

State Spotlight: Colorado. The Coyote Ridge Community Solar Farm is an initiative led by the Colorado Energy Office to demonstrate how low-income community solar can cut energy costs for utilities' highest need customers. The almost 2 MW Coyote Ridge Community Solar Farm will generate energy that will benefit low-income households, affordable housing providers and nonprofit organizations located within the service territory.[25]

State Spotlight: New Jersey. In January 2019, New Jersey's Board of Public Utilities approved at least 225 MW of community solar to be built over the next three years under a 2018 law, which will provide bill savings and power to approximately 20,000 to 30,000 homes and other customers. The program will also create local clean energy jobs and help the state meet its clean energy goals.[26]

ACCELERATING ADOPTION OF STORAGE TECHNOLOGIES. The need for continuous, real-time balancing of electricity supply with demand has defined the nature of the electricity grid to date. The emergence of cost-effective electricity storage is transforming the grid, helping to avoid excess grid infrastructure, integrating variable wind and solar resources, and enhancing grid reliability and resiliency.

The global energy storage market is growing exponentially.[27] In the U.S., energy storage revenue has grown from $58 million to $701 million over the last five years with technologies including flywheels, thermal energy storage, and advanced battery technologies.[28]

State policies that have proven successful in accelerating the adoption of storage technologies include establishing state storage targets, integrating storage into existing programs (such as RPS or clean peak standards), and incorporating storage into utility integrated resource planning and similar exercises.

State Spotlight: Arizona. Storage is emerging as an important component in Arizona's plans to modernize its grid. In February 2019, Arizona Public Service announced plans to deploy 850 MW of battery storage by 2025.[29] The utility plans to provide "solar after sunset" by coupling solar projects with battery storage, which beat new natural gas peakers in the competitive bidding process. This effort builds on the utility's 2017 success, when it installed two battery storage systems in rural Arizona to avoid rebuilding twenty miles of transmission and distribution lines.[30]

State Spotlight: California. In accordance with a 2010 California law,[31] investor-owned electric utilities in California were required to procure over 1.3 GW of energy storage by 2020. This procurement target helped establish the nation's largest commercial energy storage market. As of August 2018, the three largest utilities have already exceeded their targets based on the amount of energy storage procured or in the approval process.[32]

PROMOTING OFF-SHORE WIND RESOURCES. U.S. offshore wind has a technical resource potential of over 2,000 GWs,[33] which is one-sixth of the total existing capacity.[34] The combination of steady wind, absence of buildings or mountains, and relative proximity to the nation's largest cities, has made offshore wind an increasingly competitive clean energy resource. **Rhode Island** completed the nation's first offshore wind project in 2016. Today, there are 15 active projects off the east coast, with more under consideration in **California**, **Hawaii**, **New York** and **South Carolina.**[35]

State Spotlight: Maryland. Maryland created "offshore wind renewable energy credits" (O-RECS) as part of its 2013 Maryland Offshore Wind Act. Since then, 368 MW of offshore wind projects have been approved for development by the Maryland Public Service Commission. The projects are estimated to create 9,700 full time equivalent jobs and result in more

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

than $2 billion of economic activity, including $120 million of investments in port infrastructure and steel fabrication facilities.[36]

State Spotlight: Massachusetts. Massachusetts enacted an offshore wind legislative target of up to 1,600 MW in 2016, which they subsequently doubled to 3,200 MWs in 2018.[37] In May 2018, the utilities selected the first 800 MWs at a levelized price of 6.5 cents per kwh.[38]

ADDRESSING TRANSMISSION CONSTRAINTS AND SITING REQUIREMENTS FOR LAND-BASED WIND. Utility scale wind energy was the number one source of new U.S. electricity generation in 2018, and is expected to keep the top spot with 10.9 GWs of new capacity scheduled to come online in 2019.[39] With 2018 industry growth at 8 percent, U.S. wind power supports 114,000 American jobs, over 500 domestic factories, and more than $1 billion a year in revenue for states and communities that host wind farms.[40] Three states — Texas, Iowa, and Illinois — will host more than half the planned wind additions.[41]

Many of the nation's best land-based wind resources are located in the nation's midwest and southwest, often far from large population centers.[42] Major new transmission lines are therefore needed if the nation is to harness this resource. Such projects typically cross multiple states and federal lands, which makes the process of obtaining the environmental permits, right of ways, easements and licenses particularly challenging. The Transwest Express from **Wyoming** to **Nevada** recently received its final permit approval from Wyoming, clearing the way for construction to begin as early as 2020 and to be in operation by 2023.[43] Other major transmission proposals currently under consideration include the SSO Green Renewable Rail from **Iowa** to **Illinois** and the Grain Belt Express from **Kansas** to **Indiana**. Expediting the often decade-long transmission permitting process can significantly accelerate land-based wind development.[44]

Many states are also grappling with siting concerns from nearby residents prompted by this rapid growth. Some states have designated siting authority to state agencies, while most "home rule" states rely on local governments to manage siting.[45] Nine states, **Maine, Massachusetts, Michigan, New York, Oregon, Pennsylvania, South Dakota, Utah** and **Wisconsin**, have adopted a model state wind siting ordinance, such as requiring property line setbacks of 110-120 percent of the turbine's height, to help local officials ensure safety without hindering the industry's continued growth.[46]

ENCOURAGING DISTRIBUTED SOLAR GENERATION. With the cost of installing solar dropping 70 percent over the last decade, the solar industry continues its rapid growth.[47] Today, the U.S. solar industry includes over 242,000 employees involved in the manufacture and installation of solar power, ranging from small rooftop systems to large utility-scale solar arrays.[48]

To encourage adoption of distributed solar generation, 38 states. and 4 territories offer "net metering," which allows residential and commercial customers to sell excess solar power back to the grid.[49] In recent years, many states have considered updating their net metering policies to avoid shifting the costs of maintaining the

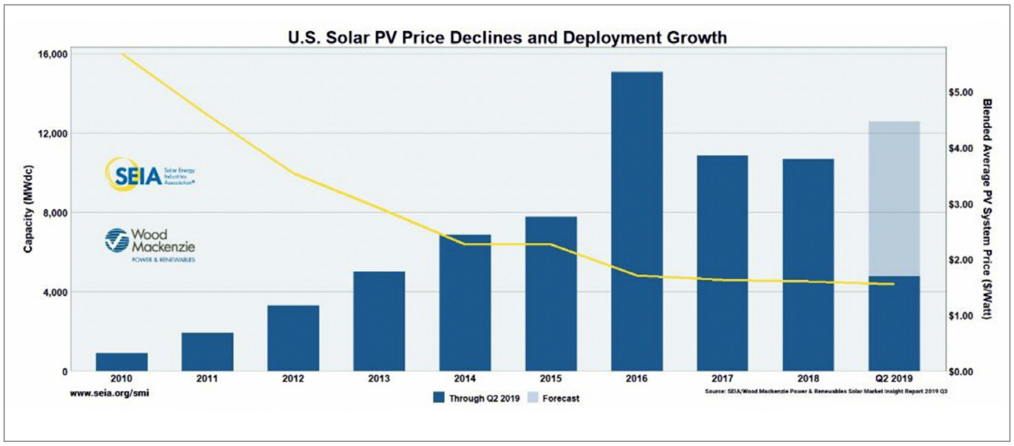

FIGURE 2: Retrieved September 18, 2019, from https://www.seia.org/solar-industry-research-data

