National Governors Association

ADVANCED GRID TECHNOLOGIES

Governor Leadership To Spur Innovation And Adoption

January 2025

EXECUTIVE SUMMARY

Electric power grids in the United States are in a period of rapid transformation, driven by a confluence of factors such as an increase in electricity demand, retirement of certain baseload power generation, an increase in distributed generation, lengthy interconnection queues and new "grid-edge" technologies being brought online.[1] Layered into this evolution are new state and national decarbonization objectives, heightened awareness of the magnitude and frequency of threats that could compromise reliable power delivery, and unprecedented federal investment through legislation like the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA).[2] With these transformative trends in process, Governors are eager to support deployment of technology solutions to facilitate their policy objectives and meet increased loads – and doing so while maintaining or even improving grid reliability, resilience and affordability.

This paper is part of a series published by the National Governors Association (NGA) to identify actions Governors can take to guide their states and territories through intentional and effective power sector transformations. While other papers explore regulatory structures, regional markets and power transmission, this paper provides a deeper dive into actions Governors can take to modernize the grid through the deployment of grid technologies. While careful planning, stakeholder engagement and robust technical analysis is needed to optimize technology investment, an understanding of the range of technologies currently available can help Governors determine how best to initiate or improve those processes in their states and territories.

[1] Distributed energy resources (DERs) are sited close to customers and can provide all or some of their electric power needs or can be used by the utility or regional grid operator to reduce demand (such as improve energy efficiency or shift load to different times) or supply energy, capacity, and ancillary service needs of the grid. The resources are small in scale and typically connected to the distribution system. Examples of DER types are solar photovoltaic (PV), wind, combined heat and power (CHP), energy storage, demand response (DR), electric vehicles (EVs), microgrids, and energy efficiency (EE).
[2] For more information on federal funding opportunities for grid modernization through the IRA and IIJA, please see the Appendix.

Often a combination of technologies will best allow states and grid operators to meet their objectives. While by no means exhaustive, this paper will focus on several of the grid modernizing technologies that are commercially available and being deployed:

Advanced Transmission Technologies:

- Grid Enhancing Technologies
  - Dynamic Line Ratings
  - Ambient Adjusted Line Ratings
  - Topology Optimization Software
  - Power Flow Controllers
- High Performance Conductors
  - Carbon/Composite Core Conductors
  - Superconductors

Distributed Generation Systems to Enhance Grid Resilience:

- Virtual Power Plants
- Microgrids Coupling On-site Generation and Storage

Utility-to-User Technologies:

- Smart Meters
- Advanced Metering Infrastructure (AMI)
- Digital Communication Networks
- Bidirectional and Managed Vehicle Charging

Energy Storage Systems

- Grid Scale Storage
- Behind-the-meter Storage

Underpinning modernization of the electric grid are regulatory structures and robust planning processes that work to meet specific objectives, such as resilience, reliability, affordability or decarbonization. Strengthening these structures and approaching grid modernization from a comprehensive planning perspective will create an environment for sustained innovation within the electrical sector.

Governors' strategies to guide the deployment of grid modernizing technologies addressed in this paper include:

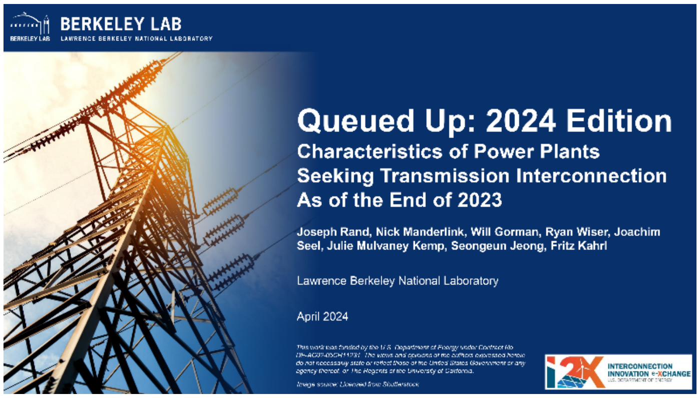
1. **Setting and pursuing** clear energy policy goals and priorities:
    a. Establishing clear energy policy and grid modernization goals
    b. Initiating processes to develop or update state energy plans
    c. Championing policies, programs or legislation that support grid modernization
    d. Pursuing federal funding opportunities for grid modernization
    e. Including grid modernization policies and programs in Governors' Budget Requests
2. **Convening key stakeholders** to examine, test and identify needs for grid modernization technologies:
    a. Appointing or convening interagency working groups on grid modernization and technology adoption
    b. Directing state agencies to assess the role and deployment of technologies in state and regional planning processes
    c. Directing or requiring the testing or piloting of grid modernizing technologies to consider larger-scale deployment
    d. Encouraging updated threat-based risk assessments and electricity demand forecasting models to help inform decision making in energy planning
3. **Participating in** regional and inter-regional grid modernization efforts.
4. **Ensuring state public utility commissioners have** the staffing and technical resources necessary to appropriately consider grid technologies as needed and engage in regional transmission planning.

WHY MODERNIZE THE GRID?

