Attachment—Additional Questions for the Record

Subcommittee on Energy
Hearing on
"The CLEAN Future Act and Electric Transmission: Delivering Clean Power to the People"
Tuesday, June 29, 2021

Patricia Hoffman, Acting Assistant Secretary, Office of Electricity, U.S. Department of Energy

QUESTIONS FROM THE HONORABLE LISA BLUNT ROCHESTER (D-DE)

Q1. Assistant Secretary Hoffman, the Administration has committed to expanding and modernizing the electrical grid, while creating good-paying union jobs. Your testimony suggests that investing in building new, major transmission projects may result in as many as 1.2 million new jobs. What measures can Congress take to ensure that those are good-paying jobs that adhere to the highest labor standards?

A1. The development of a well-trained, highly skilled electric power sector workforce is vital to implementing a national clean energy system. While most of these jobs are employed by private companies, the Department has supported a variety of programs to prepare people for technician, staff, and engineering positions in the electricity generation, transmission, and distribution industries. The programs help ensure a well-trained workforce for the grid of the future, provide opportunities for higher compensation for technicians and displaced workers, and assist with economic recovery in depressed communities and regions.

Q2. How will investing in transmission projects, like the ones you highlighted in your testimony create longer term economic benefits and how is the Department of Energy supporting this effort?

A2. Transmission investments provide long term benefits by enabling access to cleaner, more economical generation resources, which can lower the overall cost of electricity for all ratepayers. New transmission also reduces economic cost of disruptions by giving grid operators more tools to reroute power and avoid outages. The Department supports a variety of efforts to help stakeholders better understand the benefits of new transmission capacity and to facilitate its deployment.

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Q3. In your testimony you identified six aspects of DOE's budget that can help support grid reliability and resilience. Can you elaborate on those subprograms, and the ways those subprograms can ensure that we can maintain a reliable supply and delivery, even in the face of an increasing number of extreme weather events?

A3. Transmission Reliability and Resilience (TRR) focuses on maintaining the reliability and resilience of the supply, consumption, and delivery of the power in the face of changes from weather and other hazards. TRR investment in the development of advanced applications for system operators aims to enable better responses to weather events and other hazards such as wildfires. Through developing new data sources from advanced sensors (as well as leveraging traditional sources of data), TRR is building new tools to visualize system disturbances, identify mitigation measures, and improve the efficiency and effectiveness of decision-making processes. TRR is also developing tools that help system operators understand and adapt to changes in supply and load, including expanded growth in clean generation, access to distributed energy resources, and increased electrification. TRR supports building the capacity and capability within the electric sector to analyze the electricity delivery system using Big Data, advanced mathematical theory, and high-performance computing to assess the current state of the grid, mitigate reliability risks, and understand future needs. TRR is leading the development of integrated risk-based, measurement-model approaches to improve detection, mitigation, and recovery/restoration from system failure, weather events, and man-made attacks to the electric power system; and to enable the operation of degraded or damaged electricity systems while sustaining critical functionality.

The proliferation of extreme weather events puts stress on the reliable delivery of electricity because supply may more often separate from load, usually due to a downed wire or damaged component. Resilient Distribution Systems (RDS) research into microgrids addresses this risk by allowing the grid to break apart into smaller grids, and

this research seeks to make microgrids more flexible, resilient, and cost effective. RDS research also seeks to uncover new sources of resilience and reliability in dynamic controls derived from interactions with electric vehicles, smart buildings, distributed solar, and energy storage. The dynamic controls activities develop coordination technologies that allow customer-owned and utility-owned assets to work together to make the grid more stable and efficient. Reinforcing the capability of microgrids and other distribution activities, dynamic controls allow collaboration across ownership boundaries, while respecting privacy and the right to benefit from services provided to the grid.

The Energy Storage program supports the next generation of battery chemistries, improved safety and reliability of storage systems, development of optimal design and control architectures for energy storage integration, and assistance for energy storage planning and evaluation. Integrating storage into the grid can lower energy prices, secure their electrical supply, and solve a variety of reliability and equity challenges across the United States.

The Transformer Resilience and Advanced Components program develops innovations for grid hardware carrying, controlling, and converting electricity. These technologies, including transformers, critical components, and other grid hardware technologies, help the electric grid to withstand and rapidly recover from the impact of extreme terrestrial or space weather events, electrical disturbances, equipment failures, accidents, deliberate attacks, and other unknowns.

