Statement of
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and Related Agencies
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Madam Chairwoman, Ranking Member, and Members of the Committee, thank you for the opportunity to discuss the President's Fiscal Year (FY) 2021 budget for the Department of Energy's Office of Electricity (OE).

A modern electric grid is vital to the Nation's security, economy, and modern way of life, providing the foundation for our national security and the essential services that Americans rely on daily. Within the next decade, proactive, coordinated, and innovative steps will help address a worsening threat environment and growing challenge in mitigating these adversarial threats, such as:

- Fast-evolving cyber, physical, and other asymmetric targeting of our energy infrastructure, intended to impact critical lifelines affecting each of the critical infrastructure sectors;
- Significant changes in the supply mix and location (centralized, distributed, and off-shore) of the Nation's generation portfolio, generating interdependencies with potentially cascading effects among the critical infrastructure sectors; and,
- Increasing changes in the application of renewables, more active consumer participation, and new technologies and techniques, potentially increasing the electric grid's exposure to cyber threats and further complicating national-level risk management.

Accordingly, timely action will inform the research and development that facilitates industry deploying a secure, reliable, and resilient electric power grid that supports the vitality of other critical sectors that depend on electricity, such as: defense, telecommunications, banking and finance, water, and public health and safety. A secure and resilient power grid is vital to national security, economic security, and the services Americans rely upon. Our adversaries are looking for any energy-related Achilles' heels to degrade our ability to sustain a competitive, secure economy and assure critical services the public relies upon every day. Our mission is to work closely with private and public partners to lead the Department's efforts to ensure that the Nation's most critical energy infrastructure is secure and able to recover rapidly from disruptions.

This mission is supported by OE's four key priorities:

- North American Energy Resilience Model: working with the national laboratories and relevant stakeholders, develop the integrated North American Energy Resilience Model (NAERM) to conduct planning and contingency analyses and provide the situational awareness necessary to identify and address vulnerabilities in the North American energy system. It is critical that the energy sector maintain situational awareness of evolving threats and vulnerabilities and take action to address them.

- Megawatt-scale grid storage: pursue megawatt-scale bi-directional electric storage capable of supporting voltage and frequency regulation, ramping, black start, and energy management for bulk and distribution power systems. Resilience requires energy generation optionality to absorb and snap back from a major event.
- Revolutionize sensing technology utilization: pursue integration of high-speed, high-fidelity technologies for predictive, correlation, machine learning, and artificial intelligence modeling for electricity and interdependencies with oil and natural gas systems, while simultaneously enhancing cyber and physical threat awareness. Anticipating threats will position us to develop a more effective defensive posture which must also be linked to an offensive strategy that is designed to deter attacks.
- Transmission: develop robust modeling capabilities to inform electricity-related policy issues for carrying out statutory and executive requirements, while also providing policy design and analysis expertise to Federal, State, Local, Tribal, Territorial, and regional entities, focusing primarily on national security. The bottom line is that this is a team sport, requiring effective coordination *horizontally* across Federal departments and agencies and *vertically* with State, Local, Tribal, Territorial, and regional partners.

Highlights of the FY 2021 Request

At $195.0 million, the FY 2021 Budget Request reflects a $5.0 million increase over the FY 2020 enacted appropriation. The request includes funding for:

- Research and Development (R&D)—pursuing research for technologies to improve grid reliability, resilience, efficiency, flexibility, and functionality;
- Modeling and analytics—developing core analytic, assessment, and engineering capabilities that can support the technology and policy initiatives and decision making within the Department, and for stakeholders; providing situational awareness for complex interdependencies among energy infrastructure systems, such as between electricity, natural gas systems and their associated communication requirements;
- Institutional support and technical assistance—building capacity within industry and convening stakeholders to coordinate efforts to transform the electric grid; providing technical assistance to Federal, State, Local, Tribal, Territorial, and regional entities to improve policies, utility incentives, State laws, and programs that facilitate the modernization of the electric infrastructure and support critical infrastructure;
- Coordination of Federal transmission permits—streamlining permits, special use authorizations, and other approvals required under Federal law to site electric transmission facilities; and,
- Coordination with the Power Marketing Administrations (PMAs) and energy infrastructure owners—improving the resilience of Critical Defense Facilities (CDF) and their associated Defense Critical Electric Infrastructure (DCEI).

