Testimony of
Karen G. Wayland, Ph.D.
Chief Executive Officer
GridWise Alliance

U.S. House of Representatives Committee on Energy and Commerce
Subcommittee on Energy
"The CLEAN Future Act: Powering a Resilient and Prosperous America"
March 24, 2021

Good afternoon, Chairman Rush, Republican Leader Upton, and other members of the Committee. Thank you for the opportunity to appear before you today to participate in this important hearing on how Congress can improve the resilience of the electricity grid.

My name is Karen Wayland, and I am the CEO of GridWise Alliance. The mission of GridWise is to champion the principles, policies, and investments needed to transform the electricity grid by understanding the diverse perspectives and priorities of all stakeholders. GridWise uniquely serves the electricity industry by leveraging diverse stakeholder perspectives to articulate the numerous benefits of grid modernization. GridWise helps create a common understanding of the numerous and transformational operations-focused and policy-related changes taking place across the electricity industry. Our members include investor-owned utilities, municipal utilities, rural cooperative utilities, grid equipment manufactures and technology companies, vendors, national laboratory and research institutions, and others. GridWise has been convening member companies that have been leading the transformation of the electricity industry since our founding in 2003.

Threats to the Nation's Electricity System

The massive Texas power failure of February and last year's wildfires in California have focused public attention on the electric grid[1] and emphasized the growing dependence of all sectors of the economy on reliable electricity. The Texas blackout exposed some market and regulatory issues unique to that state, and the scale of economic loss is related to the size of the nation's largest state over which those losses are projected, but increasingly severe weather threatens power grids across the country. There were a record 22 weather events in 2020 in which the costs of damage exceeded $1 billion,[2] and the last two decades have seen a 67% increase in major power outages from weather events (Texas ranks second behind Michigan in the number of major outages).[3] Five of the worst wildfires in US history occurred in

[1] GridWise Alliance uses the term "electricity system" to encompass the entire network of generation, transmission, distribution and consumer/end users of electricity, and "electric grid" to refer to the transmission and distribution system. Here, we use "electric grid" as it has been used in the popular press.
[2] National Oceanic and Atmospheric Administration. "Billion Dollar Climate and Weather Disasters: Time Series." https://www.ncdc.noaa.gov/billions/time-series, accessed March 22, 2021.
[3] Climate Central. "Power OFF: Extreme Weather and Power Outages." https://medialibrary.climatecentral.org/resources/power-outages, accessed March 22, 2021.

the last four years.[4] The utility industry is also under increasing threats of disruption from cyberattacks. And because our critical infrastructure systems are increasingly interdependent, power outages can lead to cascading failures that affect other systems like water treatment (as happened in Texas last month) or gasoline dispensing (as happened in New York following Superstorm Sandy).

We should use the Texas and California blackouts as drivers for conversations about enhancing grid resilience, but we should not lose sight of the ranges of threats that could disrupt power supply at the local, regional, or national level, or even globally, each requiring different risk management practices.

When I was at the U.S. Department of Energy (DOE), my policy team commissioned a report titled "Resilience of the U.S. Electricity System: A Multi-Hazard Perspective"[5] as part of the second installment of the Quadrennial Energy Review.[6] The report identified a range of threats to the electricity sector that grid owners and operators, and federal, state, and local regulators and policy makers must consider while planning for and investing in grid resilience (Table 1). These threats range from extreme weather (hurricanes, floods, winter storms) to geological (earthquakes and geomagnetic pulses) to human-caused (cyber and physical attacks), with likelihood of occurrence varying from extremely low but with high impact to very likely with low- to-high impact. Similarly, the risks differ across the components of the electricity system. Planning for grid resilience requires risk management strategies for the range of hazards and probabilities that could impact grid infrastructure.

[4] New York Times. "These Changes Are Needed Amid Worsening Wildfires, Experts Say." https://www.nytimes.com/2020/09/10/climate/wildfires-climate-policy.html, accessed March 22, 2021.

[5] Argonne National Laboratory, Brookhaven National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories. "Resilience of the U.S. Electricity System: A Multi-Hazard Perspective." https://www.energy.gov/policy/downloads/resilience-us-electricity-system-multi-hazard-perspective, accessed March 22, 2021.

[6] U.S. Department of Energy. "Quadrennial Energy Review--Transforming the Nation's Electricity System: Second Installment of the Quadrennial Energy Review." https://www.energy.gov/sites/prod/files/2017/02/f34/Quadrennial%20Energy%20Review--Second%20Installment%20%28Full%20Report%29.pdf, accessed March 22, 2021.

Table 1. Detailed Integrated Assessment of Risk and Resilience in the Electricity Sector.
Source: "Resilience of the U.S. Electricity System: A Multi-Hazard Perspective"

