NATIONAL GOVERNORS ASSOCIATION

White Paper

Grid Smarts: State Considerations for Adopting Grid Modernization Technologies

Executive Summary

The electric power grid faces several new conditions that have prompted states and utilities to adopt a variety of new "smart" technologies. If implemented appropriately, these modern technologies can lead to achieve a number of benefits, including fewer outages, lower costs, reduced emissions and greater choice in electricity providers and services. Alongside the potential benefits, new technologies also introduce risks, including potential interoperability issues between technologies, undue costs for consumers, increased cybersecurity vulnerabilities and early obsolescence as newer technologies develop. Those dynamics call for careful study and informed decision making to maximize benefits, mitigate risks and manage costs. Moreover, deploying modern technologies should not be an end in and of itself, but a means to achieve a state's policy goals. Governors can guide the consideration of trade-offs in adopting grid modernization technologies by setting clear policy goals and ensuring that decision makers explore new technologies and related policies that best advance those goals.

Categories of grid modernization technologies include:

- Advanced metering infrastructure;
- Digital communications networks;
- Transmission and distribution automation technologies;
- Advanced software and power grid modeling algorithms; and
- High-performance physical materials.

Governors can help examine the trade-offs of adopting various grid modernization technologies through the following two steps:

- First, governors can set policy goals and convene stakeholders to examine the relevant technology. For instance, they can:
  - Appoint, convene and empower agencies or working groups to explore the adoption of modern technologies and to gather stakeholder input;
  - Direct state agencies to assess the role of technology through state and regional planning processes; and
  - Request agencies or utilities to study, test and pilot emerging technologies before rolling them out at scale.

- Second, governors can work alongside their state's utility regulators to implement new grid technologies, modernize electricity pricing structures and explore new utility business models. Governors can work with regulators to:
  - Implement performance incentives that reward utilities for meeting policy goals, such as improved resilience or reliability, reduced emissions and economic performance;
  - Foster innovation by creating market mechanisms that enable energy market actors to identify optimal technical solutions that meet the governor's policy goals; and
  - Establish new rate design mechanisms, such as time-variant rates, to leverage the more frequent automated data available from smart grid technologies and encourage optimal energy consumption and the adoption of distributed energy resources.

Introduction

The electric power grid connects our homes, schools, businesses and industries with the power they need to keep the lights on, machines humming, water flowing, smart devices buzzing and, as more and more of the transportation sector electrifies, vehicles moving.

Electric power in the United States is delivered to homes and businesses through a network of high-voltage transmission lines, lower-voltage distribution lines and a host of substations and transformers. During the past 100 years, the grid has grown from a haphazard system designed to meet local needs to a vast interconnected network of infrastructure, connecting consumers with 11 billion kilowatt-hours of electricity per day across nearly 300,000 miles of high-voltage transmission and 2.2 million miles of distribution wires.[1] The safe, reliable and affordable delivery of electricity has been a hallmark of that network; most citizens are confident that power will be there when they need it.

The electric power grid faces several new conditions as it enters its second century that call for modernization. New policy goals and market conditions are driving toward a system that is cleaner, more distributed and more resilient. The physical infrastructure of the electric grid, which connects homes and business across the country, is aging and in need of maintenance. Operating the electric grid has become more complex as demand patterns change and utilities and customers deploy more distributed and variable energy resources, which means that the software and operating systems that control the grid also warrant updating. Natural hazards such as increased storm activity and human threats such as cyberattacks heighten the need for improvements.

This paper describes commonly deployed grid modernization technologies and suggests steps governors can take to ensure that new technologies are deployed effectively and with maximum benefits to the electric grid. It does not seek to encourage the adoption of any specific technologies. It is based on an experts roundtable on grid modernization technologies and state policy options hosted by the National Governors Association (NGA) in July 2016 that included representatives from a cross-section of industry, state, federal and research organizations. The paper also highlights new policy frameworks states are exploring to support grid modernization, a more detailed review of which is contained in a recent NGA paper, *Opportunities for Governors to Align Electricity Markets with State Energy Goals*.[2]

The Need for Grid Modernization

States have many reasons for pursuing technology modernization, including: maintaining or enhancing reliability and resiliency, reducing costs, enhancing customer choice and lowering emissions. (See box, *State Motivations for Pursuing Grid Modernization*, on page 3.)

Technologies for a Modern Electric Power Grid

Emerging grid technologies can facilitate more effective, automated and rapid communications between customers, nodes throughout the grid and grid operators. These technologies can also facilitate the transition to higher levels of distributed energy resources, such as distributed generation, storage, energy efficiency, demand response and electric vehicles.