The electrical grid of the United States supports all aspects of the economy, as well as the safety of all Americans. From powering homes, schools and businesses to critical infrastructure and industries, the safe, reliable and affordable flow of electricity is essential to modern life. The electric grids have evolved from a loosely connected set of systems to a vast network of interconnected infrastructure serving hundreds of millions of customers. The electrical grid is undergoing a robust transformation, driven by (1) an increase in demand for electricity, (2) economic and technical viability of more diverse sources of energy generation, (3) the growth of distributed energy resources (DERs) and (4) states' clean energy or decarbonization policy goals or requirements. According to 2023 filings with the Federal Energy Regulatory Commission, the cumulative forecast of annual electricity load growth over the next five years has increased from 2.6% to 4.7%, with some experts cautioning that these forecasts may be underestimating actual load growth. This transformation, coupled with aging energy infrastructure; an increase in physical, natural, and cyber threats to the grid; and other constraints, has driven the need for grid modernization.

Much of the energy infrastructure across the United States is aging and in need of maintenance. For example, 70 percent of transmission infrastructure is over 25 years old. In some cases, grid components are far past their 50-year life expectancies. In addition, the increasing frequency and severity of extreme weather storms continue to stress the energy system. There have been significant investments made by utilities, the federal government, and state, local, territorial and tribal governments to improve the reliability and resilience of the electrical grid. However, there is still work to be done to prepare the current electrical grid to meet the energy needs of the future.

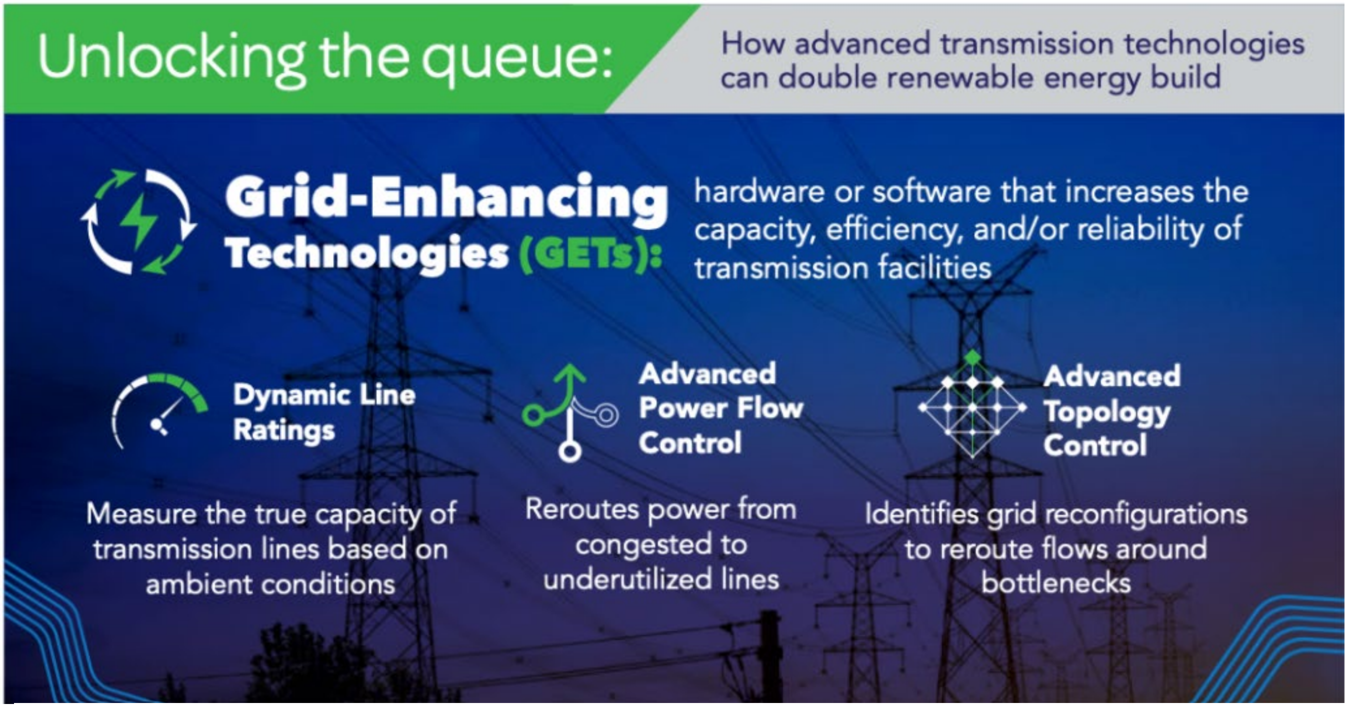
A recent study published by Lawrence Berkeley National Laboratory finds that over 10,000 projects with the capacity to generate 2,000 gigawatts are awaiting interconnection to the electrical grid at the bulk-power system level. The National Renewable Energy Laboratory estimates that the U.S. will need to double or triple transmission delivery capacity to accommodate the growth of renewable and distributed energy generation as well as the electrification of transportation and industrial sectors.



To modernize the electrical grids, policymakers, regulators and utilities will need to engage in thoughtful assessments and planning processes to evaluate what policy interventions, technology deployments and infrastructure buildouts are necessary to address the specific needs of their states, territories or jurisdictions.