Threat	Intensity		Electricity Transmission			Electricity Generation			Electricity Substations			Electricity Distribution (above)			Electricity Distribution (below)			Storage		
		P	V	I	R	V	I	R	V	I	R	V	I	R	V	I	R	V	I	R
Natural/Environmental Threats																				
Hurricane	Low (<Category 3)	High	Low	Moderate	Moderate ●	Moderate	Low	Low ●	Moderate	Moderate	Moderate ●	High	Moderate	High ●	Low	Low	Low ●	Moderate	Moderate	Moderate ◐
	High (>Category 3)	Moderate	Moderate	High	High ◐	Moderate	Moderate	Moderate ●	High	Moderate	Moderate ●	High	High	High ◐	Low	Moderate	Moderate ●	Moderate	Moderate	Moderate ◐
Drought	Low (PDSI> -3)	High	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
	High (PDSI<-3)	Moderate	Low	Low	Low ●	Moderate	Moderate	Moderate ◐	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Moderate	Moderate	Moderate ◐
Winter Storms/ Ice/Snow	Low (Minor icing/ snow)	High	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Low	Low	Low ●
	High (Major icing/ snow)	Moderate	High	High	High ●	Low	Low	Low ●	Moderate	Moderate	Moderate ●	High	High	High ●	Low	Low	Low ●	Low	Low	Low ●
Extreme Heat/Heat Wave		High	Moderate	Low	Low ●	Moderate	Moderate	Moderate ◐	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
Flood	Low (<1:10 year ARI)	High	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●
	High (>1:100 year ARI)	Low	Moderate	Moderate	Moderate ●	Moderate	Moderate	Moderate ◐	Moderate	Moderate	Moderate ◐	Moderate	Moderate	Moderate ◐	High	Moderate	Moderate ●	Moderate	Moderate	Moderate ●
Wildfire	Low (>Type III IMT)	High	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
	High (Type I IMT)	Moderate	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Moderate	Moderate	Moderate ●
Sea-level rise		High	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
Earthquake	Low (<5.0)	High	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Moderate	Low	Moderate ●	Moderate	Low	Moderate ●	Moderate	Low	Moderate ●	Moderate	Low	Moderate ●
	High (>7.0)	Low	High	Moderate	Moderate ●	High	Moderate	High ●	High	High	High ●	High	Moderate	Moderate ●	High	High	High ●	High	High	High ●
Geomagnetic	Low (G1-G2)	High	Low	Low	Low ●	Low	Low	Low ●	Moderate	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
	High (G5)	Moderate	Low	Low	Low ○	Moderate	Moderate	Moderate ◐	High	High	High ○	Moderate	Low	Low ◐	Low	Low	Low ○	Moderate	Moderate	Moderate ◐
Wildlife/Vegetation		High	Moderate	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
Human Threats																				
Physical	Low	High	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
	High	Unknown	High	High	Unknown ◐	High	High	Unknown ◐	High	High	Unknown ◐	High	High	Unknown ●	Moderate	Moderate	Unknown ●	High	High	Unknown ◐
Cyber	Low	High	Moderate	Low	Low ◐	Low	Low	Low ◐	Moderate	Moderate	High ◐	Moderate	Moderate	Moderate ○	Moderate	Moderate	Moderate ○	Low	Low	Low
	High	Unknown	High	High	Unknown ○	Moderate	Moderate	Unknown ○	High	Moderate	Unknown ○	Moderate	Moderate	Unknown ○	Moderate	Moderate	Unknown ○	Moderate	Moderate	Unknown ○
Electromagnetic	Low (Ambient EMI)	High	Low	Low	Low ●	Low	Low	Low ●	Moderate	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●	Low	Low	Low ●
	High (NEMP & HEMP)	Unknown	Low	Low	Low ●	Moderate	Moderate	Unknown ○	High	High	Unknown ○	Low	Low	Low ●	Low	Low	Low ●	Moderate	Moderate	Unknown ○
Equipment Failures		Moderate	Low	Low	Low ●	Moderate	Moderate	Moderate ●	Low	Low	Low ●	Moderate	Low	Low ●	Moderate	Low	Low ●	Moderate	Moderate	Moderate ●
Combined Threats		Unknown	High	High	Unknown ○	Moderate	Moderate	Unknown ○	High	High	Unknown ○	High	High	Unknown ○	High	High	Unknown ○	Moderate	Moderate	Unknown ○

Key to Symbols

Level of Risk: Low; Moderate; High; Unknown

Dimensions of Risk: Ⓟ – Probability; Ⓥ – Vulnerability; Ⓘ – Impact; Ⓡ – Risk

Status of Risk Management Practices for Current Threats:
- ○ – Nascent: critical vulnerabilities exist
- ◐ – Established, but opportunities for improvement remain
- ● – Well-established and robust

Caption: Assessments of risk and status of risk management practice are based on information in Section 4, published literature, and expert judgment (for statistically unknown threats). Table cells represent a qualitative assessment of risk by electric system component and threat. Some threats are divided into low or high intensity threats. Estimates of individual sub-components of risk are presented for each system component and threat: probability refers to the frequency or likelihood of a threat occurring; vulnerability refers to the sensitivity of a system component to harm or damage; impact refers to the potential severity of damage in terms of financial costs, affected customers, and/or health and safety. This table forms the basis for Table 7 in Section 5.2.

Achieving Resilience

The North American Reliability Corporation (NERC), the organization that sets standards for the reliability of the nation's bulk power system, defines reliability as the ability "to meet the electricity needs of end-use customers even when unexpected equipment failures or other factors reduce the amount of available electricity."[7] Reliability metrics capture the frequency (System Average Interruption Frequency Index, or SAIFI) and duration (System Average Interruption Duration Index, or SAIDI) of power outages. These metrics are inadequate to describe the ability of the electricity system to withstand disruptions, minimize the consequences of disruptions that do occur, and quickly recover from those disruptions, which are the defining characteristics of system resilience. A resilient electricity system can also adapt through post-incident learning that feeds into planning and future response.