INCREASING USE OF CLEAN ENERGY GENERATION AND DISTRIBUTED ENERGY RESOURCES

electricity grid to non-solar and other customers with distributed generation systems.[50] Some states have adopted alternative "value of solar" rates to compensate solar based on the variety of costs and benefits provided rather than paying a fixed retail rate.[51]

EXPANDING CORPORATE ACCESS TO RENEWABLES. Over 70 of the Fortune 100 corporations and almost 50 percent of Fortune 500 companies have set either clean energy or sustainability targets.[52] Yet these businesses have discovered a range of barriers that often prevent them from purchasing the type of electricity that they want. Common obstacles include prohibitions on the use of power purchase agreements, size restrictions on solar arrays, overly restrictive wind setback requirements, and, more fundamentally, a regulatory structure that requires the company to obtain its electricity from the local regulated monopoly.

To attract new business and economic development, governors are working with corporate leaders and utilities to develop creative solutions to hurdle these barriers. For example, in **Kentucky**, several utilities have proposed a "green tariff" to promote local clean energy projects and economic development.[53]

REVISITING HYDROPOWER. Hydropower remains the nation's largest generator of clean energy with 101 GWs currently operational.[54] As the nation incorporates more variable resources to the grid, emission-free hydropower can provide flexibility, given its ability to ramp up quickly and provide black start power when the grid is down.

Relicensing is a critical issue for the 325 hydropower plants whose licenses expire by 2032.[55] Although relicensing is a federal process, states should remain aware of the timeline for in-state assets. States interested in expanding hydropower can consider upgrades at existing projects, developing non-powered existing dams, new pumped storage projects and conduit hydro projects. To support existing hydropower, states could also consider including hydropower in their Renewable Portfolio Standards.

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GROWING ELECTRIFICATION OF TRANSPORTATION

Technologies and Key Policy Trends

TECHNOLOGIES.

More than 1 million electric vehicles (EVs) are currently on the roads in the United States (see Figure 1).[1] These principally battery-powered EVs and plug-in hybrid EVs run on gasoline and electricity.[2]

EVs' many benefits are making them an attractive choice for consumers. Compared with the hundreds of working parts in a traditional internal combustion engine, battery-powered EVs contain only a handful of moving parts and thus requiring less maintenance.[3] In addition, batteries respond more quickly than conventional engines, creating cars that are more responsive, have more torque and are quieter.[4] EVs produce no tailpipe emissions and, depending on the source of electricity, their fuel can be produced emissions free. EVs are typically more digitally connected than conventional vehicles[5] and have become the platform of choice for autonomous vehicle developers.[6]

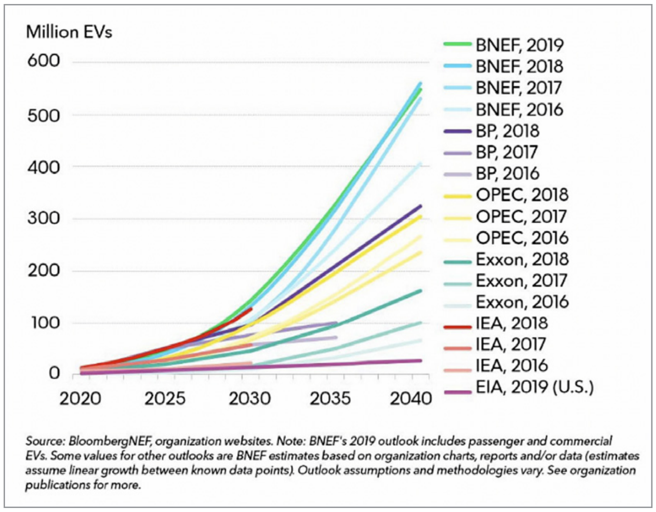

FIGURE 1: Electric vehicle outlooks, then and now

ECONOMICS.

Although still a small part of the national fleet, EV sales are increasing quickly. Predictions for the anticipated growth of U.S. EV sales vary greatly, but most forecasters (including the major oil companies) anticipate significant EV market growth and have continually revised their forecasts upward year after year.[7]

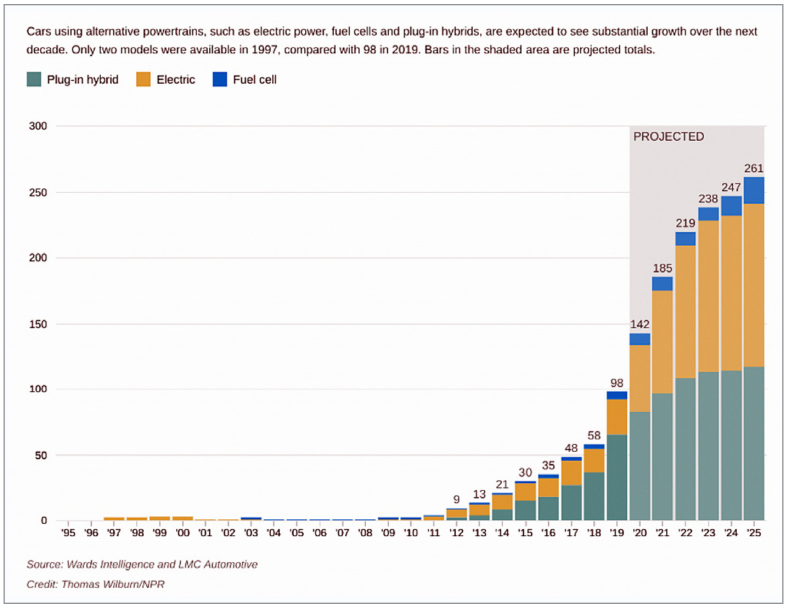

FIGURE 2: Non-gas vehicle models likely to triple by 2025

Automakers are investing heavily in EVs, with $90 billion expected to enter the mark over the next decade.[8] In addition, 43 brands are expected to offer at least one EV option in the next four years,[9] including sport utility vehicles (SUVs) and pickup trucks.[10] Approximately 261 models are projected to be available by 2025.[11]

KEY POLICY TRENDS

State support for EVs remains strong. Forty-five states offer incentives to accelerate adoption of EVs.[12] Another 14 states have established state EV adoption targets.[13] Collectively, these states aim to have more than 3.3 million EVs on the road by 2025 (see Figure 2).