New grid technologies being deployed currently or emerging include:

- **Advanced metering infrastructure** (AMI), an integrated system that includes digital electric meters, two-way communications platforms and data management systems. These smart meters, and the underlying infrastructure associated with them, create and utilize vital data on electricity supply and demand;

- **Digital communications networks** that overlay traditional electric power infrastructure to deliver data in addition to electricity. These networks allow utilities or grid operators to receive and act on data in nearly real time and allow assets across the grid to communicate with one another and respond to changes in demand, supply and congestion more seamlessly;[3]

- **Transmission and distribution** (T&D) automation technologies that leverage data to change how electricity flows through the system without human intervention. T&D automation helps utilities more quickly respond to changing conditions in, and stresses on, the power grid and more efficiently deliver power to customers;

State Motivations for Pursuing Grid Modernization

Maintaining or Enhancing Reliability and Resiliency

As grid infrastructure continues to age, natural disasters become more prevalent, and distributed energy resources (DERs) lead to higher load fluctuations on the grid, maintaining reliability and resiliency becomes a greater concern for utilities. Electric reliability measures the ability of the electric grid to deliver power when and where it is needed, while resiliency measures the ability of the electric sector to reduce the magnitude and duration of a disruption to electricity delivery. A modernized grid allows utilities to better understand and address weaknesses in the distribution system, reducing both the frequency and duration of power outages.

Reducing Costs

Although electricity demand has slowed in recent years, growth in demand at times of peak consumption (for example, summer afternoons) has grown, driving up the costs of electricity as expensive power plants are used inefficiently. Modern technologies can help the grid become more cost-efficient by: delivering power to end-use customers more efficiently; more accurately balancing demand with the lowest-cost supply available; communicating data to end-use customers that facilitate reductions in energy consumption during high-cost periods; and requiring less investment in grid operations and maintenance.

Enhancing Customer Choice

The traditional pricing of electricity encourages customers to consume electricity in a predictable fashion, albeit one that does not optimize for cost, system efficiency or environmental impacts. The data unlocked by advanced meters could allow utilities or third-party providers to create new tools and technologies that offer customers greater control over their energy consumption choices. For example, states and utilities may modernize their power systems in response to customer demand by facilitating the use of, and leveraging the data from, energy management systems that allow customers to understand and reduce their energy consumption.

Lowering Emissions

States continue to look at ways to decrease the environmental impact of electricity generation by improving efficiency, shifting consumption and using lower-emitting sources of generation. A modernized system that reduces consumption and facilitates the integration of DERs such as energy efficiency and renewable generation can help states to lower energy consumption and increase the levels of lower-emitting generation on the grid.

- **Advanced software and power grid modeling algorithms** that leverage AMI, automation and communications technologies to both geographically and temporally optimize power delivery across the grid; and

- **High-performance physical materials**, such as efficient, advanced conductors and wires, that improve the performance of traditional electricity infrastructure.

It is important to recognize that these new technologies are not a means to an end. By making informed, deliberate decisions, policymakers and grid operators can leverage the right combination of new technologies to meet state policy goals. Similarly, high-tech innovations can often be paired with more traditional, low-tech and lower-cost solutions to achieve optimal results, such as pairing distribution automation with tree trimming to improve reliability, as fallen trees and branches are common sources of disruptions to electricity service. Regardless of the approach, governors can make key decisions that will affect how technologies are deployed.

While distributed energy resources (DERs) can be critical to helping governors achieve their energy policy goals, the National Governors Association (NGA) views them as a separate category of technologies from the grid modernization technologies discussed in this paper. That desire to deploy DERs is often a driver for many of the in-front-of-the-meter grid modernization technologies described in this paper. Unique among them is energy storage, which can serve like a traditional generation resource, a distributed resource or a technology within the transmission or distribution system. The policy actions discussed in this paper, while not specific to storage, could be relevant where advanced energy storage is being applied as a grid-facing technology. A discussion of policy actions specific to energy storage can be found in the 2016 NGA paper, *State Strategies for Advancing the Use of Energy Storage* and a forthcoming update.[4]

Actions for Governors

Governors have two types of opportunities to pursue greater adoption of new grid technologies and best achieve the potential benefits those technologies can provide. First, governors can set policy goals and provide leadership to unify parties state-wide in the pursuit of goals which grid technologies may help achieve. Second, governors can work with or encourage their state's utility regulators to explore new grid technologies, modernize electricity pricing structures and examine new utility business models that align financial incentives with state policy goals.