Enhancing the resilience of the electricity grid is a multi-pronged approach encompassing planning, operations, and technology. The "Resilience of the U.S. Electricity System: A Multi-Hazard Perspective"[8] report identified three facets of building resilience:

- Resourcefulness: in practice this could be applied to the power transmission and distribution system by implementing a constant monitoring and optimized dispatching and/or load shedding to respond to anomalies. For example, if a critical transmission line is lost, power might still be delivered by temporarily overloading parallel/alternative routes and monitoring conductor temperature and time of overload conditions.
- Redundancy: over-engineering critical systems to be able to function, at least at a reduced level, in critical conditions.
- Restoration: coordination and integration among stakeholders of restoration efforts, plans optimized for a variety of scenarios to avoid the need of improvising a solution during critical conditions. Sharing best practices among different organizations (from local to global, nationwide) and practicing simulated emergencies should be mandated and coordinated at the national level. This sharing should include mutual assistance programs and their resources (personnel, equipment, parts) during the restoration phase. Electric utilities have a range of resilience options depending on the threats and hazards facing the region and specific infrastructure. Table 2 presents a list of options that utilities are pursuing to enhance system resilience with the goal of protecting the system, reducing the impact and areal extent of any damage, and accelerating restoration time.[9]

[7] North American Electricity Reliability Corporation. "Frequently Asked Questions." https://www.nerc.com/AboutNERC/Documents/NERC%20FAQs%20AUG13.pdf, accessed March 22, 2021.
[8] Argonne National Laboratory, Brookhaven National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories. "Resilience of the U.S. Electricity System: A Multi-Hazard Perspective." https://www.energy.gov/policy/downloads/resilience-us-electricity-system-multi-hazard-perspective, accessed March 22, 2021.
[9] Argonne National Laboratory. "Front-Line Resilience Perspectives: The Electdric Grid." https://www.osti.gov/biblio/1344876, accessed March 22, 2021.

Utilities have a suite of options to enhance resilience of grid infrastructure (Table 2). Grid resilience measures aim to prevent disruptions to power supplies and reduce the severity of impacts and time to recovery in the event of power loss. Hardening of critical infrastructure for resilience may include undergrounding of some power lines, upgrading poles and towers to withstand high winds, and elevating substations above projected flood levels. Trees are the leading cause of power outages,[10] so utility vegetation management programs reduce flammable materials near power lines and remove trees at risk of falling. Utilities conduct practice drills and exercises throughout the year to prepare for disaster response. In the days leading up to an event, utilities will pre-stage crews and equipment in advance of events and may have plans to deenergize some facilities to prevent damage. Mutual assistance agreements with neighboring utilities help speed restoration efforts by deploying emergency response crews to disaster areas. But hardening and disaster planning alone are not sufficient to improve resilience.

New grid technologies that improve situational awareness and control of grid equipment can improve the reliability and resilience of the electricity system. Sensors can alert grid operators to localized disruptions, allowing more targeted response by line crews, and automated grid equipment can automatically sense and response to conditions in the field, including rerouting power around downed lines and self-healing damage. Remote sensing technologies allow utilities to obtain data from drones or NASA images to more effectively manage power line vegetation or assess damage. Advanced meter infrastructure (AMI), or "smart meters," help grid operators identify local outages and prioritize response crews and verify when power is restored, both reducing the time of outages and the cost of response by reducing "truck rolls" or repair visits. Modern utility communication networks improve operational speed and visibility for grid operators, and customer-facing communication channels provide information to customers on estimated time of power restoration as well as safety information and recommendations in the event of extended outages.

Distributed generation technologies such as microgrids and mobile generators can enhance the resilience of electric infrastructure serving critical loads, such as hospitals, water treatment facilities, and emergency shelters. Microgrids incorporate a generating source like a generator or solar panels with storage and energy management systems and can be "islanded" from the grid during power disruptions to provide back-up power. Mobile generators can provide temporary power to critical facilities, and utilities should identify locations where generators can be easily connected to the grid during emergency planning processes. Rooftop solar and storage systems can provide backup power to homes during short outages.

---

[10] T&D World. "Plan for Better Vegetation Management in 2019. https://www.tdworld.com/vegetation-management/article/20971840/plan-for-better-vegetation-management-in-2019, accessed March 22, 2021.

Table 2. Electric Utility Resilience Enhancement Options.
Source: Argonne National Laboratory, Front-Line Resilience Perspectives: The Electric Grid (ANL/GSS-16-2).

Resilience Enhancement Options	Definition	Example
Hardening	Physical changes that improve the durability and stability of specific pieces of infrastructure	Raising and sealing water-sensitive equipment
Security measures	Measures that detect and deter intrusions, attacks, and/or the effects of manmade disasters	In-depth security checks on all employees, badged entry and limited access areas, and surveillance and monitoring
Maintenance and general readiness	Routine efforts to minimize or prevent outages	Vegetation management and regular inspection and replacement of worn-out components
Modernization, control enhancements, and smart-grid technology	Technology and materials enhancements to create a more flexible and efficient grid	Integration of smart-grid technologies, such as smart meters and phasor measurement units
Diversified and integrated grid	Transitioning of the grid from a centralized system to a decentralized generation and distribution system	Integration of distributed generation sources, such as renewable energy sources and establishment of microgrids
Redundancy, backup equipment, and inventory management	Measures to prepare for potential disruptions to service	Maintenance of spare equipment inventory, priority agreements with suppliers, and maintenance of a supply of backup generators
Mutual aid programs	Agreements that encourage entities to plan ahead and put in place mechanisms to acquire emergency assistance during or after a disaster	Agreements between utilities to send aid or support after a disaster
Succession training, knowledge transfer, and workforce development	Planning for transfer of knowledge and skills from a large retiring workforce, to a smaller, younger workforce	Proactive efforts to create training and cross-training programs and succession plans
Business continuity and emergency action planning	A formal plan that addresses actions and procedures to maintain operations preceding an event	Components including employee awareness, training, and exercising
Models	Mathematical constructs that provide information on performance and/or disruptions to aide in decisionmaking	Probabilistic risk models to assist in predicting outage impacts after an event