Modernizing electrical grids can include robust buildouts of energy infrastructure, such as building new or replacing and retrofitting existing transmission lines and distribution systems. Building new lines and expanding existing transmission infrastructure can increase grid capacity, power system reliability and energy affordability, but embarking on large-scale projects can be difficult, costly and take many years to implement. Investments in grid modernization technologies can improve affordability, resilience and reliability through increasing line capacity, managing demand and load, and allowing for microgrid systems to operate during grid failures. Often with lower investment costs, the benefits of technology deployments can be realized on a much shorter timescale and complement larger scale investments. A 2021 study published by the Brattle Group and WATT Coalition found that the implementation of grid-enhancing technologies could lead to $5 billion in yearly energy production cost savings, double the amount of renewable energy sources added to the grid without large-scale transmission expansions, and reduce carbon emissions by 90 million tons. Similarly, a 2023 study published by the Rocky Mountain Institute found that the deployment of grid-enhancing technologies in the PJM footprint, a regional transmission operator serving thirteen states and the District of Columbia, could yield approximately $1 billion annually in production cost savings across the region by enabling the interconnection of 6.6 gigawatts of new, low-cost renewable energy generation on the grid.

Careful planning, stakeholder engagement and technical analysis is ultimately needed to optimize technology investment. An understanding of the range of technologies currently available can help Governors determine how best to initiate those processes in their states and territories.



Graphic courtesy of the WATT Coalition

REASONS FOR PURSUING GRID MODERNIZATION

Maintaining and Improving Grid Stability

As generation facilities and the grid continue to age, threats to the grid become more prevalent, and increased demand exacerbates transmission carrying capacities. Maintaining the reliability of energy systems is becoming a greater challenge for states and territories. A resilient grid results in fewer outages, faster service restoration after an emergency, and more efficient load management. Strategic planning and assessment of electricity needs, including advanced grid technologies and other resilience strategies, can inform which technologies and investments will best address state policy goals. Thoughtful investments in decentralized energy resources and microgrids have the potential to remove strain from existing grids and allow reprioritization of other transmission and distribution needs, for example.

Meeting Increased Electricity Demands and Protecting Ratepayers

In recent years, more frequent and severe extreme weather, rising manufacturing and data center energy demand, economic growth and transportation and building electrification have had a significant impact on electricity needs. With demand projected to increase in the future, the deployment of modern technologies can help the grid become more efficient and effectively meet demand by: (1) delivering power to end-use customers more efficiently, (2) managing demand more effectively with lower-cost supply, (3) collecting and utilizing customer data to facilitate reductions in energy consumption during high-demand, high-cost periods, and (4) requiring less investment in grid operations and maintenance.

Decarbonization and Reduced Emissions

States and territories continue to look for ways to reduce the emissions and environmental impact of electricity generation by improving efficiency, reducing consumption and utilizing cleaner forms of energy generation. Many Governors have adopted broad emission reduction goals for the coming decades. As of November 2024, twenty-three states and the District of Columbia had adopted some form of decarbonization target, many of which were initiated by executive action or signed into law by Governors. Core to these solutions is the deployment of low-carbon, carbon-free and carbon neutral generation sources, including wind, solar and nuclear energy among others. Often, the lowest-cost renewable resources may not be located in close proximity to power demand and load centers, thus added transmission capacity is needed. A modernized power grid can more efficiently transmit power to where it is needed, increasing power line carrying capacity and facilitating power-sector emissions reductions.

Market Evolution: Economic Development and Job Creation

The passage of the federal Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) created many federal incentives for grid modernization, including technology deployment. By taking advantage of these opportunities, Governors can build their state's economy and create jobs that support grid modernization. Similarly, private industry within the energy sector is also utilizing state and federal incentives to produce innovative technologies to meet the demands for grid modernization. This has led to the commercial deployment of cost-effective and advanced grid technologies. Grid modernization supports economic development through direct job creation and by enabling the new power generation needed to support economic activity in related sectors, such as manufacturing. Additionally, ensuring reliable and affordable electricity is available to meet the electricity needs of facilities that bring economic opportunities, such as large manufacturing sites and data centers, can be facilitated through grid technology deployment.

Investment in and Deployment of Distributed Energy Resources

Increasingly, consumer demand is driving the incorporation of distributed energy resources (DERs), behind-the-meter resources such as rooftop solar, residential energy storage systems and electric vehicles into the fabric of U.S. electric systems and communities across the country. DER deployment can contribute to Governors' efficiency, affordability and emissions-reductions goals. Grids are evolving to improve integration and utilization of DERs; enable intelligent, flexible, efficient and secure distribution systems; and automate grid balancing across significantly more electricity resources, both supply and demand. Grid modernizing technologies can help integrate DERs into the broader electrical grid and use the growing pool of DERs for grid services that strengthen the broader system.

GRID MODERNIZATION TECHNOLOGY OVERVIEW

Advanced technologies are being integrated into electricity grids to supply energy closer to loads, maximize energy delivery capacity, and increase the effectiveness, reliability and efficiency of the energy system. These technologies can also facilitate the efficient integration of higher levels of DERs, including distributed generation (e.g., rooftop solar, fuel-based generators); storage (e.g., EV batteries, power walls); demand response; flexible demand (e.g., EV chargers, heat pumps); and more.