Energy Delivery Grid Operations Technology (EDGOT) focuses on developing large, networked energy transmission, distribution, communication, and data infrastructures across multiple utility boundaries in support of reliable and resilient energy delivery

systems. EDGOT will enhance the national-scale operational capability to ensure reliable and resilient energy delivery across multiple energy sectors and provide the architecture and process for a range of large-scale mitigation solutions to emerging threats. The EDGOT technology portfolio will enable assessment of risks and uncertainty, evaluation and identification of effective mitigation strategies, and support of more informed infrastructure planning and investment decisions by both public and private sectors, thereby enhancing U.S. energy and economic security.

Transmission Permitting and Technical Assistance (TPTA) works with electricity system partners and stakeholders to modernize the grid and ensure equitable and adequate transmission capacity across the United States. TPTA works with Federal, State, and industry partners to address the climate crisis by decarbonizing the electricity sector, supporting transmission planning, and maximizing cost-effective demand-side resources and solutions to achieve 100 percent carbon-free electricity by 2035.

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QUESTIONS FROM THE HONORABLE CATHY MCMORRIS RODGERS (R-WA)

Q1. During the hearing, you seemed to agree that hydropower, America's most abundant renewable resource, plays an important role for grid resilience and reliability. You also spoke about the need for better coordination among permitting agencies for the review of infrastructure projects.

Q1a. What role do you see hydropower playing as more intermittent and weather-dependent resources are added to regional energy grids?

A1a. The rapid evolution in the power system in recent years has created new roles for hydropower as a flexible resource that can balance high penetrations of variable resources. In addition to being a significant source of renewable and carbon-free generation, the technical capabilities of hydropower (including pumped storage hydropower) make it well-suited to provide storage, flexibility, inertia, and other grid services that will be increasingly needed as additional variable resources come online. Power system modeling results from DOE's Office of Energy Efficiency and Renewable Energy's Water Power Technologies Office's HydroWIRES Initiative show that hydropower is an important pathway toward a future high-renewable power system. For example, the recently released North American Renewable Integration Study (NARIS) showed that the present level of hydropower flexibility in the fleet would contribute to an approximately 3 percent decrease in operating costs and about a 1 percent decrease in emissions for a continental-scale high-renewable power system scenario in 2050. As renewable penetration increases, ongoing work in HydroWIRES suggests even greater value for hydropower's flexibility. Beyond day-to-day needs, in areas where hydropower is abundant, its availability and flexibility are also key to mitigating system stress during extreme weather events such as droughts and floods.

Pumped storage hydropower (PSH), which provides 93 percent of grid-scale energy storage in the United States, will play a unique role as the power system moves toward

deep decarbonization. PSH can provide services ranging from fast frequency response to 12-hour energy storage and longer. By providing large-scale storage, results from the HydroWIRES initiative show that PSH can also reduce transmission congestion and thus serve as a transmission alternative, potentially alleviating some of the growing needs for transmission for renewable energy. Despite an absence of large-scale deployments in past decades, a resurgence of interest in PSH in recent years has advanced several U.S. projects further in the development pipeline. PSH has also gained increasing interest internationally, as many countries have developed innovative policy and market mechanisms to successfully build new PSH projects, and these lessons and mechanisms may be transferrable to the United States.

Q1b. With the number of existing hydropower projects that will require Federal relicensing set to double in the coming decade, what steps has DOE taken to provide technical assistance and policy recommendations to streamline and support the licensing process?

A1b. DOE's Water Power Technologies Office (WPTO), in collaboration with the National Renewable Energy Laboratory (NREL) and Oak Ridge National Laboratory (ORNL), has prepared a report examining the hydropower licensing and federal authorization process. The report includes quantitative and qualitative analyses of the Federal Energy Regulatory Commission (FERC) licensing and federal and state approval timelines, the project attributes that may influence those timelines, and their combined effect on costs and risk to license applicants. This report does not include any specific recommendations for licensing reform. It seeks only to provide an objective evaluation of the current federal regulatory process to allow policymakers to identify any needed areas for reform. The study was conducted with extensive input from relevant federal agencies (e.g., FERC, National Oceanic and Atmospheric Administration, Fish and Wildlife Service) and other non-federal stakeholders, and it is scheduled to be published before the end of FY21.

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DOE WPTO has also worked with ORNL to develop HydroSource, a digital platform consisting of hydropower-related datasets, data models, visualizations, and analytical tools that supports and enables hydropower research and development (R&D) on topics of national interest. This includes U.S. hydropower siting, relicensing, deployment, resources assessment and characterization, environmental impact reduction, technology-to-market activities, and climate change impact assessment. By increasing transparency and making river and hydropower-relevant data easier to access, HydroSource provides users with information and resources needed for informal strategic environmental permitting and regulatory processes.