GROWING ELECTRIFICATION OF TRANSPORTATION

New wave of EV models highlights need for public EV charging infrastructure. With dozens of new EV models (including SUVs and pickup trucks) reported to be in the product pipeline for debut by 2022,[14] state legislatures and utility commissions are increasingly pushing to build public EV charging stations. In addition to taking advantage of billions of dollars in settlement funds from the Volkswagen diesel emissions test cheating, many states are exploring the role of their electric utilities in building the EV charging network needed. State public utility commissions (PUCs) have already approved roughly $1 billion in utility EV infrastructure investments, with another $1.5 billion in additional utility investments already proposed.[15]

The EV industry is moving on its own to address the EV charging station infrastructure gap. Automakers are moving to build an EV charging network to support vehicle sales. Tesla, for example, has already built a proprietary network of more than 13,000 chargers in 1,500 locations for its customers.[16] Volkswagen has agreed, as part of its Clean Air Act civil settlement, to invest $2 billion in a wholly owned subsidiary, Electrify America, to build an open-access national EV charging network.[17] Most recently, General Motors (GM) announced a major effort to build fast direct current (DC) charging stations across the nation.[18]

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GROWING ELECTRIFICATION OF TRANSPORTATION

Opportunities, Challenges and State Solutions

OPPORTUNITIES. Electrifying the transportation sector offers a range of environmental, health and economic benefits. First, transportation is the largest source of U.S. anthropogenic greenhouse gas (GHG) emissions, having reached 36% in 2017.[1] Electric vehicles (EVs) produce no direct tailpipe emissions, which helps reduce urban air pollution and address GHG concerns. EVs also typically produce fewer life cycle emissions than conventional vehicles because power plants with modern pollution-control equipment are far cleaner than cars burning gasoline or diesel fuel, although the exact level of pollution benefit varies based on the local electricity mix.[2]

In addition to reduced fuel costs, EVs have significantly fewer moving parts than conventional vehicles,[3] which reduces the consumer's life cycle maintenance costs.[4] EVs may also be useful in smoothing electricity demand by encouraging refueling at times of excess generation and potentially providing power back to the grid during peak hours of demand.[5] Meanwhile, public enthusiasm for EVs continues to grow.[6]

CHALLENGES. To achieve wide-scale adoption, EVs need to overcome several challenges. First, most consumers are unfamiliar with the technology and the array of vehicle options and incentives available.[7] The high upfront costs for most EVs creates another barrier, although some experts predict that the cost of purchasing an EV will be less than a conventional vehicle by as soon as 2022 because of rapidly declining battery costs.[8] Broader EV adoption will call for widespread public EV charging infrastructure.[9] In addition, there are concerns that extensive adoption of EVs will cause stress on the existing electricity distribution infrastructure and drive the need for enhanced price signals.[10]

STATE SOLUTIONS. Governors have successfully advanced a range of state policies to accelerate adoption of EVs:

- ***Offer "cash on the hood" rebates.*** Provide incentives to offset the upfront costs of EVs at the time of purchse.
- ***Use electric utilities to bridge the EV infrastructure gap.*** Create partnerships with publicly regulated, investor-owned utilities to use ratepayer funds to build EV charging stations across the utility's service territories.
- ***Invest Volkswagen's settlement funds in EV charging stations.*** States can use the funds they received from the settlement of the Volkswagen diesel emissions test cheating to build EV charging infrastructure.
- ***Provide financial incentives for EV supply equipment.*** Offer incentives to defray the costs of installing EV supply equipment for residential, commercial and retail service stations.
- ***Offer incentives beyond rebates.*** Create innovative incentives such as high-occupancy vehicle (HOV) lane permits, special parking privileges, exempting EVs from emissions testing, offering discounts on tolls and reduced rates for charging.
- ***Use the state vehicle fleet to lead by example.*** Establish state government fleet requirements, acquisition goals or preferences for the procurement of EVs.
- ***Establish zero emission vehicle (ZEV) mandates.*** Require automakers to offer for sale a specific number of EVs in the state.
- ***Incorporate transportation electrification into state and utility planning.*** Create interagency work groups and integrate growing EV adoption rates into other, ongoing planning activities, such as utility integrated resource plans or congestion mitigation and air quality planning processes. Utilities can also consider offering separate rates for EVs to encourage optimal charging, including time-of-use rates or special nighttime pricing.
- ***Update energy building codes to require EV-ready buildings and homes.*** Incorporate into the state's energy building code a requirement to include a percentage of EV supply equipment or EV-ready parking spaces in all new construction.

GROWING ELECTRIFICATION OF TRANSPORTATION

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GROWING ELECTRIFICATION OF TRANSPORTATION

State Solutions Spotlights

Governors have successfully advanced a range of state policies to accelerate adoption of electric vehicles (EVs):[1]

- Offer "cash on the hood" rebates.
- Use electric utilities to bridge the EV infrastructure gap.
- Invest funds from the Volkswagen diesel settlement in EV charging stations.
- Provide financial incentives for EV supply equipment.
- Offer incentives beyond rebates.
- Use the state vehicle fleet to lead by example.
- Establish zero emission vehicle (ZEV) mandates.
- Incorporate transportation electrification into state and utility planning.
- Update energy building codes to require EV-ready buildings and homes.

Offer "cash on the hood" rebates. With Tesla and General Motors (GM) already having reached the 200,000-vehicle limit for the federal EV tax credit,[2] state incentives have become even more important (see Figure 3). Thirteen states — **California, Connecticut, Colorado, Delaware, Louisiana, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Texas** and **Washington —** offer their own rebates or tax incentives for the purchase of a new EV.[3] Washington has also created a rebate for the purchase of a used EV that retails for less than $30,000.[4]

Ranging from $1,500 to $5,000, these "on the hood" incentives, that provide more immediate incentives than tax credits, have proven extremely effective. Revealingly, jurisdictions — including **Georgia** — that have removed or let sunset their EV tax incentives have experienced sales drops of more than 50%.[5]