This paper focuses on common, commercially ready technologies that modernize electric grids and identifies steps Governors can take to ensure the effective deployment of these technologies to maximize the grid. This list is by no means exhaustive, and this paper does not seek to encourage the adoption of any specific technology or endorse specific policies. The mix of technologies and policies will be determined by the needs of the grid, policy context in the state, and other factors.

Advanced Transmission Technologies:

Grid-Enhancing Technologies

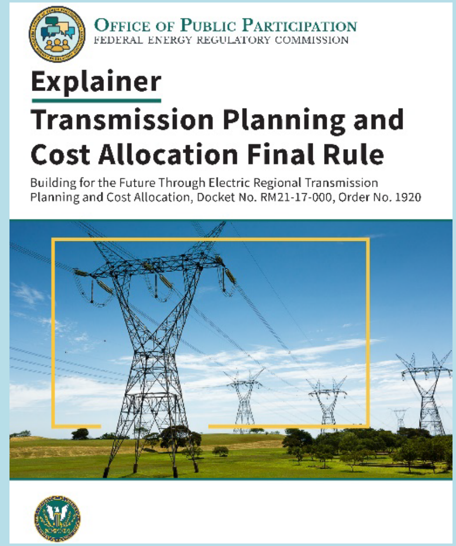
- Currently, transmission lines predominantly use static ratings that rely on a set of conservative weather measurements, such as low wind speed, high solar radiation, and high temperature, to predetermine a fixed level of line carrying capacity. Dynamic line ratings (DLRs) can calculate the real-time capacity of transmission lines, which can be limited by the heat of the line. Adjusting the line ratings in real time allows for more efficient use of the lines as compared to traditional lines, which can understate capacity. DLRs use real-time monitoring to optimize energy flow by identifying when, for example, wind speeds produce greater cooling of the line and allow for more power flow. In addition to increasing transmission capacity, DLR technologies can provide additional grid visibility that can reduce line overloads and improve planning processes.

- Ambient adjusted line ratings (AARs) use line-specific data that reflect forecasted hourly changes in ambient air temperature data and day-to-night shifts in solar heating, but do not monitor changes in real time or consider solar radiation, wind, cloud cover, or other important factors impacting the transmission line's capacity. As a result, AARs do not provide the same level of benefits as DLRs. AAR data allows for additional flexibility over static line ratings, though it is primarily a predictive technology. The Federal Energy Regulatory Commission (FERC) Orders 881 and 881a, issued in 2021, will require transmission operators to adopt AARs for transmission lines by July 2025.
- Advanced grid modeling and software algorithms like topology optimization use software to analyze the flow of power through the grid, allowing for reconfigurations to reduce congestion. Studies on the deployment of topology optimization across several electricity markets, including PJM, MISO, SPP, and ERCOT, found reduced congestion costs between 25% to 50%.
- Advanced power flow controllers (AFPC) use software to control or direct the flow of electricity across the transmission system to balance energy between overloaded and underused lines.

High-Performance Conductors

- Carbon/Composite Core Conductors, also referred to as Advanced Conductors or High-Temperature Low-Sag Conductors, are overhead, bare conductors that use a trapezoid-shaped wire of annealed aluminum to carry electrical current and have a carbon or composite core for support. Carbon and composite core conductors have three key advantages over traditional conductors: (1) they can double the capacity of existing transmission lines, (2) they are around 30% more efficient, and (3) they have about 50% less sag. A report published by Energy Innovation and GridLab found that widespread reconductoring of transmission lines with advanced conductors could rapidly increase transmission capacity and save $85 billion in energy system costs by 2035.
- Superconductors are a type of high-performance conductor that uses a class of metallic compounds that exhibit negligible resistance when cooled using liquid nitrogen. This allows for very low losses in energy and high power-flow capabilities. High-temperature superconductors have four key advantages over traditional conductors: (1) they create a five-fold increase in capacity for alternating current and tenfold increase for direct current, (2) they have no thermal sag and can be deployed underground, (3) they are at least 50% more energy efficient than traditional conductors, and (4) they can transfer high capacity at lower voltages, avoiding substation build and costs.

In 2024, the Federal Energy Regulatory Commission (FERC) issued a final rule FERC Order 1920, updated in November 2024 under Order 1920-A, which makes significant changes to transmission planning and cost allocation. In addition to increasing the role of states in transmission planning and cost allocation, Order 1920 includes a requirement for transmission providers to consider alternative transmission technologies, including dynamic line ratings, advanced power flow controllers, and advanced conductors. In long-term and regional transmission plans, transmission owners are required to consider deployment of these technologies.



Distributed Energy Generation and Systems:

- Virtual Power Plants (VPPs) are aggregations of DERs that can balance electricity demand and supply, as well as provide utility-scale grid services. VPPs can include electric vehicles and their chargers, smart appliances (such as thermostats, water heaters, and HVAC systems), battery storage, and solar arrays, all of which can be operated, charged, and/or discharged flexibly at opportune times to reduce demand during peak hours and utilize energy during hours with excess renewable and/or lower-cost power. This supports reliable and affordable grid operation. The deployment of VPPs turns the growing pool of DERs into an opportunity for utilities and grid operators to meet future load growth and maintain system stability.
- A microgrid is a single entity composed of interconnected DERs and customer end-uses that can connect and disconnect from the broader energy grid to operate as ‘islands’ when there is a disruption in service on the centralized grid. Microgrids can be adapted to grow as deployments of distributed resources are added, can more efficiently manage localized load to reduce energy losses, and can potentially provide demand-side flexibility to the grid. Microgrids can be used for both residential and large-scale commercial and industrial applications.
- Distributed Energy Management Systems (DERMS) can be deployed to optimize the management and control of distributed energy assets. This is accomplished by enabling critical capabilities such as monitoring, estimating current and future state DERs, and modeling real-time and forecasted activity.