GridWise Alliance Recommendations for Improving Grid Resilience: Grid Investments for Economic Recovery

As noted above, the U.S. economy is increasingly dependent on electric power. The growing interdependency of lifeline systems and the electricity system increases the risk of a "cascading effect" during extreme events. As extreme weather events increase in frequency and strength, grid owners and operators are taking deliberate measures to ensure the system's reliability and flexibility support the Nation's needs. Utilities around the country are developing investment plans to deploy grid modernization technologies that can significantly enhance electric system reliability and resilience and prevent these cascading events.

Over the last year, the COVID pandemic has challenged the nation in ways few crises in history have before. The implications of the pandemic highlighted the need to make significant investments in the nation's public health preparedness and address the severe economic hardship and job loss facing many, which Congress addressed in the 2020 and 2021 COVID response packages. The pandemic and recent large-scale power disruptions associated with climate change also highlighted the need to invest in broader societal infrastructure to strengthen the country's resilience against future disasters/disruptions.

Congress is likely to consider a massive economic stimulus and infrastructure bill in the next few months to create jobs and address the climate crisis. Electricity is the most critical service upon which all other services rely, and as such, the electricity sector can be the engine to drive post-COVID-19 recovery and strengthen the resilience of the electricity system. Congress should include funding for grid modernization in any infrastructure package designed to stimulate the economy and create jobs.

Significant investments to make the grid smarter and more secure will be required to fully realize the benefits that the electric grid can provide to the U.S. economy. Before COVID-19, smart grid investments were projected to reach almost $14 billion a year by 2024,[11] and utilities were projected to spend more than $100 billion on networking and communications equipment[12] over the next decade. These investments would have been accompanied by new construction and high-tech jobs, but given the economic downturn, the grid's owners and operators may be forced to scale back those planned investments in the face of low load and consumer debt. Federal funding for grid modernization will leverage private capital, accelerate grid modernization plans, and help de-risk state public utility commission decisions.

GridWise Alliance has developed a set of investment priorities, "**Grid Investments for Economic Recovery,**"[13] for an infrastructure package. The policy framework includes over $50 billion in funding for programs across the federal government to deploy technologies that would increase grid flexibility, improve the integration of buildings and vehicles with the grid, address cybersecurity threats, create a domestic supply chain for critical

[11] U.S. Department of Energy. "Smart Grid System Report: 2018 Report to Congress." https://www.energy.gov/sites/prod/files/2019/02/f59/Smart%20Grid%20System%20Report%20November%202018_1.pdf, accessed March 22, 2021.

[12] Utility Dive. "Networking and communications for smart grids and utility applications: A $100B opportunity" https://www.utilitydive.com/news/networking-and-communications-for-smart-grids-and-utility-applications-a/545873/, accessed March 22, 2021.

[13] GridWise Alliance. "Policy Framework for Grid Investments for Economic Recovery." https://gridwise.org/wp-content/uploads/2021/01/Policy-Framework-for-Stimulus-Investments-in-Grid-Modernization-FINAL-1.5.21-002.pdf, accessed March 22, 2021.

grid equipment, modernize utility communication networks and help address the digital divide, and provide workforce training for digital, high tech grid jobs. The GridWise investment recommendations also includes over $18 billion for mission critical public infrastructure resilience and emergency preparedness. This funding should be provided to defray the costs of resiliency, critical infrastructure, intelligence, flexibility of buildings, cybersecurity and other emergency preparedness investments within a performance contract or other public private partnership arrangement. Federal funding would be limited to one-fifth of the total investment and would leverage $100 billion in total for grid-integrated resiliency infrastructure. Our recommendations also include funding for wildfire detection technologies.

According to the 2020 U.S. Energy and Employment Report (USEER),[14] energy jobs grew faster in 2019 than job growth as a whole, and the transmission, storage, and distribution sector, which employed over 700,000 people, was projected to grow 3.5% in 2020. This growth can be restored or accelerated by federal investment. Smart grid funding of $8 billion in the 2009 recovery bill created 80,000 jobs and accelerated the deployment of new technologies. The overall 2009 clean energy investments, including renewable generation, advanced vehicles, transit, equipment manufacturing, and job training, resulted in at least 720,000 new jobs.[15] If Congress makes investment in the nation's grid in 2020, the electricity sector can be the engine to drive post-COVID-19 recovery.

GridWise Alliance Recommendations for Improving Grid Resilience: CLEAN Future Act Provisions

With support from DOE, the GridWise Alliance brought together experts from utilities and grid equipment manufacturers and vendors for a workshop to develop recommendations for improving grid reliability and resilience in the face of very large-scale events (VLSE) like the Texas freeze of 2021, Superstorm Sandy in 2012, and the California wildfires of 2012 and 2020. The 20 utilities participating in the workshop represented over 40% of the nation's electric customers. The workshop resulted in a set of key recommendations detailed in "Improving Electric Grid Reliability and Resilience: Lessons Learned from Superstorm Sandy and Other Extreme Events."[16] Those recommendations are relevant for today's hearing about how the CLEAN Future Act can enhance grid resilience. Below I discuss provisions in Title II and Title III of the CLEAN Future Act (excluding Subtitle A) that address the GridWise lessons learned and recommendations for grid resilience.