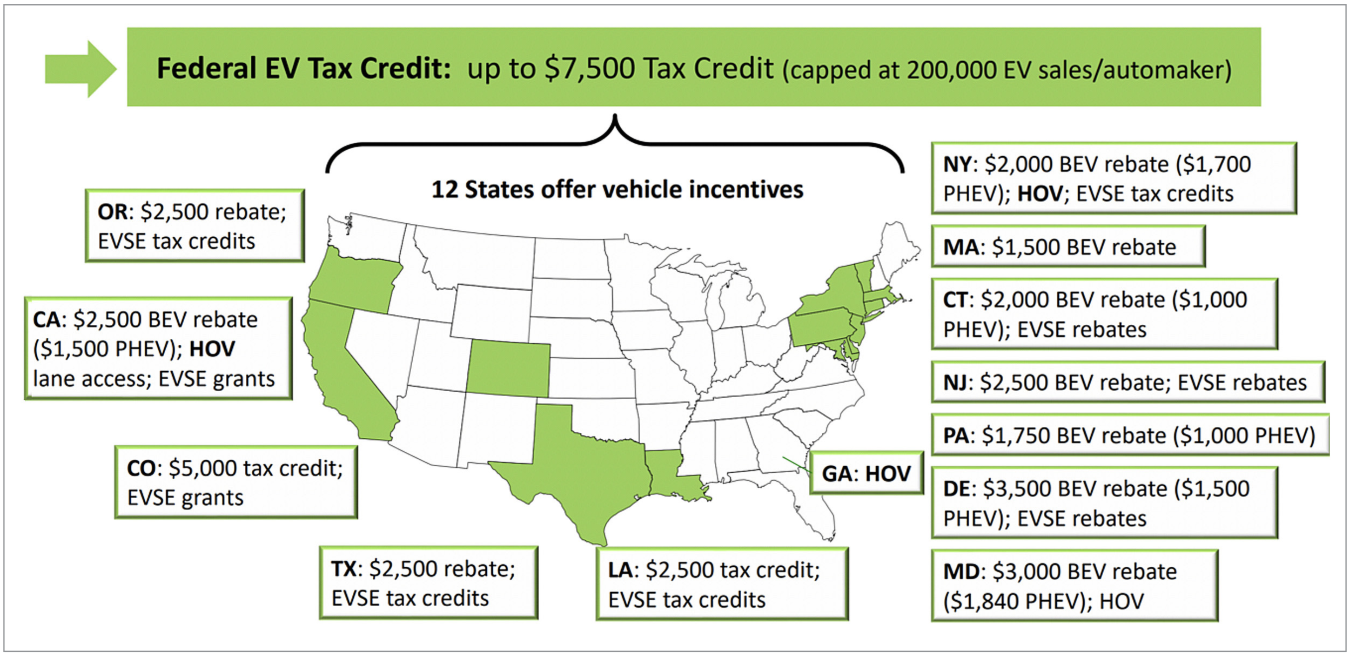

Figure 3: Key federal and state electric vehicle incentives (monetary and nonmonetary)

Source: Britta Gross, director of GM's Advanced Vehicle Commercialization Policy, presentation at the National Governors Association's North/Central Regional Transportation Electrification Workshop, Apr. 29, 2019.[6]

GROWING ELECTRIFICATION OF TRANSPORTATION

USE ELECTRIC UTILITIES TO BRIDGE THE EV INFRASTRUCTURE GAP. Residential EV drivers do 80% of their EV charging at home,[7] but broader EV adoption will necessitate widespread public EV charging infrastructure. Some estimate that EV charging infrastructure deployment must grow by 20% annually to meet a projection of 3 million EVs on the road by 2025.[8]

To prepare for this growing demand, states are exploring how best to use their publicly regulated, investor-owned utilities to build the needed EV charging network. Several states, including California, Oregon and **New Mexico**, have recently enacted laws requiring their public utility commissions (PUC) to review utility EV infrastructure programs.[9] State PUCs have already approved roughly $1 billion in utility EV infrastructure investments, and utilities have already proposed another $1.5 billion in additional investments.[10] Consider the following state spotlights:

State spotlight: Maryland. To achieve Maryland's goal of having 60,000 ZEVs on the road by 2020 and 300,000 ZEVs on the road by 2025,[11] the Maryland Commission approved a utility proposal in 2019 to use ratepayer funds to install 5,000 EV charging stations.[12] The five-year pilot program will include residential, workplace and public charging. The commission required time-of-use rates to encourage off-peak usage and the creation of a separate rate class for the 900 public charging stations to ensure that those users cover the costs of the stations. The other stations, to be built on private property, will not be utility owned.

State spotlight: Michigan. With 14,000 EVs already on **Michigan**'s roads, the Michigan Public Service Commission (MPSC) recently approved its first utility EV infrastructure project: Consumers Energy's PowerMIDrive.[13] The initiative includes rebates of up to $5,000 to encourage third parties to install up to 200 Level 2 chargers and incentives of up to $70,000 for 24 DC fast chargers. The effort includes off-peak and super-off-peak pricing to avoid contributing to peak demand.

State spotlight: New York. Gov. Andrew Cuomo's Charge NY 2.0 initiative set a goal of installing at least 10,000 EV charging stations by the end of 2021.[14] To meet this goal, the New York Public Service Commission has requested utility proposals for DC fast charging as well as residential charging.[15] The commission is exploring rates that would encourage EV charging at off-peak hours or mitigate renewable energy curtailment.

INVEST FUNDS FROM THE VOLKSWAGEN DIESEL SETTLEMENT IN EV CHARGING STATIONS. As a result of Volkswagen's diesel emissions test cheating, the company agreed to pay U.S. states almost $3 billion to reduce air pollution, of which 15%, or about $450 million, can be used for EV charging infrastructure.[16] Consider the following state spotlights:

State spotlight: Colorado. The Colorado Energy Office launched Charge Ahead Colorado, using its Volkswagen settlement money in addition to funds from the Federal Highway Administration's Congestion Mitigation Air Quality program and state dollars.[17] Prioritizing workplace and multifamily locations, the program provides rebates of up to 80% to local governments, school districts, state agencies, nonprofits organizations, apartment/condominium complexes and private businesses. The state also awarded a third-party EV charging company, ChargePoint, more than $10 million to build a network of 33 DC fast chargers across the state.

State spotlight: Virginia. **Virginia** was one of the first states to commit to using the full 15% of its Volkswagen settlement funds on EV charging infrastructure. In autumn 2018, the commonwealth entered into a public-private partnership with a third-party EV charging company, EVgo, to spend its $14 million settlement on a public network of DC fast chargers and Level 2 chargers.[18]

PROVIDE FINANCIAL INCENTIVES FOR EV SUPPLY EQUIPMENT. Twenty-seven states offer incentives to defray the costs of installing EV supply equipment for residential, commercial and retail service stations.[19] The price of a Level 2 residential charger ranges from $500 to $2,000 for the charger and professional electrical installation.[20] Program details vary; for example, Oregon is offering $300 customer rebates and **Utah**'s Rocky Mountain Power utility is offering up to 75% off of equipment costs.[21]

GROWING ELECTRIFICATION OF TRANSPORTATION

OFFER INCENTIVES BEYOND REBATES. States are using a creative range of incentives beyond rebates to accelerate EV adoption. Thirteen states allow EVs to use HOV lanes or provide special parking privileges.[22] A different set of 14 states exempt hybrid or electric cars from emissions testing.[23] Other incentives include discounts on tolls and reduced rates for charging.

USE THE STATE VEHICLE FLEET TO LEAD BY EXAMPLE. State governments own approximately 500,000 vehicles, which cost more than $2.5 billion annually to operate and maintain.[24] With fewer moving parts than gasoline-powered engines and less expensive fuel costs, EVs are an attractive option for state fleets.

To date, 28 states have EV or hybrid fleet requirements, acquisition goals or preferences for the procurement of EV or hybrid vehicles.[25] California has established a process to ensure that, through normal fleet replacement, at least 50% of light-duty vehicles are ZEVs by 2025.[26] Colorado aims to purchase at least 200 EVs for the state fleet by 2020, whereas **Illinois** has a goal of 15% EVs by 2025.[27] Washington Gov. Jay Inslee issued a 2018 executive order that requires state agencies to prioritize the purchase or lease of EVs.[28]

ESTABLISH ZEV MANDATES. ZEVs include full battery EVs, hydrogen fuel cell vehicles and plug-in hybrid-electric vehicles. California established its first ZEV regulation in 1990 to require automakers to offer for sale specific numbers of EVs to continue selling cars in the state.[29] Nine states — Connecticut, **Maine**, Maryland, Massachusetts, New Jersey, New York, Oregon, **Rhode Island** and **Vermont** have adopted California's ZEV mandate.[30] Together with California, these states represent nearly 30% of new car sales in the United States.[31] Consider the following state spotlights:

State spotlight: California. California aims to be carbon neutral by 2045, so the state has established a goal of 1.5 million ZEVs on the road by 2025, growing to 5 million by 2030.[32] California's ZEV mandate requires that auto manufacturers produce a set number of ZEV and plug-in hybrid vehicles each year based on the total number of vehicles each manufacturer sells. The percentage grows from 7% in 2019 to 22% in 2025. Nine other states have adopted the California ZEV regulations.