Utility-to-User Technologies:

- Smart meters are electronic meters with two-way digital communication capabilities that transmit user data between a customer and utility. This allows for enhanced services such as demand response and outage monitoring. As of 2022, approximately 72 percent of meters in use in the United States were “smart,” and smart meter penetration is expected to rise to 90 percent by 2030. Advanced metering infrastructure (AMI) is an integrated system of smart meters, communications systems, and meter-data management systems that collect user data in real-time and provide two-way communication between the customer's meter and the utility. AMI systems allow for enhanced customer control and allow utilities to offer incentives for demand reduction programs, such as time-of-use rates. Utilities across the United States are deploying AMI systems.

- Digital communication networks overlay traditional electric power infrastructure and can deliver data in addition to electricity. These networks allow utilities or regional grid operators to receive and act on data in near real-time and allow assets across the grid to communicate with one another and respond to changes in demand, supply, and congestion more seamlessly.
- Bidirectional electric vehicle charging, also referred to vehicle-to-grid (V2G), allows energy to flow both ways between the electric vehicle and the grid. Where available, customers can participate in voluntary programs that provide financial incentives which, during times of peak demand, use smart grid technologies to charge a vehicle battery when demand on the grid is lower and can discharge a portion of the vehicle's battery to flow back to the grid during times of peak demand.

Energy Storage Systems:

- Energy storage systems can be used to provide energy during times of need and store energy during times of abundance. There are many types of energy storage systems—including pumped-hydroelectric, batteries, thermal systems, compressed-air, and more—that can be deployed at small scale or utility scale. Storage systems can be utilized to balance supply and demand to manage reliability and affordability. Storage can also be sited within the transmission and distribution system, where it can improve the capabilities of the grid.

Discussion

It is important to recognize that these technologies should be considered holistically and deployed strategically. By making informed, deliberate decisions, policymakers, utilities and regional grid operators can leverage the right combination of technologies to meet state policy goals. Before deploying grid modernization technologies, it is important to assess the current state of grid infrastructure and how the technologies being considered can be deployed into the existing electricity system. Grid technologies will advance the reliability, affordability, and emissions-reductions goals of grid modernization only if they are able to work effectively within the energy system. To achieve this, states can consider a holistic approach to energy system planning.

States and territories can holistically model the needs of the grid and impacts of these technologies through integrated transmission and distribution system planning. This process aligns the state energy planning process with the planning processes of utilities and other energy stakeholders and includes customers as a resource alongside grid resources.[3] In addition, as regional and national energy interdependencies continue to grow, Governors can take a leading role in initiating or improving multi-state and regional planning paradigms to address grid modernization, transmission expansion and energy resilience.

Similarly, high-tech innovations can often be paired with more traditional, low-tech and low-cost solutions to achieve optimal results, such as utility resilience programs that pair distribution automation with system hardening and vegetation management to improve reliability or grid-enhancing technology deployment considered alongside transmission expansion. Regardless of the approach, Governors can make key decisions that will affect how technologies are deployed.

GUBERNATORIAL LEADERSHIP IN GRID MODERNIZATION

The decision to pursue new technologies to modernize electricity grids should evaluate the trade-offs of different approaches. Grid modernization has many benefits, but the deployment of these technologies can also bring costs and risks, including potential financial impacts on ratepayers (which may be balanced against longer term cost savings), cybersecurity vulnerabilities and concerns of technological development outpacing deployment. Careful study and informed decision making on the part of policymakers and the private sector is necessary to maximize benefits, mitigate risks and manage costs associated with grid modernization. There are many actions Governors can take to encourage or require the deployment of grid modernization technologies. These actions can be broken down into four categories: 1) Setting and pursuing energy policy and grid modernization goals; 2) Convening stakeholders to study and consider grid technologies; 3) Participating in regional or multistate grid modernization efforts; and 4) Working with and providing necessary resources to utility regulators.

1. Setting and pursuing energy policy and grid modernization goals

These goals can establish a Governor's broad energy policy vision and instigate policy actions that will lead to grid modernization. For instance, Governors can:

a. Establish far-reaching energy policy and grid modernization goals.

i. Many Governors have set ambitious energy policy goals like achieving net-zero emissions by 2050, decarbonizing or electrifying certain sectors by 2035 and more. Longer-term, forward-looking policy goals can spur action. Achieving these goals will require significant investments in the electrical grid to improve efficiency, enable the integration of renewable energy generation and manage growing electrical loads. By instituting broad goals, Governors can encourage grid modernization and the adoption of advanced grid technologies to achieve these goals.