GRIDWISE LESSON LEARNED: GRID MODERNIZATION TECHNOLOGIES CAN PREVENT OUTAGES AND DECREASE PROJECTED IMPACTS

State and federal policy makers and electric utilities must accelerate the integration of existing grid modernization technologies to enhance grid resilience, reliability, safety, and security. Smart grid technologies can monitor and protect against disruption, optimize performance, and self-heal

[14] National Association of State Energy Officials and Energy Futures Initiave. "U.S. Energy and Employment Jobs Report." https://www.usenergyjobs.org/, accessed March 22, 2021.

[15] White House Archives. "Impact of the American Recovery and Reinvestment Act on the Clean Energy Transformation." https://obamawhitehouse.archives.gov/blog/2010/04/21/impact-american-recovery-and-reinvestment-act-clean-energy-transformation, accessed March 22, 2021.

[16] GridWise Alliance. 'Improving Grid Reliability and Resilience: Lessons Learned from Superstorm Sandy and Other Extreme Events." https://gridwise.org/superstorm-sandy-report/, accessed March 22, 2021.

automatically. Improved situational awareness and control of grid equipment significantly enhance a utility's ability to reduce the impact of VLSEs and speed restoration efforts.

CLEAN Section 230. 21st Century Power Grid: Directs the Secretary of Energy to establish a program to fund projects that improve resiliency, performance, or efficiency of the electricity grid and authorizes $700 million per year from 2022-2031.

- GridWise Alliance strongly supports DOE initiatives that provide funding for grid modernization projects. Utility grid modernization plans usually consider system-wide upgrades to their distribution or transmission networks and can require significant investment. The DOE Office of Electricity Smart Grid Investment Grant Program (SGIG) provided $3.4 billion of funding for 99 utility grid modernization projects over three years. For 19 of those projects, the total cost of each, including federal and recipient funding, exceeded $100 million. However, the economic and resilience benefits of the combined federal and private capital investments have been significant. GridWise recommends increasing the authorization in Section 230 to $2.6 billion a year from 2022 to 2031 or $8 billion over three years.

GRIDWISE LESSON LEARNED: DISTRIBUTED GENERATION TECHNOLOGIES SUCH AS MICROGRIDS AND MOBILE GENERATORS CAN ENHANCE THE RESILIENCE OF ELECTRIC INFRASTRUCTURE SERVING CRITICAL LOADS

A diversified and integrated grid can enhance resilience, with distributed energy resources able to provide back-up power to individual customers and flexibility for grid operations. Microgrids—distributed electric generation resources incorporating storage, load control, and energy management systems—are able to operate independently of the grid, although in normal operating conditions, they are integrated with the grid. On the customer side, distributed energy resources (DERs) like electric vehicles, rooftop solar, and storage can provide resilience to individual buildings; when DERs can be integrated with the grid and aggregated, they can provide services (e.g. power, voltage support, frequency regulation) that grid operators can harness to balance the grid during extreme events.

<u>**Microgrids**</u>

CLEAN Section 231. Microgrids. Requires the Secretary of Energy to develop a strategy to promote the deployment of hybrid microgrids for isolated communities and critical infrastructure.
CLEAN Section 236. Clean Energy Microgrid Grant Program. Establishes a program to provide technical assistance and project development for microgrid projects; authorizes $50 million for technical assistance and outreach per year and $1.5 billion in grants for projects per year from FY 2022-2031.

- GridWise Alliance supports the expanded deployment of microgrids to provide power to critical infrastructure and isolated communities and supports the authorization levels in the CLEAN Future Act. Technical assistance should include identifying policy and regulatory issues that inhibit the management of microgrids and DERs during emergencies.
- GridWise Alliance applauds the inclusion of provisions requiring that environmental justice communities can access DOE resources to help them develop and deploy resilience measures like microgrids.
- GridWise Alliance recommends that stakeholders explore potential solutions to regulatory and policy barriers associated with multi-customer microgrids. Some issues raised by GridWise resilience workshop participants include:
    - Backup generators can run out of fuel; how will fuel supplies be obtained and ensured?

- Backup generators can be rendered inoperable due to flooding; are there ways in which to protect these assets from flooding?
- Renewable energy (e.g., rooftop solar) still requires an operational grid to supply local loads; how can the system supply these loads without grid power?
- Multi-customer microgrids have diverse operating requirements; who balances supply and demand on multi-customer microgrids?
- Some states prohibit third party sales of electricity; how will that affect the viability of multi-customer microgrids?
- Microgrids are becoming more prevalent; will utilities be allowed to own and/or manage microgrids?
- Regarding ways in which to integrate and tie multi-customer microgrids to the utility grid: what new rules, if any, are needed?

<u>**Distributed Energy Resources (DERs)**</u>

CLEAN Section 241. Distributed Energy Resources. Directs the Secretary of Energy to establish a loan program for the deployment of distributed energy systems to improve grid security and resiliency, increase the use of local renewable energy resources, and enhance peak load management and reduce energy costs for rural customers.
CLEAN Section 242. Grant Program for Solar Installations Located In, Or That Serve, Low-Income And Underserved Areas: Directs the Secretary of Energy to establish a program of loans and grants for construction of solar facilities to serve multi-family affordable housing.
CLEAN Section 245. Distributed Renewable Energy: Requires the Secretary of Energy to establish a non-profit corporation, Distributed Energy Opportunity Board, and to designate certain communities as "Distributed Energy Opportunity Communities" that can receive competitive grants.