State spotlight: Colorado. Gov. Jared Polis issued an executive order in January 2019 creating a state agency to develop and propose a ZEV program to the Colorado Air Quality Control Commission,[33] which has since voted unanimously to consider the ZEV proposal in August 2019.[34]

INCORPORATE TRANSPORTATION ELECTRIFICATION INTO STATE AND UTILITY PLANNING. The impacts of nascent electrification on transportation ripple across state governments, including transportation agencies, PUCs, environment departments and energy offices. Many governors have created interagency work groups to help identify and navigate the opportunities and challenges.[35]

In addition, states are learning to integrate growing EV adoption into other ongoing planning activities. For example, utility integrated resource plans are increasingly considering the impact of EVs on overall resource adequacy and distribution system planning. Similarly, state environmental agencies are calculating the reduced emissions in their congestion mitigation and air quality planning processes.

UPDATE ENERGY BUILDING CODES TO REQUIRE EV-READY BUILDINGS AND HOMES. One way to reduce the cost of installing the EV charging infrastructure needed is to incorporate it into ongoing construction activities. For example, Oregon Gov. Kate Brown issued a 2017 executive order that, among other things, required parking structures for all newly constructed residential and commercial buildings to support the installation of at least a Level 2 charger by Oct. 1, 2022.[36] Similarly, in Vermont, commercial and residential projects over a certain size are required under the state's energy building code to include a percentage of EV supply equipment or EV-ready parking spaces.[37]

GROWING ELECTRIFICATION OF TRANSPORTATION

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ADDRESSING CYBER AND PHYSICAL THREATS

Technologies and Key Policy Trends

TECHNOLOGIES AND THREATS OVERVIEW.

Cyberthreats have emerged as a major concern and have been growing rapidly over the past decade. Between 2010 and 2016, the number of incidents reported to the U.S. Department of Homeland Security Industrial Control Systems Cyber Emergency Response Team increased sixfold.[1] In 2016, the energy sector was the third most targeted industry, accounting for 20% of reported incidents.[2] The consequences of a cyberattack on the electricity system could be serious: disrupting power or fuel supplies, damaging specialized equipment and jeopardizing public welfare. Traditional generation and transmission that use internet-connected supervisory control and data acquisition systems (SCADAs) can be vulnerable to attack. Clean energy technology can also be vulnerable, given that many of those technologies are also internet connected or supported by internet-connected devices.[3,4]

Cyberattacks on U.S. energy infrastructure have had limited consequences so far because they have mainly targeted personal information rather than operating units,[5,6,7] but there have been significant cyberattacks globally. The most notable cyberattacks occurred in Ukraine in 2015 and 2016. In 2015, cyberattackers manipulated circuit breakers across multiple distribution operators to cause a 3.5-hour power outage for 225,000 people. In 2016, malicious hackers created and deployed modular malware specifically targeting industrial control systems and were able to take 200 megawatts (MW) offline.

The United States has thus far avoided cyberattacks of consequence, but major incidents of concern have occurred. In 2017, several nuclear power generation sites experienced cyberintrusions.[8] These intrusions did not extend beyond the business systems, did not affect power delivery or cause safety concerns, but targeting of U.S. nuclear power plants is cause for concern. In March 2019, a cyberattack in the Western Interconnection temporarily eliminated visibility into SCADAs. The affected utilities were able to maintain adequate electricity supply, but the attack did interrupt internal operations[9] and represented the first successful attack on U.S. grid operations.

New threats continue to emerge. According to statements made by the Director of National Intelligence during the Worldwide Threat Assessment to Congress in 2019, malicious actors and nation-states have the ability to disrupt U.S. electric and gas distribution systems "with the goal of being able to cause substantial damage."[10]

In addition, physical threats caused by nature have always been a concern for governors and the energy sector alike. Potential earthquakes along major fault lines like the San Andreas in **California**, Cascadia in the Pacific Northwest and New Madrid in the Midwest, have posed longstanding dangers, alongside hurricanes, heavy snow and other storms, wildfires and floods. These threats are in addition to longstanding grid incidents involving animals and drivers, vandalism and physical attacks on grid infrastructure by bad actors.

In the past decade, natural threats have grown more intense. The overall number of hurricanes has remained the same, but the storms have increased in intensity and caused record-breaking levels of damage.[11] Rising sea surface temperatures cause increased wind speeds during storms, and rising sea levels amplify storm surges. The 2017 hurricane season resulted in a historic $282 billion in damages.[12] Similarly, wildfires have increased in frequency and duration. In fact, 61% of all fires ever recorded in the West have occurred since 2000, and the number of fires that burn more than 100,000 acres has climbed steadily in the past 20 years.[13] The frequency of flooding is also expected to increase. A Federal Emergency Management Agency report on the National Flood Insurance Program estimated that U.S. floodplains will grow by 45% by the end of the century.[14] At the same time, deaths attributed to flooding have risen. Over the past 30 years, flooding had killed on average 86 people annually. In the past 10 years, this average increased to 95, and there were more than 100 deaths each year in 2015, 2016 and 2017.[15]

ADDRESSING CYBER AND PHYSICAL THREATS

On the bad actors front, in 2013, Pacific Gas and Electric's Metcalf transmission substation was attacked by snipers, causing an estimated $15 million in damages.[16] Although limited in scope, that incident highlighted the vulnerabilities of the system and led to increased calls for securing substations and making them less accessible to the public.

KEY POLICY TRENDS

Establishment of the U.S. Department of Energy (DOE) Office of Cybersecurity, Energy Security, and Emergency Response (CESER). DOE established CESER in 2018 to elevate the importance of cybersecurity issues in the energy industry. The office focuses on increasing emergency preparedness and coordinated response to disruptions to the energy sector, including physical incursions and cyberattacks, natural disasters and human-made events.[17] The office works closely with states to share information and provide support during emergencies; provide technical assistance and research; and host emergency exercises, trainings and workshops.

Growth and development of energy industry information sharing and analysis centers (ISACs). The energy industry is represented by three ISACs; the Electricity ISAC, the Oil and Natural Gas ISAC and the Downstream Natural Gas ISAC. Each ISAC has been growing in membership, building trust within the industry and increasing information sharing.

Increased importance of cybersecurity in energy industry subsector coordinating councils. Energy industry coordinating councils have also increased their focus on cybersecurity. The industry is represented by two main councils: the Electricity Subsector Coordinating Council and the Oil and Natural Gas Subsector Coordinating Council. These councils have established cybersecurity work groups or initiatives to address industry cybersecurity concerns. Governors and states are represented through the Energy Sector Government Coordinating Council, which often meets jointly with the industry councils.