Additionally, to support licensing, DOE and NREL have developed the RAPID toolkit, a user-friendly online resource that helps all hydropower licensing stakeholders (license applicants, non-governmental organizations, etc.) navigate the FERC licensing process.

DOE's Hydropower Program also develops new technologies, tools, and data to enhance understanding and improve the environmental performance of hydropower facilities. These advancements and improvements help inform and streamline the environmental evaluations and studies associated with the licensing process.

DOE WPTO's work focuses particularly on issues related to fish passage and migration, water quality, and water release management. For example, the HydroPASSAGE project, a multiyear R&D collaboration between Pacific Northwest National Laboratory (PNNL) and ORNL, successfully tested, licensed, and commercialized several tools to reduce fish injury and mortality of entrained fish, which should lower the regulatory costs of licensing and operations.

Other technologies currently being tested and commercialized include a mobile water quality monitoring platform for taking measurements in dangerous and difficult-to-access

locations near hydropower plant intakes and tailraces, and miniaturized and longer-lasting fish tags that improve fish monitoring and allow tracking of fish species and life-stages that have never been possible before. These and other successful efforts are highlighted in the most recent Accomplishments Report from DOE.[1]

Q1c. Should Congress designate a lead agency to coordinate hydropower licensing, to hold participating agencies accountable to a schedule? Should participating agencies or Tribes be allowed to veto a project that would serve the broad public interest and improve grid reliability?

A1c. It is outside DOE's purview to make a specific legislative recommendation concerning regulatory processes. Besides the RAPID toolkit, DOE is an observer to the industry and stakeholder-led collaboration "Uncommon Dialogue" [2] and provides objective technical information on hydropower. Although DOE is not a member of the working group, one of Uncommon Dialogue's working groups is specifically dedicated to developing reforms to the FERC licensing process that will benefit all stakeholders.

Q1d. DOE's Hydropower Vision Report (2016) found that U.S. hydropower could grow from 101 gigawatts (GW) of capacity to nearly 150 GW by 2050. The report also identified stakeholder actions that could support the expansion of hydropower facilities. Is the U.S. on track to meet the goals set forth in the report? What steps has DOE taken since?

A1d. There has been growth in several of the opportunity areas originally identified in the report in particular powering non-powered dams and increasing capacity/generation at existing hydropower facilities. According to the U.S. Hydropower Market Report, (published by ORNL and supported by DOE),[3] hydropower capacity increased by 431

[1] https://www.energy.gov/eere/water/water-power-technologies-office-accomplishments-2019-2020
[2] https://woods.stanford.edu/research/hydropower, a comprehensive conversation, facilitated by Stanford University, among the hydropower industry, led by the National Hydropower Association; environmental non-governmental organizations, led by American Rivers; and tribal representatives
[3] https://www.energy.gov/sites/prod/files/2021/01/f82/us-hydropower-market-report-full-2021.pdf

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MW since the publication of the last Hydropower Market Report (2017 – 2019) and a total of 1,688 MW from 2010 TO 2019.9. The net increase in the past decade was primarily from capacity additions to the existing fleet (1,704 MW), but 562 MW came from new developments, which mostly added hydropower generation to nonpowered dams and conduits. Capacity added from new projects or upgrades to the existing fleet from 2010 to 2019 (2,225 MW) outweighed capacity reductions due to plant retirements or downrates (538 MW).[4]

However, to date, the largest area of growth potential in the United States, pumped storage hydropower, has seen limited growth, with additional capacity at existing facilities being the driver of additional pumped storage, rather than through the construction of new facilities. Net PSH capacity increased by 1,333 MW from 2010 to 2019. Except for the Olivenhain-Hodges facility in California (42 MW), the remaining increase came from upgrades to six existing PSH plants: Castaic in California, Northfield Mountain in Massachusetts, Muddy Run in Pennsylvania, and Bad Creek, Fairfield, and Jocassee in South Carolina. The most recent increase—228 MW reported in 2018—results from upgrading the four units of the Northfield Mountain facility.[5]

There is a significant pipeline of pumped storage projects in the development process, and several have received their licensing approvals. Sixty-seven new PSH projects with a total proposed capacity of 52.48 GW were in various stages of evaluation or development at the end 2019. Much of the potential growth in hydro from the HydroVision report would come from PSH, but even with a robust pipeline of new projects, no new site construction has commenced due primarily to permitting challenges, market structures, and financing barriers, like the upfront capital costs.