- GridWise Alliance supports the expansion of DER deployment to meet resilience and climate goals and to meet changing customer expectations. To maximize the full value and potential of DERs for resilience and other goals, grid operators need a more flexible and agile grid architecture.[17] Advanced control and monitoring systems that can dynamically respond to system changes will enable safe and reliable power restoration and support safe dispatch of DERs during VLSEs. GridWise recommends pairing investments to scale deployment of DERs on the customer side with investments in grid modernization to achieve continued power quality and reliability at the distribution level through the optimization and aggregation of local DERs.
- GridWise Alliance recommends allowing some portion of the funds authorized in these sections to be used for Advanced Metering Infrastructure (AMI, or "smart meters") and smart inverters.
  - <u>Smart meters</u> significantly contribute to grid resilience by providing grid operators with granular information about the location of power outages and verification that power has been restored. Utilities use this information to prioritize dispatching repair crews and in communicating with customers, which reduces restoration costs and total outage time. Customers also experience benefits, including less lost productivity, food spoilage, and inconvenience, and reduced public health and safety hazards.[18] GridWise resilience

[17] GridWise Alliance. "In an Accelerated Energy Transition, Can U.S. Utilities Fast-Track Transformation?" https://gridwise.org/wp-content/uploads/2019/12/Perspectives-on-a-Future-Distribution-System.pdf, accessed March 22, 2021.
[18] U.S. Department of Energy. "Smart Grid Investments Improve Grid Reliability, Resilience, and Storm Recovery." https://www.energy.gov/sites/prod/files/2014/12/f19/SG-ImprovesRestoration-Nov2014.pdf, accessed March 22, 2021.

workshop participants estimated that integrating AMI meters with restoration processes shaved 2-3 days off the time it would have taken to completely restore power after Superstorm Sandy, a 10-15% improvement in the speed of restoration.
    - Smart inverters provide grid support functions, such as voltage regulation, frequency support and ride through capabilities.[19] In the event of a power disruption, a rooftop solar system will automatically shut off to prevent electricity to flow onto the power lines and potentially electrocute line workers. Smart inverters may include a circuit to allow customers to power their homes without sending electricity to the grid. Solar-battery combinations also allow customers to island their systems from the grid during power outages but have the added resilience benefit of providing power when the sun is not shining.

Buildings and Energy Efficiency

Buildings consume 76% of electricity generated in the United States.[20] Title III of the CLEAN Future Act includes a series of provisions designed to improve the energy efficiency of federal, residential, and commercial buildings through updated building codes, funding for building retrofits, state energy grants, and other policy levers. Improving the efficiency of the nation's building stock will enhance resilience to energy disruptions in addition to saving energy. Well-insulated buildings reduce heating and cooling load during periods of high electricity demand associated with extreme weather and keep occupants more comfortable during power outages. Focusing resources for weatherization on underserved and low-income communities is critical to ensure that those populations do not suffer disproportionately during energy disruptions. GridWise Alliance strongly supports improving the energy efficiency of the nation's building stock, but the specific policy provisions to achieve greater efficiency are outside the GridWise mission of promoting grid modernization.

If passed and fully funded, the building and efficiency provisions in the CLEAN Future Act will result in the weatherization and retrofitting of millions of public and private buildings across the country. During the construction process, grid-connected Energy Management Systems (EMS) should be installed in addition to insulation and energy efficient windows and appliances, where possible. Grid-integrated buildings can be significant assets to the grid through load shifting, demand response, and aggregation of distributed generation. According to the National Association of State Energy Officials (NASEO), greater optimization of the significant energy demand and supply functions that buildings offer—on an automated basis—has far-reaching electricity policy and regulatory implications. The benefits include lower costs, enhanced resilience, reduced peak loads, enhanced energy efficiency and better integration of distributed energy resources.[21]

- GridWise Alliance recommends that the Committee explore how to enhance the grid-integration capabilities of buildings that receive funding through Title III programs. Funding should facilitate aggregation and management of building loads through grid-connected Energy Management

[19] Interstate Renewable Energy Council. "Smart Inverters." https://irecusa.org/regulatory-reform/smart-inverters/, accessed March 22, 2021.
[20] U.S. Department of Energy. "Quadrennial Technology Review, Chapter 5: Increasing Efficiency of Building Systems and Technologies." https://www.energy.gov/sites/prod/files/2017/03/f34/qtr-2015-chapter5.pdf, accessed March 22, 2021.
[21] National Association of State Energy Officials. "Grid-interactive Efficient Buildings: State Briefing Paper." https://naseo.org/data/sites/1/documents/publications/v3-Final-Updated-GEB-Doc-10-30.pdf, accessed March 22, 2021.

- Systems (EMS) and smart equipment/appliances within the building, and Advanced Meter Infrastructure (AMI) at the grid-building interface. Though not the subject of today's hearing, electric vehicles (EV's) can also provide power and essential reliability services to the grid, and policies designed to increase deployment of EVs (Title IV) should also encourage vehicle-to-grid integration capabilities.

CLEAN Section 371. Facilities Energy Resiliency: Requires the Secretary of Energy to distribute grants to States under the State Energy Program (SEP) for building projects that increase the resilience, energy efficiency, renewable energy, grid integration at public facilities. Authorizes $3.6 billion per year from FY 2022-2031. Also authorizes $500 million for the AFFECT program under the Federal Energy Management Program for covered projects and $1.5 billion in grants to tribal organizations.