Establishment of state resilience officers. As the intensity of storms increases and the amount of damages paid out balloons, states have increased their efforts to enhance resilience. They are designating officers to consider resilience across multiple functions. Governors in **Colorado, Florida, New Jersey, North Carolina, Oregon** and **Virginia** have all either designated a resilience officer or created a statewide resilience office.

Updating energy assurance plans with resilience in mind. States are also revising and updating their energy assurance plans with resilience measures to counter the growing intensity of storms and increased damage. This work has taken the form of altering planning protocols to include resilience metrics, institutionalizing existing relationships between state agencies and the private sector, improving communication among state agencies and with the federal government, addressing fuel assurance issues and investigating how microgrids and combined heat and power could help increase resilience.[18] New Jersey, **Hawaii** and **Michigan** have begun working on a petroleum "annex" to their energy assurance plans to better plan for petroleum supply issues during and after emergencies.[19] Colorado created a resilience framework to "assess current risks, plans and practices, and to build resiliency into policies, actions and investments across multiple sectors."[20] The framework is intended to help communities better understand the stresses they face and create a plan to prepare for them appropriately. Oregon created an energy resilience guidebook for consumer-owned utilities intended to help local these utilities better prepare for emergencies, prioritize investments and understand their role in emergencies relative to the state and federal government.[21]

Increased deployment of distributed generation and distributed energy resources to enhance resiliency. Currently, 29 states have a renewable portfolio standard; three states have a clean energy standard and 10 other states have renewable or clean energy goals.[22] These standards and goals have led to increased deployment of distributed generation and distributed energy resources alongside utility-scale resources. Together, such resources can provide grid services during a physical or cyberincident and mitigate future outages by providing fuel diversity and self-generation.

ADDRESSING CYBER AND PHYSICAL THREATS

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ADDRESSING CYBER AND PHYSICAL THREATS

Opportunities, Challenges and State Solutions

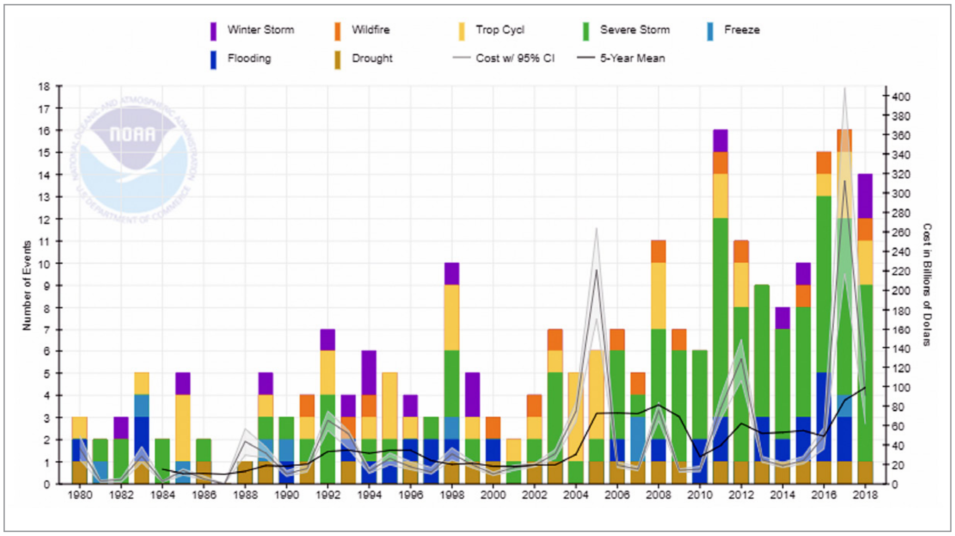

Figure 1: Consumer Price Index-adjusted billion-dollar disaster types by year

OPPORTUNITIES. Clean energy and the technologies that accompany it, such as battery storage, present unique opportunities to increase resiliency and address the rising number of cyber and physical attacks. In the event that a storm or cyberattack takes a large-scale power generator offline, distributed generation in the community could be used to provide power to critical customers in the interim or help provide "black start" services (i.e., when a generator starts from a total or partial shutdown). Distributed energy resources can also be used in microgrids to enable communities or critical assets to operate apart from the larger grid during emergencies caused by cyber or physical events.

Smart and digitally connected grid technologies have been critical enablers of clean energy expansion. Everything from smart meters to new sensors to home monitoring systems make it easier to effectively integrate and optimize the use of clean energy. These elements can also be helpful in the event of a storm or cyberattack that disrupts grid operations (see Figure 1). Increased awareness and visibility from sensors and smart meters could facilitate dynamic system reconfiguration to route around comprised assets. Smart building and home energy management systems could be used for demand response to reduce the burden on the energy system during an incident, making recovery easier and faster.

CHALLENGES. Clean energy technologies present many opportunities to increase resiliency, but they also introduce vulnerabilities. Much clean energy technology is integrated with or enabled by smart technology. Most smart technology used to enable clean energy technology is internet connected. Every new connection to the internet presents a new access point for malicious hackers to infiltrate.

In addition to the internet connectivity issue, smart technology presents supply chain risks. Most smart devices are sourced and manufactured all over the world. It is often difficult to know where each component of a device originated. If the firmware or hardware in the device is compromised during manufacturing, it could make the device more vulnerable when deployed in the field. Threat actors may use this approach to gain access to energy infrastructure around the world.

The variable nature of some clean energy generation can also be a challenge if inverter technology becomes compromised. Inverters are used to convert direct current output of a clean resource into utility frequency alternating current output — a critical step in ensuring that grid frequency does not fluctuate outside the feasible range. When grid frequency deviates from its set range, it can cause grid outages. If an inverter is compromised and the current conversion is altered, those fluctuations in current can lead to outages.

Compromised electric vehicles (EVs) and EV infrastructure can also create grid reliability problems. The introduction

ADDRESSING CYBER AND PHYSICAL THREATS

or removal of one EV and its charging demands from the electric grid is usually not a concern. However, if a network of EVs or charging infrastructure were to become compromised, that network could be used as a vector to spread malware throughout a system, transferring malware to chargers or buildings every time an EV charges. If a network of charging stations were compromised, the sudden introduction or removal of many charging EVs could cause wide power deviations, prompting a grid outage.