Detailed Elements of the FY 2021 Request

Transmission Reliability and Resilience

The Transmission Reliability and Resilience (TRR) program provides the electric sector with the necessary tools and analyses to assess risks, inform decisions, and improve power system planning and performance, including mitigating the risks of large-scale blackouts. TRR is focused on early-stage and foundational research and development concentrated on measurement and control of the electricity system, as well as model development and validation for assessing risks across integrated energy systems. TRR brings together energy stakeholders from government, industry, and academia to generate ideas and develop solutions to the Nation's energy infrastructure challenges.

The $56.0 million request for TRR includes support for development of the North American Energy Resilience Model (NAERM), sensors and data analytics for transmission systems, next-generation mathematical and statistical algorithms for improvement of the security, reliability, and resilience of the electric power system, and research on protective relaying approaches to improve system resilience against modern threats while enhancing recovery operations following natural and man-made disasters.

Understanding how the North American energy system reacts to disruptions to one or more individual components is a vital part of the Nation's ability to protect critical infrastructure, including Critical Defense Facilities, most of which rely on the civilian grid for power. NAERM will allow the United States to conduct planning and contingency analyses that address vulnerabilities in the North American energy system. This capability will incorporate all relevant assets of the integrated bulk energy system, including the associated communications systems, and identify recommendations for infrastructure investments and improvements to be made by asset owners and operators that would improve resilience and mitigate the risks associated with energy system interdependencies and nation-state threats. Furthermore, the NAERM will facilitate the optimization of the bulk power system including identifying opportunities to reduce congestion charges and spinning reserve margins. NAERM will also allow for the exploration of sequences of events that create risks across critical infrastructure sectors and the identification and analysis of key critical infrastructure interdependencies, facilitate the strategic integration of renewable generation resources throughout North America, allow us to better target future R&D requirements through more holistic analyses of the system as a whole, and help generate more realistic training and exercising in the face of evolving cyber, physical, and other asymmetric threats to the electric grid.

Through NAERM, the Federal Government will have the ability to better evaluate strategic opportunities for improving system performance through the deployment of certain types of infrastructure, for example, energy storage for frequency control. This and other features of NAERM will inform national security investments and enhance decision making and the use of authorities to respond to Grid Security Emergencies. The ability to analyze data and models, predict consequences, and prioritize infrastructure protection is a necessary prerequisite for enhancing the resilience of the North American energy system. The FY 2021 request of $21.0 million for NAERM allows for the completion of a foundational near-real-time analysis capability.

The Sensors and Data Analytics program will develop and integrate high-speed, high-fidelity sensing technologies and advanced data analytics for improved diagnostics, prediction, and determination of action during normal and extreme-event conditions in both electric transmission and generation systems. Sensors and Data Analytics R&D will enable the state of the power system to be determined with greater

speed, accuracy, and precision than ever before. This is necessary to manage the increasing complexity of the grid's operations and its assets; and to monitor and manage the interconnected and interdependent effects among the Nation's critical infrastructures, which are realizing increasing levels of threat conditions. The energy sector can leverage this information to increase its ability to mitigate disruptions to key infrastructure and to identify alternative pathways and solutions for secure energy delivery.

Resilient Distribution Systems

With a request of $18.3 million, the Resilient Distribution Systems (RDS) program will continue to focus on addressing the challenges facing the electric power grid by developing innovative technologies, tools, and techniques to enable industry to modernize the distribution portion of the electric delivery system. RDS pursues strategic investments in early-stage R&D of innovative technologies and practices that improve reliability, resilience, outage recovery, and operational efficiency.

Research on microgrids, localized grids that can disconnect from the traditional grid to operate autonomously and help mitigate grid disturbances to strengthen grid resilience, continues to be a focus. Advanced protection and control schemes will be developed for both singular microgrids and networked microgrids to enhance system-wide value of reliability, resilience, and efficiency. Further, the consequence-based, quantitative models utilized by the microgrid feasibility analyses will be incorporated into energy master planning for communities and CDF, strengthening their resilience posture with respect to extreme weather and cyber-physical events. Other advanced microgrid technologies and tools will also be utilized to meet the mission assurance needs of DCEI.

Dynamic Controls and Communications (DC&C) R&D will develop the theoretical basis for methods and tools to evolve from centralized command and control to a more decentralized but coordinated system, as well as develop low-latency resilient communications networks capable of adapting to extreme events and disruptions.