- GridWise Alliance strongly supports federal support to defray the costs of resiliency, critical infrastructure, intelligence, flexibility of buildings, cybersecurity and other emergency preparedness investments for mission critical energy infrastructure. Where possible, these investments should enhance the ability of buildings and associated technologies to be grid-integrated and provide grid services.

GRIDWISE LESSON LEARNED: INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) INFRASTRUCTURES SHOULD BE MORE RESILIENT, RELIABLE AND SECURE

Utilities' investments in operational fiber and wireless broadband communications network are essential for a modern grid. The legacy communications networks utilities have used for decades to monitor and control the state of the grid and stay in contact with utility workers and customers are inadequate for integrating new grid and customer technologies, which are driving increased communications traffic. These include "demand response systems, advanced metering infrastructure (AMI), distributed grid operations, grid automation, operational systems for managing power generation, outages and flows, two-way communications for consumer energy efficiency initiatives, transmission interconnectivity, and network security monitoring and reporting."[22] Utility communication systems can include fiber networks and private wireless networks must be integrated with legacy communications networks. Modern communications networks could also be leveraged to provide middle mile broadband and last mile internet service for end-use consumers. A modern, digital communications network is therefore the backbone of a modern grid and can provide significant resilience benefits, but it will have to be more reliable than other grid infrastructure in order to support a resilient grid that can monitor and react quickly to disruptions.

CLEAN Section 230. 21st Century Power Grid: Directs the Secretary of Energy to establish a program to fund projects that improve resiliency, performance, or efficiency of the electricity grid and authorizes $700 million per year from 2022-2031.

- GridWise Alliance strongly supports DOE initiatives that provide funding for grid modernization projects. Section 230 should be amended to explicitly reference investments in utility communications networks. GridWise recommends authorizing investments in grid communications at $2 billion over three years. The USDA Rural Utility Service (RUS) can also provide low-interest loans to rural cooperatives for upgrading utility communication networks, and the appropriate committee could increase RUS borrowing authority for this purpose.

[22] Power Grid International. "Challenges, Solutions in Utility Communications Networks." https://www.power-grid.com/smart-grid/challenges-solutions-in-utility-communications-networks/#gref, accessed March 22, 2021.

GRIDWISE LESSON LEARNED: ENHANCED EMERGENCY RESPONSE PLANNING PROCESSES CAN RESULT IN BETTER DEPLOYMENT AND COORDINATION OF HUMAN AND OTHER RESOURCES

Electric utilities, in conjunction with the appropriate federal and state agencies, continually develop predictive restoration plans at a regional level. These plans can be informed by enhanced weather and damage forecasting and advances in situational awareness and should use real-time validations to continually refine and update such plans. Mutual assistance agreements with neighboring utilities help speed restoration efforts by deploying emergency response crews to disaster areas. In the days leading up to an event, utilities will pre-stage crews and equipment in advance of events and may have plans to deenergize some facilities to prevent damage. Congress has raised specific concerns about the vulnerabilities of large power transformers (LPTs) given the growing threats to transformers and the long lead time in replacing them and required DOE to submit a plan to Congress for the establishment of a strategic transformer reserve.[23] The utility industry has a number of initiatives to create spare transformer reserves and stockpile parts and related equipment.

Planning for the response and restoration of energy disruptions is not the sole purview of the energy sector. VLSEs often affect multiple interdependent infrastructures (e.g., ICT and water) and several states and/or regions. Thus, planning for an event of this magnitude must involve coordination and collaboration at the federal, regional, state, and local levels, and between the public and private sectors, to address the breadth and inter-related nature of these potential impacts. Such efforts also must integrate people, technologies, and processes to maximize preparedness. State and federal emergency management offices should conduct annual joint simulations, drills, and related "pre-event" scenario planning efforts at the local, state, and regional levels to test their plans and strengthen their ability to collectively respond to VLSEs.

In 2009, DOE provided $38 million in funding to states to update their energy assurance plans, and in 2010 provided $8 million for 43 cities to do the same.[24] (The funds came through the Infrastructure Security and Emergency Response division, or ISER, within the Office of Electricity; ISER is now within the Office of Cybersecurity, Energy Security, and Emergency Response, or CESER.) DOE also provided funding and technical assistance for a series of exercises to test the updated energy assurance plans. Energy assurance plans identify key public and private points of contact for the energy sector and emergency response units, formulate roles and responsibilities, lay out legal parameters, and identify critical infrastructure and potential hazards to each, as well as outline mitigation measures. Ideally these plans should be updated at least annually, but the reality is that most states and municipalities do not. In 2017, 12 states updated their energy assurance plans with some form of DOE assistance, and the National Association of State Energy Officials provided some technical assistance to three states in the process of updating their plans.[25]

---

[23] U.S. Department of Energy. "Strategic Transformer Reserve: Report to Congress." https://www.energy.gov/sites/prod/files/2017/04/f34/Strategic%20Transformer%20Reserve%20Report%20-%20FINAL.pdf, accessed March 22, 2021.

[24] U.S. Department of Energy. "Recovery Act: Local Energy Assurance Planning Initiatives." https://www.energy.gov/ceser/recovery-act-local-energy-assurance-planning-initiatives, accessed March 22, 2021.

[25] U.S. Department of Energy. "State, Local, Tribal and Territorial Energy Assurance: 2017 Year in Review." https://www.energy.gov/sites/default/files/2018/03/f50/SLTT%20Energy%20Assurance%202017%20Year%20in%20Review.pdf, accessed March 22, 2021.