STATE SOLUTIONS. Governors are supporting a variety of policies to counter rising cyber and physical threats. State solutions include the following:

- ***Coordinate preparedness and planning efforts.*** Coordinating and planning state emergency efforts with the electricity sector are critical. Incorporating cybersecurity into those planning and preparedness efforts and identifying how new generation and distributed technologies can support those efforts are vital to addressing this threat.
- ***Establish cybersecurity governance bodies focused on energy industry issues.*** Governors use these bodies to accomplish a variety of goals, the most common of which are to assess the current cybersecurity preparedness level of the industry, establish roles and responsibilities, and monitor and improve cybersecurity preparedness.
- ***Protect sensitive information, including classified threat information and critical energy infrastructure information, to encourage private sector information sharing.*** Threat information sharing among public and private actors is critical to threat detection, preparation and response. Governors may need to create additional protections or consider how to securely store and exempt sensitive electricity system data from public inquiry.
- ***Collaborate with utility regulators to enhance their cybersecurity oversight.*** Public utility commissions (PUCs) are key to improving state utility cybersecurity postures through their oversight of parts of the electric utility industry, ability to authorize cost recovery for investments and their roles during restoration and response activities. Governors can support grid cybersecurity by directing or encouraging PUCs to examine the adoption and deployment of new technologies or processes by regulated utilities; they can also direct regulated entities to conduct cybersecurity assessments and audits to better understand their cybersecurity posture.
- ***Participate in cyberexercises.*** Exercises that simulate cyberattacks can help governments and utilities practice coordinated responses, identify gaps or misalignments in plans, strengthen communication channels and address areas for improvement.
- ***Assess resiliency capabilities and gaps.*** Governors can support cross-agency collaboration to examine the status of resiliency in their state, assess gaps and prioritize action steps.
- ***Encourage the growth of microgrids and energy storage.*** Increasing the deployment of microgrids and energy storage can increase energy system resilience during or after a cyber or physical attack (see Figure 2). These technologies can be used to support critical assets such as hospitals and emergency shelters to ensure continuity of critical, life-saving functions.

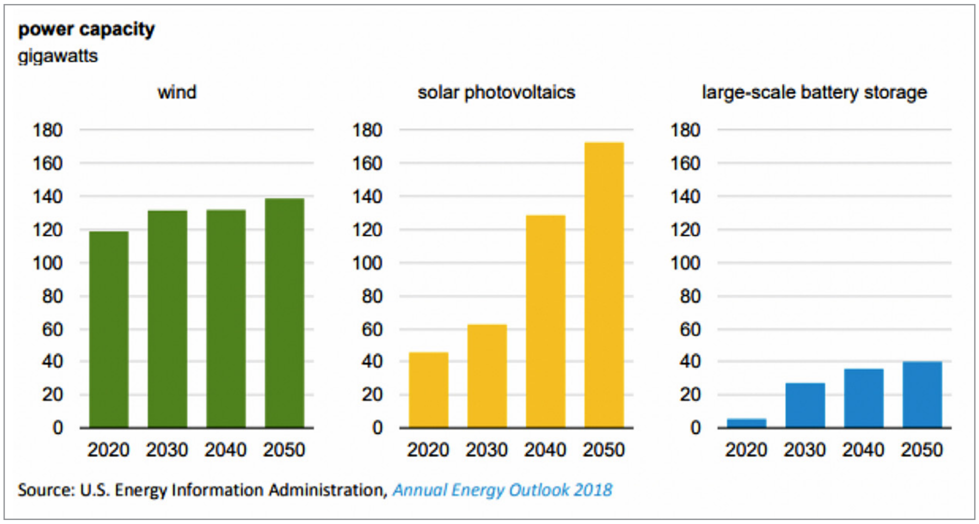

Figure 2: U.S. large-scale wind, solar and battery storage capacity projections, 2020-2050

ADDRESSING CYBER AND PHYSICAL THREATS

State Solutions Spotlights

Governors have supported a range of state actions to counter growing cyber and physical threats:

- Coordinate preparedness and planning efforts.
- Establish cybersecurity governance bodies focused on energy industry issues.
- Protect sensitive information to encourage private sector information sharing.
- Collaborate with utility regulators to enhance their cybersecurity oversight.
- Participate in cyber exercises.
- Assess resiliency capabilities and gaps.
- Encourage the growth of microgrids and energy storage.

COORDINATE PREPAREDNESS AND PLANNING EFFORTS. All states conduct energy preparedness and planning efforts through their state energy assurance plans, generally created under the leadership of state energy offices. These plans are often coordinated with the electricity sector to ensure smooth operations during emergencies. As the threat of physical and cyberattacks rise, states should begin to incorporate a resilience mindset and cyberdisruption planning into their energy assurance plans. States will want to define roles and responsibilities, establish communication guidelines and coordinate response efforts to ensure that they are prepared for a cyberincident. Consider the following state spotlights:

State spotlight: Oregon. Oregon developed a comprehensive state energy assurance plan that coordinates nine state agencies and various federal and private partners to restore electricity, fuel and natural gas in the event of an emergency. In this plan, responsibilities are clearly delineated; for instance, designating the Oregon PUC as the lead agency during electrical system disruptions.[1] Additional support agencies are enlisted as the risks and consequences increase. The Oregon PUC and the Office of Emergency Management are the primary agencies responsible for cybersecurity planning, preparedness, response and recovery from breaches.

State spotlight: Montana. **Montana** incorporated planning for cyberthreats into its latest energy assurance plan, whereby responsibility for responding to cyberthreats is led by the utilities, with oversight and support from state and federal agencies.[2] In addition, the Montana Department of Justice operates the Montana All Threat Intelligence Center to facilitate cyber communication and threat response organization.[3]

State spotlight: Oklahoma. **Oklahoma**'s state energy assurance plan describes private sector cybersecurity plans, activities and resources. Cybersecurity responsibilities are delineated, with a discussion of response and communication strategies during and after a cyberevent.[4]

ESTABLISH CYBERSECURITY GOVERNANCE BODIES FOCUSED ON ENERGY INDUSTRY ISSUES. Cybersecurity governance bodies take many forms, but their overall mission is to identify cyberthreats facing the state and develop solutions to mitigate those threats. As of 2017, 22 state cybersecurity governance bodies were in existence.[5] Some of those bodies established committees specifically to study critical infrastructure or the energy industry. In some cases, governance bodies have been established exclusively to study and develop solutions for cybersecurity in the energy industry. These bodies can be critical to supporting the industry and addressing growing cyberthreats. Consider the following state spotlights:

State spotlight: Texas. **Texas** enacted a pair of bills to strengthen the state's electric grid security. Senate Bill (S.B.) 475 establishes the Texas Electric Grid Security Council to "facilitate the creation, aggregation, coordination, and dissemination of best security practices for the electric industry." The three-member council has the ability to create and disseminate grid security best practices, revise the state emergency plan to ensure coordinated restoration efforts and prepare for grid-related security threats.[6] S.B. 936 creates a cybersecurity monitor program through the PUC. The

ADDRESSING CYBER AND PHYSICAL THREATS

monitor manages a comprehensive cybersecurity outreach program, gathers and disseminates best practices for electricity cybersecurity, reviews utility voluntary cybersecurity self-assessments and reports to the PUC about electrical utility industry cybersecurity preparedness level. The bill also directs the PUC to allow the recovery of reasonable and necessary costs related to findings/activities of the cybersecurity monitor.[7]

State spotlight: Vermont. In 2017, Gov. Phil Scott issued an executive order that created a 10-member Governor's Cybersecurity Advisory Team to provide advice on the state's cybersecurity readiness, strategy and planning with members from the public and private sectors.[8] The cross-disciplinary team is charged with developing a strategic plan and enhancing the relationships and lines of communication across federal, state and local governments and with the private sector. The focus of this group is cybersecurity broadly, with members including state information technology and homeland security leads alongside other state officials and academic experts. Underscoring the criticality of cybersecurity in the electricity sector, Gov. Scott also appointed the chief executive officer of the **Vermont** Electric Power Company to serve as an advisor.[9]