Opportunities for Gubernatorial Leadership

The decision to pursue new technologies should focus on trade-offs. There can be many benefits to modernization of the electric grid, but the technologies can also bring costs and risks, including financial risks to ratepayers (with uncertain benefits), increased cybersecurity vulnerabilities, interoperability issues between technologies and the risk that technologies may advance and make what were once "new" technologies obsolete. Careful study and informed decision making on the part of policymakers and the private sector are needed to maximize benefits, mitigate risks and manage costs.

Governors should set their priority goals in advance and let those serve as the foundation for policy and regulatory decisions, rather than promoting a particular technology solution first. This will help to ensure that any new technologies that are deployed provide the optimal tools to meet those policy goals. The **Massachusetts** Department of Public Utilities' (DPU) 2014 docket on grid modernization laid out four objectives (reducing outages, optimizing demand, integrating distributed energy resources and improving asset management) that were identified by the administration as critical to meeting the state's overall energy and environmental goals.[5] The DPU judged the plans filed by utilities through the lens of those four goals.

To inform the adoption of new technologies, governors can work with key state officials and stakeholders to identify guiding policy goals and understand how the new technologies can help meet those goals. In considering the role for new grid technologies the value of existing low-tech solutions and low-cost technologies should still be considered as potentially viable options. Governors can help identify relevant agencies and stakeholders and provide them with specific charges in several ways:

- Governors can appoint, convene and empower agencies or working groups to explore the adoption of new technologies and to gather stakeholder input. The effort to restructure electric utility incentives and markets in **New York**, known as "Reforming the Energy Vision," has relied on public-private working groups, including one on platform technology, to provide recommendations to regulators.[6] Similarly, the consensus report of **Rhode Island** stakeholders' investigation of grid modernization recommended a new cost-benefit framework for assessing grid technology investments that is informing power sector modernization.[7] These efforts are not limited to agencies whose primary responsibility is the energy sector. In **Illinois**, Governor Bruce Rauner tasked the state's chief information officer to facilitate the state's progress toward being a "Smart State," one that relies on data and digital connectivity to improve services and operations and enhance quality of life and economic development. As part of this effort, the state has identified the deployment of digitally connected technologies in the energy sector as an opportunity for digital transformation where state government might have a leading policy role.[8]

- Governors can direct state agencies to assess the role of technology through state planning processes, such as comprehensive state energy plans or energy assurance plans. In December 2016, **Iowa** released a new state energy plan that included two recommendations for advancing the deployment of grid modernization technologies. The plan called for the development of an integrated grid modernization vision and encouraged utilities to propose grid technology pilots, both through the formal regulatory process and—for municipal and cooperative utilities—alternative means.[9]

  State energy assurance plans are another avenue for integrating grid technologies into state planning through the lens of improving reliability and resiliency. Every state developed an energy assurance plan between 2010 and 2013. As states update those plans, they have an opportunity to address the role of grid technologies in facilitating reliability and resiliency. Most states and territories account for the role of renewable energy or address cybersecurity threats in their energy assurance plans. However, few of those plans have been updated to address the role that grid technologies can play in facilitating resiliency. As states look to update those plans, governors can request that agencies producing them address grid resiliency through the lens of new technology.

- Governors can ask agencies and utilities to study, test and pilot emerging technologies before rolling them out at scale. This can be done at the state level, but governors and agencies also can leverage pilot studies and demonstration projects in other states, including those through U.S. Department of Energy (DOE) national laboratories. For example, U.S. DOE's smartgrid.gov website contains case studies from 131 demonstration projects and technology deployments funded between 2009 and 2015. Those case studies cover transmission and distribution systems as well as AMI deployments, providing states with data on a range of technology choices and electricity market types. As technologies are advancing rapidly, states should balance the testing and demonstration of technology with the need to deploy technologies quickly to best capture benefits in the short and long term.

Opportunities for Regulatory Action

All investor-owned utilities and some consumer-owned utilities (municipal utilities and rural electric cooperatives) are regulated by state public utilities commissions (PUCs). These regulated utilities must seek approval to recover investments through rates and are subject to other requirements placed upon them by their regulators, such as making specific investments. While PUCs are typically independent state regulatory bodies, there are opportunities for governors to work with PUCs to implement new grid technologies, modernize tariff structures and explore new utility business models. Governors can do so in several ways:

- Governors can work with their state's PUC to implement performance incentives that reward utilities for meeting policy goals, such as improved resilience or reliability, reduced emissions and better economic performance.[10] Performance incentives allow utilities the flexibility to identify and deploy the best technologies to meet policy goals via performance metrics that are enforceable by the PUC. For example, the **Hawaii** PUC adopted a performance-based compensation mechanism in 2013 with metrics that addressed system reliability, cost, safety, customer satisfaction and other factors, with financial rewards granted to the utility for exemplary performance and penalties for poor performance.[11] Similar mechanisms that could incentivize grid-level investments exist in **California**, New York and 20 other states to encourage utility investments in distributed energy resources such as customer-sited renewable energy generation and energy efficiency.[12]