RDS has supported the development of an Advanced Distribution Management Systems (ADMS) application platform, known as GridAPPS-D. In FY 2020, we are expanding the core capabilities of GridAPPS-D to include distributed applications, and are partnering with utilities and vendors to demonstrate specific use cases. These capabilities will be transitioned to industry in FY 2020 and FY 2021 to facilitate development of additional capabilities informed by industry needs.

Energy Storage

The electric power grid is the backbone of our modern economy and national security. Reliable operation of the grid has rested on two key principles: 1) reasonably predictable load, and 2) a corresponding ability to reliably control generation. As the electric grid evolves to accommodate more distributed energy resources, new models and tools, such as energy storage, can help effectively manage these changes. The OE research portfolio greatly advances the deployment of grid-scale bi-directional electric energy storage—grid energy storage is one of the key components of a flexible and resilient grid. In support of this objective, $83.5 million is requested in FY 2021.

OE's Energy Storage program focuses on grid-related aspects of DOE's integrated Energy Storage Grand Challenge (ESGC) strategy, which aims to deploy, in a coordinated effort, the Department's extensive resources and expertise to address technology development, commercialization, manufacturing, valuation, and workforce challenges related to energy storage. The ESGC incorporates DOE's Advanced Energy Storage Initiative.

Of the $83.5 million requested, $43.5 million continues R&D support, to include materials research on the next generation of battery chemistries, the development of new materials and new device technologies for efficient power conversion, improved safety and reliability of storage systems, the development of optimal design and control architectures for energy storage integration, and the development of open source models and software tools for system level energy storage planning and evaluation.

Advanced materials R&D is focused primarily on improving the cost and performance of battery chemistries based on domestically-available earth-abundant materials for next generation flow batteries and advanced sodium- and zinc-based systems. Research is also aimed at improving the lifetime and performance of these chemistries and all critical cell components, and moving these technologies toward practical prototypes that can achieve specific cost targets under $200 per kilowatt-hour (kWh).

Power electronics and power conversion systems can represent up to 30 percent of an installed storage system's cost-advanced materials device development efforts in order to achieve lower costs for and increased efficiencies in these components. The safety and reliability of energy storage systems is critical for large-scale deployment of storage technologies into grid infrastructure, and continues to be an active R&D area in the program. OE's Energy Storage program continues to be the primary conduit between research and industry for energy storage safety, thereby enabling the establishment of strong safety standards.

The remaining $40 million request for Energy Storage supports the construction of OE's Grid Storage Launchpad (GSL), which is located at Pacific Northwest National Laboratory and is aimed at accelerating materials development, testing, and independent evaluation of battery materials and battery systems for grid applications. The FY 2021 Request completes design funding and initiates construction funding, and would allow for the initiation of the design-build acquisition strategy in which design and construction services are secured together.

GSL will focus on identifying and solving issues within early-stage materials and prototype battery systems (less than 100 kilowatts) before moving to larger-scale systems; and will standardize grid performance testing across the spectrum of battery materials, battery systems, inverters, auxiliary power, and battery management systems under grid use-case conditions. GSL will also develop new capabilities for rapidly scaling up new materials for grid-scale bi-directional electric storage, delivering dedicated state of the art characterization capabilities that do not currently exist, and conducting realistic testing of design options and energy storage reliability. The facility will provide independent validation of the entire storage system, from materials and chemicals to battery modules and power electronics, and offer development solutions that can reduce the levelized cost of future systems.

Transformer Resilience and Advanced Components

The Transformer Resilience and Advanced Components (TRAC) program supports the hardening, response, and restoration of electric infrastructure by addressing the unique challenges facing transformers, critical components, and other grid hardware technologies responsible for carrying, controlling, and converting electricity from where it is generated to where it is needed. Transformers, power lines, and substation equipment are often exposed to the elements and are vulnerable to an increasing number of natural and man-made threats. To enhance the security, reliability, and resilience of the electric power system, the next generation of these grid hardware technologies will need to be

designed and built to withstand and rapidly recover from the impact of extreme terrestrial- or space-weather events, electrical disturbances, equipment failures, accidents, and deliberate attacks.