[4] https://www.energy.gov/sites/prod/files/2021/01/f82/us-hydropower-market-report-full-2021.pdf
[5] https://www.energy.gov/sites/prod/files/2021/01/f82/us-hydropower-market-report-full-2021.pdf

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Since the HydroVision report, DOE has developed several efforts to support both expansion of nonpowered dams – like in its Innovations for Low-Impact Hydropower Growth[6] activity area to expand on technologies to power nonpowered dams and develop new stream-reach technologies – as well as efforts focused on reducing barriers to pumped storage development. On PSH, this includes supporting innovative technology R&D, and providing relevant technical assistance to developers, which are a significant focus of ongoing and proposed future DOE efforts through the HydroWIRES initiative, which was also launched since the report.[7]

Over the past few years, DOE has continued to work closely with a broad group of stakeholders (many of whom contributed to the original Hydropower Vision report), to reexamine and update the "Vision Roadmap," which is the comprehensive list of all stakeholder actions (not just those specific to DOE or the federal government) identified as important to realize the opportunities and hydropower growth potential identified in the report. This effort, led by these stakeholders ("Visionaries"), and facilitated by DOE and several National Labs, will produce an updated Vision Roadmap, scheduled to be released in FY22.

DOE and its Office of Energy Efficiency and Renewable Energy (EERE) have also worked to raise the profile and opportunities presented specifically by pumped storage technology by taking international leadership roles, most recently through efforts to engage in the International Forum on Pumped Storage Hydropower.[8] Acting EERE Assistant Secretary Kelly Speakes-Backman recently assumed the role of co-chair of the forum, with former Prime Minister of Australia Malcolm Turnbull. Recent information

[6] https://www.energy.gov/eere/water/innovations-low-impact-hydropower-growth
[7] https://www.energy.gov/eere/water/hydrowires-initiative
[8] https://www.energy.gov/eere/water/international-forum-pumped-storage-hydropower

and successes of other important DOE-led efforts are highlighted in the most recent Accomplishments Report from DOE.[9]

[9] https://www.energy.gov/eere/water/water-power-technologies-office-accomplishments-2019-2020

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QUESTIONS FROM THE HONORABLE MICHAEL BURGESS (R-TX)

Q1. Would more transmission ensure that the grid of the future is totally immune to extreme weather?

A1. Historically, weather-related disturbances are the leading source of grid outages. Options for managing the vulnerabilities of the electric grid span a wide range of technologies, including investments in physical infrastructure such as transmission, distribution, energy storage, microgrids and distributed generation technologies. We can do all we can to mitigate transmission disturbances, but just like any technology, we can't guarantee 100% resilience. Additional transmission lines will, however, give grid operators more tools to avoid outages by giving them the ability to reroute power to other lines if there is an issue.

Q2. Does the CLEAN Future Act promote more reliable power generation during times of crisis?

A2. The CLEAN Future Act contains many provisions to ensure power reliability, especially during times of crisis. The Act instructs the Federal Government to "facilitate and advance cost-effective investments in the Nation's electric grid system, including the bulk electricity transmission system, to enhance reliability…" Specifically, the Act supports the development and deployment of technologies such as microgrids, which can enable enhanced reliability by providing grid services or backup power, and other advanced technologies that support reliability including energy storage, underground transmission lines, and smart grid technologies.

The Act also supports advanced transformers like Large Power Transformers (LPTs)—grid hardware that is critical to delivering power from generators onto the grid. Specifically, the Act instructs the Secretary to establish a program to "reduce the vulnerability of the electric grid to physical attack, cyber attack, electromagnetic pulse,

geomagnetic disturbances, severe weather, climate change, and seismic events" by emphasizing the strategic transportation and placement of LPTs and other critical grid equipment. The Act has several provisions to ensure that there is the greatest chance of uninterrupted power supply and availability during crisis.

Q3. Does the CLEAN Future Act improve fuel reliability?

A3. Provisions in the Act will improve fuel reliability, the availability of energy sources or fuel to power generators when required by the system operator. The Act addresses several fuel types and demonstrates the potential for advancements that yield increased reliability. For example, the Act proposes "improved efficiency of natural gas pipeline systems, including gas gathering systems and gas transmission systems, in order to reduce compressor fuel consumption in these systems, through improved technology and operational practice," benefiting fuel reliability of natural gas plants and interdependent gas systems.