- Governors can foster innovation in electricity markets by encouraging market mechanisms that enable market actors to identify optimal technical solutions to meet the governor's policy goals within the constraints of those markets. Under the traditional regulatory environment in which utilities acted as natural monopolies, utilities played a significant role in shaping how technologies were installed on the grid and used on the distribution system. However, technological advances are creating potential roles for third-party providers to deliver electricity products and service to utilities and their customers. States with restructured electricity markets (those in which distribution utilities do not also generate electricity) may have more flexibility in allowing third-party companies to interact directly with customers or leverage data generated through grid modernization technologies. If a state chooses to do so, it may be able to foster competition between the utility and other entities to drive innovation and reduce costs. For states with traditionally regulated, vertically integrated utilities, competition will not be a factor, but states could still provide opportunities for third-party entities to access some utility or customer data and partner with the utility to provide new products and services to customers.

  Governors can work with state regulators and wholesale market operators to identify areas where markets can be made more open or transparent and provide secure access to other technology service providers. In **Pennsylvania**, for example, the PUC authorized third-party access to smart meter data, subject to opt-in by customers, to expand the information available to those customers and encourage more energy conservation.[13]

Governors can work with regulators to explore new rate design mechanisms, such as time-variant rates, to leverage the more frequent automated data available from smart grid technologies and encourage optimal energy consumption and the adoption of distributed energy resources. These innovative rate designs provide price signals to customers to shift consumption to times of lower congestion and times when lower-cost power is available. Time-variant rates have been piloted or implemented in states and utilities across the country, including **Arizona**, **California**, the Kauai Island Utility Cooperative in **Hawaii**, **Maryland**, **Massachusetts**, and **Oklahoma** Gas and Electric in Oklahoma.[14]

Conclusion

Governors and other state policy makers need to recognize and understand the benefits, costs, risks and other considerations of a host of technology and policy solutions associated with a modern electricity grid. One technology solution is not likely adequate to meet all of a state's policy goals, and technologies may need to be layered together to produce optimal outcomes. Some options, such as data analytics, may not be part of typical utility engineering function and others—like voltage optimization—may be standard practice among utilities and considered outside of grid modernization. As governors consider how grid technologies can help meet their energy policy goals, they should determine how more fundamental grid modernization measures, such as AMI and grid automation, can be leveraged using supportive technologies and how data from AMI and grid sensors can augment existing efforts.

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Endnotes

[1] *This paper serves as a follow-up to NGA's* 2014 Governors' Guide to Modernizing the Electric Power Grid. For more information on the history of the U.S. electric grid, the role of states in regulatory oversight and strategies governors can use to foster the modernization of the electric grid, please consult that report. https://www.nga.org/files/live/sites/NGA/files/pdf/2014/1403GovernorsGuideModernizingElectricPowerGrid.pdf.
[2] Wasserman, Aliza and Cramer, Sam. *Opportunities for Governors to Align Electricity Markets with State Energy Goals*. National Governors Association. November 2016. https://www.nga.org/files/live/sites/NGA/files/pdf/2016/1611GovernorsElectricityMarkets.pdf.
[3] Congestion in the power grid is a situation in which a transmission or distribution line is unable to handle demanded power loads. This can occur during times high demand or if another line is taken out of service due to a storm or another emergency.
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[9] Iowa Energy Plan. Prepared by the Iowa Development Authority and the Iowa Department of Transportation. December 2016. http://www.iowaenergyplan.org/docs/IowaEnergyPlan.pdf (accessed November 21, 2017).
[10] For more information on utility performance incentive structures, see: NGA's issue brief, Opportunities for Governors to Align Electricity Markets with State Energy Goals, which can be found here: https://www.nga.org/files/live/sites/NGA/files/pdf/2016/1611GovernorsElectricityMarkets.pdf.
[11] Melissa Whited et al., Utility Performance Incentive Mechanisms: A Handbook for Regulators (Denver: Western Interstate Energy Board.2015). http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf (accessed January 17, 2017).
[12] Ibid.
[13] Power Markets Today. "Pennsylvania OKs 3rd-Party Access to Customer Data." July 1, 2016. http://www.powermarketstoday.com/public/Pennsylvania-OKs-3rdparty-access-to-customer-data.cfm (accessed January 17, 2017).
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