In FY 2021, $9.0 million is requested to continue to address critical research needs for solid-state power substations with an emphasis on advanced materials, embedded intelligence for equipment monitoring, and capabilities to evaluate prototype converter building blocks. Greater utilization of high voltage power electronic converters within substations, including in hybrid and solid-state transformer applications, can provide power flow control capabilities and reactive power support, limit fault currents, and increase system reliability and resilience. High-fidelity modeling and simulation will further enhance the understanding of the value and impact these capabilities will provide.

Defense Critical Electric Infrastructure Energy Mission Assurance

The Defense Critical Electric Infrastructure Energy Mission Assurance program will identify, evaluate, prioritize, and assist in developing executable strategies to strengthen the energy infrastructure systems supporting the critical infrastructure needed to ensure continuity of defense activities following severe natural and manmade disasters. By working closely with the Department of Defense and, specifically, focusing on prioritized defense critical missions, these investments will help assure the provision of energy resources to those locations designated by the Secretary of Energy (the Secretary) as Critical Defense Facilities (CDFs), as codified by the 2015 Fixing America's Surface Transportation Act.

Within the $1.65 million request, investments will capitalize on previous OE-led work with its Power Marketing Administrations (PMA), the National Nuclear Security Administration, the Department of Homeland Security, the Department of Defense, the Army Corps of Engineers, the Bureau of Reclamation, and other energy infrastructure stakeholders, as appropriate. The request includes on-site evaluations and the development of methodologies and preliminary engineering to improve the resilience of electric power provided to CDFs, including development of electric power resilience requirements for essential critical infrastructure nodes. Going forward, it is vital that the intelligence, law enforcement, and operator communities work more closely than ever before to maintain a constant vigilance as threats affecting critical missions and operations change.

Transmission Permitting and Technical Assistance

$7.0 million is requested for OE's Transmission Permitting and Technical Assistance (TPTA) Division to promote a resilient and reliable electricity system by addressing key institutional issues through a collaborative process with Federal, State, Local, Tribal, Territorial, regional, community, and industry decision makers. TPTA's Technical Assistance program works with stakeholders to address emerging issues by enabling informed institutional decision-making, which leads to prudent electric grid investment strategies and related practices.

Evolving Federal and State policies, the changing technological landscape, the emergence of new participants in the management of electricity, and the convergence of the electric grid with other infrastructures are the key factors that introduce increased levels of complexity and uncertainty in our grid management practices. In addition, the increasing interdependence between the electric grid and other key infrastructures, including natural gas, transportation, and communications, presents critical issues concerning fuel security and energy delivery reliability. TPTA will leverage NAERM to identify risks resulting from energy system interdependencies, as well as potential infrastructure investments and risk mitigation strategies, and works with our PMAs, the Department's Office of Cybersecurity, Energy

Security, and Emergency Response, and other stakeholders to address these opportunities, especially those related to critical electric infrastructure investments, including DCEI.

TPTA also implements a number of legal authorities that seek to address grid reliability and security issues. During emergency circumstances resulting from unexpected outages of grid assets, TPTA assists the Secretary in ensuring the reliable, uninterrupted provision of electricity to citizens. TPTA issues Presidential permits and export authorization orders, which facilitate important international transmission line projects that cross U.S. borders to connect the U.S. grid to additional reliable sources of power within North America.

Program Direction

The FY 2021 Budget Request includes $19.6 million for Program Direction, which supports Federal staff providing executive management, programmatic oversight, and critical technical and administrative support necessary for the effective implementation of the OE program. The Request funds 62 full-time equivalent employees, based primarily at Headquarters and the National Energy Technology Laboratory in West Virginia.

Conclusion

OE's FY 2021 Budget Request will give our team the tools and resources that will ensure and maintaini steady and sustained progress towards modernizing and strengthening of the Nation's electricity system.

The United States has reached an important juncture in the evolution of how electricity is delivered to consumers. As America's population continues to grow and the world becomes increasingly digitized and complex, consumers must have access to reliable, secure, and clean sources of energy to meet the demands and challenges of living in a modern, vibrant society. Near-peer adversaries are actively pursuing remote capabilities to target the electric grid as a way of degrading the Nation's ability to project power, sustain a competitive, secure economy, and assure critical public services. As the Nation and the world continue changing, the Nation's power grid must also change and adapt to the diversity and uncertainty of future energy demands and generation portfolios, and growing threats.

OE's Request invests in activities that will allow us to address these ongoing challenges and continue moving the Nation towards a more resilient and secure energy future.

This concludes my statement. I look forward to answering any questions that you may have.