The Act also benefits fuel reliability on a larger scale. An isolated system may yield reduced system fuel reliability, as system operators have fewer generators to utilize in ensuring overall fuel reliability. Transmission technology upgrades like those enabled in the Act, such as transmission buildout, topology optimization, and advanced conductors, can mitigate the reliability concerns of isolated systems and enable system-level fuel reliability by rapidly transmitting power from multiple generators across large regions.

Q4. Is reliable power generation more important for grid reliability than more transmission?

A4. Grid reliability—the ability of the electric system to operate without instability or failure, even during disturbances and extreme events—is generally ensured through operator proficiency and advanced technologies. Reliable power generation may help with grid reliability, as consistent and predictable generation helps operators balance supply and

demand. However, even the most reliable power generation may not be enough to achieve a completely reliable grid, as extreme weather events or out-of-service lines could still force power to be shut off in parts of the system. In these cases, grid reliability may be maintained by advanced technology solutions including energy storage technologies (also useful to ensure power reliability from variable sources) or enhanced transmission.

Advanced transmission solutions are critical to ensuring system reliability. This includes buildout of new lines as well as unlocking additional capacity within the existing system using technologies like dynamic line rating and power flow controllers. Advanced transmission can efficiently bring large amounts of power across long distances, a crucial capability when normally reliable power generation is down due to a crisis or unpredictable event. Reliable power generation and transmission buildout are both important tools with key roles to help ensure grid reliability.

Q5. Given recent cyber-attacks on critical infrastructure, such as the Colonial pipeline, I've grown increasingly concerned about how our nation safeguards its energy infrastructure. What preventative measures can be taken to ensure that new transmission lines be protected against cyber-attacks?

A5. The Department of Energy (DOE) is taking measures to ensure critical energy infrastructure including new transmission lines are protected against cyber attacks. With the increasing growth of distributed energy resources on the power grid, more visibility and availability of control systems are needed to accurately monitor power flow on transmission networks. DOE's Office of Electricity (OE) is ensuring the reliability and resilience of the U.S. electric grid through research and development (R&D) concentrated on measurement and control of the electricity system. OE is also developing and validating models to assess evolving system needs and mitigate risks across integrated energy systems. This is complemented by the broader cybersecurity research,

development, and deployment efforts by the Office of Cybersecurity, Energy Security, and Emergency Response (CESER) on various cybersecurity technologies to identify, protect, detect, and respond to cyber incidents.

One major electricity transmission and distribution system vulnerability relates to synchronization and timing using the global positioning system (GPS) and network timing protocol (NTP). OE is an active member representing the electric grid in the GPS Vulnerability Test Plan Development Working Group under Executive Order 13905, Strengthening National Resilience Through Responsible Use of Positioning, Navigation, and Timing Services. In response to cyber attacks targeting GPS and NTP vulnerabilities, OE created the Center for Alternative Synchronization and Timing (CAST) to provide secure and economical synchronization and timing to our Federal agency and utility sector partners and avoid exposure to these vulnerabilities.

CESER is leading efforts to secure the energy sector more broadly. In April 2021, CESER collaborated with the Department of Homeland Security (DHS) and the Electricity Subsector Coordinating Council (ESCC) on an effort to improve the visibility of cyber threats in the operational technology (OT) environment through the Industrial Control Systems (ICS) Cybersecurity Initiative and Electricity Subsector Action Plan. The plan will enhance detection and mitigation and enable near real-time situational awareness and response in the OT environment.

Further, CESER is leading other critical efforts such as: coordinating Department-wide efforts to ensure security by design in future electric grid and oil and natural gas technologies; strengthening security and resilience in the SLTT community through training and exercises; strengthening cyber emergency response efforts; and improving the supply chain cybersecurity. DOE's supply chain cybersecurity efforts are led under

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the Cyber Testing for Resilient Industrial Control Systems (CyTRICS) initiative. CyTRICS is identifying threats and disclosing vulnerabilities, both within hardware and software found in the digital supply chain, in partnership with manufacturers and suppliers to identify high priority OT components, perform expert testing before deployment, share information about vulnerabilities in the digital supply chain, and inform improvements in component design and manufacturing.

The Department remains committed to securing U.S. energy infrastructure, leveraging public-private partnership and engagement, identifying best practices, and looking for practical, effective ways to diminish malicious actions and influence intended to compromise energy systems and U.S. national security.