CLEAN Section 352. State Energy Security Plans: Allows states to use State Energy Program (SEP) funds administered by the DOE Office of Energy Efficiency and Emergency Response to implement, revise, and review a State Energy Security Plan and requires the governor of a state to submit the revised plan to the Secretary of Energy annually.

- GridWise Alliance recommends that CLEAN Future Act be amended to include a permanent authorization to DOE Office of Cybersecurity, Energy Security and Emergency Response (CESER) of $50 million for states to modernize their energy emergency planning, analysis and preparedness functions.
- The Committee could consider allowing states to use some of these planning funds to develop plans for investments in energy-sector resilience in response to threats and hazards identified in the energy assurance planning process. These investment plans could be funded with state funds or with Building Resilient Infrastructure and Communities (BRIC) funding available through the Federal Emergency Management Agency (FEMA).

ADDITIONAL CLEAN FUTURE ACT PROVISIONS

Transmission

The workshop that led to the recommendations in the GridWise Alliance report, "Improving Grid Reliability and Resilience,"[26] did not distinguish between the transmission and distribution systems, although much of the focus was on the effects of extreme events on the nation's distribution system. Nevertheless, GridWise Alliance members believe that modernizing the nation's transmission system is a critical element for enhancing the resilience and reliability of the overall electricity grid.

More investment in transmission infrastructure—both adding new miles and upgrading existing miles—is necessary to improve the resilience of the bulk power system. This investment increase should increase transmission capacity, connect new renewable generation sources to load centers, accommodate new demand for electricity as buildings and transportation are increasingly powered by electricity, and allow for significantly enhanced balancing in real time between supply and demand across large regions. During extreme weather events or other disruptions in power supply, the transmission grid can access generating sources that provide both geographic and fuel supply diversity.

The transmission provisions in the CLEAN Future Act are important policy proposals that address the trifecta of challenges facing transmission expansion in this country: siting, permitting, and cost allocation. GridWise Alliance members plan, construct, and operate transmission, as well as design and build transmission equipment. Gridwise Alliance members share a consensus that transmission planning must consider the significant shift in resource mix and increased demand from widespread electrification expected in the future. Proactive planning will accelerate the evolution of the transmission system to meet climate, resilience, reliability and affordability goals.

Cybersecurity

Cyberattacks are a constant and increasing threat to the electricity system. The interdependence of all sectors of the economy on the electricity system make it an attractive target for state-sponsored actors,

[26] GridWise Alliance. 'Improving Grid Reliability and Resilience: Lessons Learned from Superstorm Sandy and Other Extreme Events." https://gridwise.org/superstorm-sandy-report/, accessed March 22, 2021.

organized crime, "hactivists," and amateurs alike.[27] The growing number of grid-integrated devices, from solar panels to thermostats to smart appliances, create new entry points for malicious actors to attack the grid. Utility operational technology (OT) systems are increasingly connected to utility information technology (IT) systems, and grid technology is more digitized and connected across the Internet, making the risk of a cyberattack that could significantly damage critical equipment and cause widespread power disruptions a national security threat that policy makers must tackle.

DOE is the sector-specific lead in combatting cybersecurity threats to the energy industry and has incorporated cybersecurity across its research, development, and deployment (RD&D) mission, as well as in its national security and nuclear weapons stewardship functions. In particular, the DOE Office of Cybersecurity, Energy Security, and Emergency Response (CESER) funds platforms that can monitor cyberattacks and share information across the utility industry and also provides funding for the deployment of technologies that can prevent cyberattacks from damaging grid equipment. These are important efforts in enhancing the cyber resilience of the nation's utilities. CESER also provides funding to train a cyber workforce. Protecting the grid from cyberattacks is hampered by the lack of qualified cyber professionals, with a projected shortage of nearly half a million workers.[28]

The 21st Century Power Grid section (Sec.230) of the CLEAN Future Act includes a requirement that each project funded in this program must develop a cybersecurity plan. Previous funding opportunities that included such a requirement led to enhanced cybersecurity for grid projects that will be replicable across the utility enterprise. But the CLEAN Future Act should include broader cybersecurity policies throughout the bill to protect the electricity system. And when Congress considers an infrastructure funding package, it should address the growing cybersecurity risks confronting the electricity system. The GridWise Alliance "Grid Investments for Economic Recovery"[29] proposal recommends:

- $500 million to DOE Cybersecurity for Energy Delivery Systems (CEDS) for cybersecurity workforce development
- $500 million to DOE CEDS for cyber assessments and cyber threat monitoring for small and medium utilities
- $1 billion to DOE CESER for cybersecurity technology deployment

CONCLUSION

GridWise Alliance thanks the Committee for the opportunity to provide feedback on the CLEAN Future Act and how to enhance the resilience of the nation's electricity system.

---

[27] National Academies of Science. "The Future of Electric Power in the U.S.: Draft Report." https://www.nationalacademies.org/our-work/the-future-of-electric-power-in-the-us, accessed March 22, 2021.
[28] CPO Magazine. "Cybersecurity Workforce Shortage Continues to Grow." https://www.cpomagazine.com/cyber-security/cybersecurity-workforce-shortage-continues-to-grow/, accessed March 22, 2021.
[29] GridWise Alliance. "Policy Framework for Grid Investments for Economic Recovery." https://gridwise.org/wp-content/uploads/2021/01/Policy-Framework-for-Stimulus-Investments-in-Grid-Modernization-FINAL-1.5.21-002.pdf, accessed March 22, 2021.