PROTECT SENSITIVE INFORMATION, INCLUDING CLASSIFIED THREAT INFORMATION AND CRITICAL ENERGY INFRASTRUCTURE INFORMATION, TO ENCOURAGE PRIVATE SECTOR INFORMATION SHARING. The federal government enacted the Cybersecurity Information Sharing Act (CISA) in 2015 to make it easier for private companies to share cyberthreat information with the federal government. CISA also introduced protections to exempt that information from being disclosed in response to a Freedom of Information Act request. Many states have similar laws to protect cyberthreat information and critical energy infrastructure information from being subject to disclosure. The National Governors Association issued a paper detailing how state laws and court rules have been protecting critical energy infrastructure information against public disclosure.[10] These protections help encourage private companies to share critical information with states and the federal government. Consider the following state spotlights:

State spotlight: Idaho. **Idaho**'s cybersecurity exemption covers records held by any public agency that are "related to proposed or existing critical infrastructure" if disclosure "is reasonably likely to jeopardize the safety of persons, property or the public safety."[11] For purposes of this exemption, "critical infrastructure" means any system, "whether physical or virtual," and including electrical, computer or telecommunications systems, whose disruption "would have a debilitating impact" on economic security, public health or safety or any combination of those matters.[12]

State spotlight: Louisiana. **Louisiana** enacted a state version of the federal CISA law in 2019.[13] The Louisiana law also addressed a gray area involving legal counsel and disclosure. S.B. 46 states, "sharing a cyberthreat indicator or defensive measure information does not constitute a waiver of any applicable privilege or protection provided in the Louisiana Code of Evidence."[14]

COLLABORATE WITH UTILITY REGULATORS TO ENHANCE THEIR CYBERSECURITY OVERSIGHT. PUCs are key to improving energy cybersecurity through their oversight of parts of the electrical utility industry, their ability to authorize cost recovery for investments and their roles during restoration and response activities. States can support grid cybersecurity by directing or encouraging PUCs to examine the adoption and deployment of new technologies or processes by regulated utilities and to direct regulated entities to conduct cybersecurity assessments and audits to better understand their cybersecurity efforts. Consider the following state spotlights:

State Spotlight: Connecticut. In 2013, then-Gov. Dannel Malloy signed the Compressive Energy Strategy, which directed the Public Utilities Regulatory Authority (PURA) to conduct a "cyber review" to assess the state's electric, natural gas and water utilities' cyber capabilities and recommend actions to strengthen deterrence.[15] Following the review, PURA held technical meetings with utilities to review how they manage cyber risk. Through voluntary standards and guidelines, the industry adopted utility-wide cyber updates and procedures to improve expertise and help identify vulnerabilities.[16]

ADDRESSING CYBER AND PHYSICAL THREATS

State spotlight: New Jersey. In 2011, the New Jersey Board of Public Utilities (BPU) passed an order requiring regulated utilities to report all cyberincidents involving their industrial control systems.[17] In 2016, the BPU built on that order by issuing a new order requiring regulated utilities to safeguard their computer systems, to join and share information with the New Jersey Cybersecurity and Communications Integration Cell and to implement BPU's Cyber Security Program.[18]

PARTICIPATE IN CYBER EXERCISES. Exercises simulating cyberattacks can help government and utilities practice coordinated responses, identify gaps or misalignments in plans, strengthen communication channels and address areas for improvement.[19] They can be an efficient way to test security and response with limited resources.[20] Some utilities conduct internal cyber exercises or partner with other organizations, including academia, technology companies, vendors and other utilities, to identify vulnerabilities and response strategies where results can be reported to state regulators.[21] Other exercises test coordination more broadly across industry, federal, state, local and international entities. One well-recognized cross-sector exercise, GridEx, convenes thousands of industry and government participants over multiple days every two years to test the electricity sector's ability to respond to cyber and physical attacks.[22] Consider the following state spotlights:

State spotlight: New York. In 2014, New York put on the State Critical Infrastructure Cybersecurity Exercise. The exercise tested incident response capabilities through a mock cyberattack on critical infrastructure that affected energy delivery systems. There were 120 participants from 13 utilities; industry organizations; and federal, state, local and tribal governments.[23]

Assess resiliency capabilities and gaps. Governors play a critical role in helping enhance resiliency in the wake of increasing physical threats: to withstand disasters better, respond and recover more quickly and excel under new conditions. Given the interdependency of the energy sector, such efforts, even if specific to electricity delivery only, call for a cross-agency effort to assess current capabilities and gaps. The National Governors Association has created the State Resiliency Assessment and Planning Tool (SRAP Tool) as the first-ever tool for state policy makers that uses a self-assessment rating scale encompassing a series of 41 questions across five categories. The tool is currently being revised based on feedback from states and is due to be released in Spring 2020. Governors can explore the use of that that tool or similar assessments.[24]

ENCOURAGE THE GROWTH OF MICROGRIDS AND ENERGY STORAGE. Microgrids and energy storage can increase resiliency during and after a cyberattack or a weather-related incident by giving communities the ability to provide their own power if electrical service is disabled. Many states are pursuing energy storage targets and deploying microgrids to increase overall system resiliency. Various approaches exist for implementing these targets. California established an energy storage target through legislation. **Connecticut** and **Massachusetts** are encouraging the growth of microgrids through grant programs. Other states, including Connecticut, Massachusetts, New Jersey and **New York**, are changing regulatory statues and using public-private partnerships to encourage and finance "public purpose" microgrids. Consider the following state spotlights:

State spotlight: California. In 2010, California enacted the first energy storage mandate in the United States.[25] The legislation required the three largest investor-owned utilities to deploy 1,325 MW of energy storage capacity by 2020. The state extended that target in 2016, requiring the utilities to procure an additional 500 MW of storage, bringing the total to 1,825 MW of energy storage.

State spotlight: Massachusetts. In 2014, the Massachusetts Department of Public Utilities issued an order requiring public utilities to develop a 10-year grid modernization program. In response, the Massachusetts Clean Energy Center (MassCEC), a state economic development agency, began offering a Community Microgrids Program to "catalyze the development of community microgrids… to lower customer energy costs, reduce greenhouse gas emissions, and provide increased energy resilience."[26] In 2018, MassCEC awarded $1.4 million in funding for feasibility studies for 14 projects located across the state.[27]

ADDRESSING CYBER AND PHYSICAL THREATS

State spotlight: Puerto Rico. Following the devastation of Hurricane Maria, **Puerto Rico** has been considering increased deployment of microgrids to increase resiliency and improve electricity service. The Comisión de Energía de Puerto Rico (Puerto Rico Energy Bureau) passed a new set of rules in 2018 to "promote and encourage the growth of microgrid systems" in Puerto Rico.[28] The new rules establish the legal and regulatory frameworks for microgrid operation on the island. The rules clarify three important directives: 1) Define classes of microgrids, 2) specify the types of generation that can be deployed and 3) clarify the role of utilities and municipalities.

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