[3] For more information on Integrated Distribution System Planning, including an interactive decision framework, see: https://emp.lbl.gov/projects/integrated-distribution-system-planning

ii. In 2018, **New Jersey** Governor Phil Murphy issued an executive order establishing a goal for New Jersey to reach 100 percent clean energy consumption by 2050. This order motivated significant policy action in the state, including a major report on grid modernization and technology deployments, which was published in 2022. In 2023, Governor Murphy issued an executive order accelerating the state's goal of 100 percent clean energy consumption from 2050 up to 2035. the state's goal of 100 percent clean energy consumption from 2050 up to 2035.

iii. In 2019, **New Mexico** Governor Michelle Lujan Grisham issued an executive order setting a goal for a 45 percent reduction in greenhouse gas emissions by 2030, and created the New Mexico Interagency Climate Change Task Force that developed a multi-agency, statewide strategy to meet the goal. to meet the goal.

b. Initiate or Update State Energy Planning processes.

i. Governors can direct state agencies to assess the role of grid technologies through state planning processes, such as comprehensive state energy planning and state energy security plans. State energy plans assess energy supply and demand, examine existing energy policies, and identify opportunities for improvements to the energy system in the state.

ii. In February 2023, **Alaska** Governor Mike Dunleavy issued an administrative order establishing the Alaska Energy Security Task Force which will update the statewide energy plan to address energy affordability and reliability while incorporating innovation.

iii. Former **North Carolina** Governor Roy Cooper issued an executive order on broad clean energy and climate-related policies that led to the creation of the Climate Risk Assessment and Resilience Plan, which calls for grid modernization utilizing diverse methods including advanced grid technologies.

iv. In July 2023, **South Carolina** Governor Henry McMaster issued an executive order initiating an update to the state energy plan. The executive order creates the PowerSC Energy Resources and Economic Development Interagency Working Group comprised of key state government stakeholders. In addition to updating the state energy plan, PowerSC will evaluate energy efficiency measures such as state building codes.

v. The National Governors Association and the National Association of State Energy Officials (NASEO) conducted a webinar series on comprehensive state energy planning in 2024, which can be viewed here. NASEO also maintains a database of current state energy plans, which can be found here.

c. **Champion new state policies, legislation, or programs.**

i. Governors have many direct powers to facilitate the deployment of grid modernization technologies but are also able to utilize their soft powers to advance grid modernization. Governors can utilize their position as the leader of their state or territory to advance the deployment of grid technologies by voicing support for legislation, fiscal policies and programs that facilitate modernization of the grid.

ii. In the last two years, several Governors have signed legislation directing utilities to consider the use of advanced grid technologies in long-term planning. **Virginia** Governor Glenn Youngkin signed legislation in 2024 that would require utilities to complete a comprehensive assessment of the potential use of grid-enhancing technologies and advanced conductors within integrated resource plans. Similarly, **California** Governor Gavin Newsom and **Minnesota** Governor Tim Walz signed legislation in 2024 to require utilities operating in those states to consider advanced transmission technologies in transmission planning. In 2023, **Montana** Governor Greg Gianforte signed legislation that would allow the Public Service Commission to approve incentives for the deployment of advanced conductors.

iii. In 2024, **Massachusetts** Governor Maura Healey signed legislation that included several provisions promoting the meaningful consideration of advanced transmission technologies, including: (A) requiring the Massachusetts Energy Facilities Siting Board to determine whether sufficient consideration was given to the use of advanced transmission technologies when reviewing proposals for new transmission infrastructure of significant modifications to existing infrastructure; (B) directing utilities, as part of capital improvement or rate base proceedings, to conduct analysis related to the deployment of advanced transmission technologies, advanced conductors, grid-enhancing technologies and energy storage and allowing utilities to propose rate incentives to encourage the deployment of such technologies; (C) mandating that utilities make a filing with the legislature and grid operator every five years on the deployment of advanced transmission technologies; and (D) requiring the state's public utility commission study the use, costs and benefits, and impediments to advanced transmission technology deployment.

iv. In April 2023, **Vermont** Governor Phil Scott attended the groundbreaking for the construction of Vermont's first all-electric neighborhood that will be powered by DERs and a virtual power plant.

d. Pursue federal funding opportunities for grid modernization.

i. The passage of the federal IIJA and the IRA have created robust funding streams through which states and territories can support the deployment of grid modernization technologies. States and territories have the opportunity to apply for and receive significant funding and financing from the federal government to make major investments to modernize the electric grid. Governors and their policy advisors can work with state agencies, utility commissioners and the private sector to pursue federal funding opportunities to fully fund or supplement public and private investments in grid technologies.

ii. Beginning in 2022, and available through 2026, states and territories can utilize federal funding, such as the 40101(d) formula grant program and the competitive Grid Resilience and Innovation Partnerships (GRIP) program from the IIJA, to fund grant programs for grid modernization for smaller, less-resourced utilities, such as rural electric co-ops and municipal utilities. So far, U.S. DOE has announced two rounds of GRIP awards, funding $5.7 billion to projects in 48 states for investments in grid resilience including the deployment of battery storage, microgrids, advanced conductors, advanced power flow controllers, dynamic line ratings and more.

e. Include grid modernization policies in Governors' Budget Requests.

i. State and territory budgeting processes vary greatly, but generally involve the submission of a Governor's budget request or proposal to the legislature in which the Governors lays out their fiscal priorities. Through these budget requests, Governors demonstrate their priorities and have significant sway over state funding for programs. By including specific funding allocations or incentives for grid modernization projects or programs, Governors can encourage the deployment of grid modernization technologies.

ii. **Colorado** Governor Jared Polis included tax incentives for the deployment of DERs such as geothermal energy and green hydrogen, along with projects that reduce industry and transportation emissions in the 2023-2024 fiscal year budget request. A Governor could consider a similar approach to create incentives for grid modernization projects.

iii. **New Mexico** Governor Michelle Lujan Grisham's executive budget recommendation for State Fiscal Year 2026 includes $1 million for grid modernization grant program funding and $2 million to fund a state-specific quadrennial energy review/transition plan.

iv. Providing regulatory oversight and program implementation for a more complex grid requires more resources and personnel. Governors can encourage state legislators to empower state regulators and energy offices by directing funding for more staff resources to public utility commissions and energy offices.

2. **Convening stakeholders to study and consider grid technologies by:**
    a. **Appointing or convening agencies or working groups to explore technology adoption.**
        i. In 2023, **Massachusetts** Governor Maura Healey convened a Clean Energy Transmission Working Group composed of public and private sector representatives across multiple industries. The Working Group developed a report that examined advanced transmission technologies and recommended supporting mechanisms to optimize the use of the electric grid. Following this report, the Massachusetts Executive Office of Energy and Environmental Affairs hosted two public forums focused on accelerating the deployment of innovative transmission technologies across New England.
        ii. In October 2019, **Michigan** Governor Gretchen Whitmer launched the MI Power Grid in consultation with the Michigan Public Service Commission (PSC). From 2019 to 2023, MI Power Grid was an initiative to study, guide, and make policy decisions on Michigan's transition to clean energy and a modernized grid. Over 350 stakeholders participated in 70 meetings that led to 70 PSC orders in 16 case dockets that expanded non-wires alternatives in Michigan. This included the deployment of microgrids, battery storage, electric vehicle infrastructure, digital controls and optimization tools.
        iii. In 2023, **Oklahoma** Governor Kevin Stitt convened a Task Force on Emerging Technologies to study and make recommendations on artificial intelligence, related technologies, and the impact of such technologies on public and private sectors. The Task Force studied the impact of AI-enabled technologies for energy systems, noting the ability for these modernizing technologies to increase efficiency, reduce consumer costs and improve system resilience.
    b. **Directing state agencies to assess the role and deployment of technologies in state and regional planning processes.**
        i. In 2023, **California** Governor Gavin Newsom signed bill SB49 into law directing the State Energy Resources Conservation and Development Commission and Public Utilities Commission to evaluate the use of state-owned highway rights-of-way for solar energy, battery storage, and transmission infrastructure. This designation reaffirms the Governor's support for grid modernization and DERs while reducing barriers to DER deployment and transmission expansion through the use of state-owned land.
        ii. In 2023, **Maine** Governor Janet Mills signed LD 952, An Act to Create a 21st Century Electric Grid. This law requires the Governor's Energy Office to hire a third-party consultant to study how a distribution system operator would improve and modernize the electric system in Maine, with particular focus on increasing reliability, deploying grid-enhancing technologies and reducing consumer costs.

iii. In May 2020, **New Mexico** Governor Michelle Lujan Grisham signed the Energy Grid Modernization Roadmap (HB 233) into law, directing the Energy, Minerals, and Natural Resources Department to develop a strategic plan for grid modernization as well as establish grant funding for projects deploying grid modernization technologies. This led to the convening of a Grid Modernization Advisory Group that developed grid modernization principles and recommendations, including the endorsement of utility deployment of advanced metering infrastructure and energy storage.

c. **Requesting agencies and utilities to test and pilot new technologies to consider larger scale deployment.**

i. In October 2019, **California** Governor Gavin Newsom signed a bill into law directing the California Public Utilities Commission to authorize and pilot electric vehicle-grid-integration (VGI). Following the passage of the law, Pacific Gas & Electric, a large investor-owned utility operating in California, initiated several VGI pilot programs.

ii. In 2021, the **Connecticut** Public Utilities Regulatory Authority issued the Equitable Modern Grid Framework, which included the Innovative Technology Applications and Programs Innovation Pilots. This framework supports the development and deployment of innovative grid technologies through a "sandbox" concept, allowing utilities to test, learn and scale successful deployments more quickly.

iii. In May 2024, **Maryland** Governor Wes Moore signed legislation directing the regulated utilities operating within the state to establish plans or develop pilot programs for vehicle-to-grid electric vehicle charging and virtual power plant networks and submit these plans to the Public Service Commission by July 1, 2025.

iv. In 2022, **Virginia** Governor Glenn Youngkin announced the Energy Technology Testbed DELTA Lab in southwest Virginia. Built to meet the objectives in Virginia's 2022 State Energy Plan, the Testbed will allow for the testing and piloting of a variety of distributed energy generation projects, including solar, hydrogen, geothermal, small modular nuclear reactors, pumped hydro and battery storage.

d. **Encouraging the consideration of updated risk assessments and electricity demand forecasts to help inform decision making in energy planning.**

i. As electricity demand rises and Governors seek to modernize electrical grids, the implementation of advanced grid modeling with multiple electricity demand growth scenarios and forecasting techniques and updated risk assessments will aid in the decision-making and planning processes, including the consideration of grid modernization technology deployments.

ii. In April 2024, the U.S. Department of Energy Office of Cybersecurity, Energy Security, and Emergency Response published the report "Risk

Assessment Essentials for State Energy Security Plans," which provides an overview of different approaches to developing infrastructure risk assessments, a requirement to complete annual State Energy Security Plans. In addition to identifying key risks to energy infrastructure and cross-sector interdependencies, risk assessments, grid modeling, and advanced forecasting are useful tools when planning for grid modernization.

3. **Participating in regional or multistate grid modernization efforts:**

As the leaders of their state or territory, Governors have a unique opportunity to collaborate with their peers to forge interstate and regional partnerships. Electrical grids span borders and interconnects the nation. Working across state lines allows for coordination in planning and can lead to benefits for all states involved. For instance, Governors can collaborate on:

a. **Regional or multistate collaboration on improvements to interstate transmission and the deployment of advanced transmission technologies.**

i. In 2024, a multi-state group of **Arizona**, **Idaho**, **Oregon**, **Utah** and **Wyoming** received funding from the U.S. Department of Energy for project Reliable Electric Lines: Infrastructure Expansion Framework (RELIEF). This project will improve the interstate transmission system through the deployment of advanced high-temperature, low-sag conductor cables, increasing transmission capacity in the region.

ii. In 2023, the Governors of **Connecticut**, **Maine**, **Massachusetts**, **New Hampshire**, **Rhode Island** and **Vermont** announced a multi-state transmission collaboration to optimize the acquisition of federal funding for transmission infrastructure and prepare the regional system for an increase in DERs like wind and solar energy generation.

iii. In 2023, **Connecticut**, **Maine**, **Massachusetts**, **New Hampshire**, **New Jersey**, **New York**, **Rhode Island** and **Vermont** requested the U.S. Department of Energy form a first-of-its-kind, multi-state partnership on interregional transmission. In 2024, ten states—**Connecticut**, **Delaware**, **Maine**, **Maryland**, **Massachusetts**, **New Hampshire**, **New Jersey**, **New York**, **Rhode Island** and **Vermont**—entered into a memorandum of understanding to formalize the bipartisan Northeast States Collaborative on Interregional Transmission to explore mutually beneficial transmission opportunities across three planning regions (New England ISO (ISO-NE); New York ISO (NYISO); PJM).

iv. In May 2024, 21 states joined the Federal-State Modern Grid Deployment Initiative, a public-private mobilization effort to upgrade over 100,000 miles of existing transmission lines. **Arizona**, **California**, **Colorado**, **Connecticut**, **Delaware**, **Hawai'i**, **Illinois**, **Kentucky**, **Maine**, **Maryland**, **Massachusetts**, **Michigan**, **New Jersey**, **New Mexico**, **New York**, **North Carolina**, **Oregon**, **Pennsylvania**, **Rhode Island**, **Washington** and **Wisconsin** are participants.

b. **Multistate energy generation projects.**

   i. Multiple states have collaborated on hydrogen hub projects to take advantage of federal funding opportunities to support hydrogen energy generation. In October 2023, the U.S. Department of Energy announced that seven hydrogen hubs had won $7 billion in grant funding to launch Regional Clean Hydrogen Hubs (H2Hubs) to accelerate commercial scale deployment. Of the seven winners, five of the applications were submitted by multistate teams.

   ii. In October 2023, the Governors of **Connecticut**, **Massachusetts** and **Rhode Island** announced their intention to prioritize regional applications for offshore wind projects to reduce costs while meeting decarbonization goals. The three states signed a memorandum of understanding that establishes guidelines for multi-state coordination for offshore wind procurement. The effort aims to reduce costs passed on to consumers and encourage investment in offshore wind as the industry faces supply chain and cost challenges.

4. **Working with and providing necessary resources to utility regulators to support new technologies and modernize electricity pricing structures and utility regulation.**

   a. NGA will be releasing a forthcoming publication that includes a detailed discussion on the history of utility regulatory models and the role Governors can play in shaping the future of utility regulation.

CONCLUSION

U.S. electrical grids are critical infrastructure that keep the country moving forward. As grids age and are placed under increased stress from growing electricity demand, a new mix of generation sources, increasingly frequent extreme weather events, and an increase in physical and cyber threats, the country faces the challenge of grid modernization to meet the energy needs of the future while delivering new value to residents. There is no single way to modernize and improve electrical grids. Governors can consider the use of grid modernization technologies as one means of doing so.

The deployment of grid modernization technologies provides various benefits to the grid and supports the achievement of efficiency, reliability, affordability and decarbonization goals. It is important to recognize the benefits, costs, risks and other factors associated with the adoption of grid technologies and how their deployment would impact the broader energy system and energy consumers. Governors can guide the consideration of tradeoffs in adopting grid modernization technologies by setting clear policy goals, encouraging collaboration, and ensuring decision-makers explore new technologies and policies to meet grid modernization needs.

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This paper was authored by Fiona Forrester, Policy Analyst, National Governors Association, with guidance from Dan Lauf, Program Director, Energy, National Governors Association. For more information, please email fforrester@nga.org and dlauf@nga.org.

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