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Thank you Senator Cantwell and members of the Committee for hosting this Field Hearing in Seattle. I appreciate the opportunity to address the Department of Energy's (DOE) historic, current, and growing responsibilities for helping the energy sector prepare for and respond to a wide range of threats and hazards.

Let me also thank Senator Cantwell, the Committee and the Congress for the recent focus on energy emergency response in both the FAST Act and in the Balanced Budget Act of 2015. These actions underscore the ongoing need to modernize our approaches to, and infrastructure for, responding to energy emergencies in a rapidly changing threat environment and energy space.

Rapidly Changing Energy Systems and Threats

This hearing to examine the current and future Federal role in responding to energy-related emergencies is very timely given that the Nation's energy systems and their vulnerabilities are undergoing significant changes. To appreciate DOE's essential and expanded role in energy emergency response today and in the future, it is important to place this discussion in the context of these remarkable changes and to examine the authorities and resources the Department has to address current and rapidly-evolving threats to these systems. While most of our energy infrastructures are privately owned and operated, energy is foundational to the Nation's economic prosperity and national security. As the President has pointed out, energy and communications systems enable all other infrastructures to function. If we don't protect the energy sector, we're putting every other sector of the economy in peril.

Changed Energy Profile. Let me briefly highlight the dramatically changed energy profile of the United States over the last decade and then discuss the evolving threat environment. The U.S. is now the number one producer of oil and gas in the world and we are producing more oil than we import for the first time in decades. Renewable energy technology deployment is rising and prices are falling. Energy efficiency policies and technologies are contributing to projected slow growth in demand for electricity, and flat or declining demand for oil. Natural gas recently

replaced coal as the largest fuel source for power generation. Importantly, unconventional oil and gas are also being produced in unconventional locations with potential implications for the transportation infrastructure to move these supplies to market, including recent congestion on railroads, inland waterways and ports, which will continue to need to be evaluated. U.S. companies are also exporting oil and natural gas, with security implications for global supply chains.

The April 2015 Quadrennial Energy Review (QER) concluded that in key areas, the country's energy and related infrastructures have not kept pace with changes in the volume and geography of oil and gas production.

Furthermore, integrated North American electricity grids and energy markets have increased the need for joint grid security strategies. The U.S. has new responsibilities for protecting LNG export supply chains. We also remain large net crude oil importers but now are large net oil product exporters as well as exporters of some crude oil; thus, we remain directly tied to world oil markets and global oil price volatility.

Finally, our allies and other key partners have significant energy supply and infrastructure vulnerabilities as was exposed by the 2014 Russian aggression in Ukraine. In response to this aggression, the U.S. and its G-7 partners developed a set of broad and collective energy security principles, two of which are especially important for today's discussion:

- Putting in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.
- Improving energy systems resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks.

A discussion of the evolving threat environment should start with the establishment of DOE in 1977 and how its role in emergency response was described in the Department of Energy Organization Act. At that time, the nation's energy vulnerability was perceived to be largely associated with growing oil imports, a global oil cartel, the real threat of physical disruption of oil supplies, and the inadequacy of an effective emergency response mechanism.

The Federal reaction to the Arab oil embargoes, the associated long gasoline lines, and the public's sense of extreme vulnerability led to the establishment of both the Department of Energy and its Strategic Petroleum Reserve (SPR). A reflection of the times, the only reference to emergency response in the DOE Organization Act was fundamentally about gasoline rationing and listed in the purposes of the Department as "[facilitating the] establishment of an effective strategy for distributing and allocating fuels in periods of short supply."

It should be noted that there are other essential emergency authorities, some of which predate the establishment of the Department, that have guided its actions in energy emergencies today and will do so going forward. These will be discussed shortly.

Changing Threat Environment. Fast forward to this century: We face a very different set of threats to our energy systems that guide both the structure and nature of our energy emergency

responses. Energy infrastructure is extending across state and international boundaries. We are also now operating in a post-9/11 threat environment that provides a new context and framework for what we as a Department are responsible for and do in emergency response. We know that adversaries and homegrown actors are interested in the vulnerabilities of our critical infrastructures. In response, there are now a range of laws, actions, and Presidential directives and orders designed to protect our citizens, economy and critical infrastructures from those with malevolent intent. Threats include natural and manmade events such as severe weather, natural disasters, electromagnetic pulses (EMPs), aging infrastructure, cyber threats, and growing infrastructure interdependencies. Some examples are dramatic extreme weather events like Superstorm Sandy, natural disasters like earthquakes and wildfires, and the growing perils of aging infrastructure like at Aliso Canyon, along with lower level but nevertheless troubling occurrences such as a series of as yet unexplained attacks on exposed electricity substations, including the Metcalfe incident in California and the Liberty substation in Arizona. As a result, public consciousness has been raised about the vulnerability of our electric grid and the need for the U.S.to substantially raise its game in addressing those vulnerabilities.

The threat of more devastating malevolent attacks such as EMPs underscores the vulnerabilities associated with the growing reliance of our society on electricity, starting with the "internet of things" where an estimated 50 billion devices or more are connected to an internet that relies on electricity. All of our critical infrastructures – finance, telecommunications, health care, industry, energy, indeed the systems we need to respond to energy emergencies – are connected to and often managed via the internet and they all rely on electricity. This makes our energy systems especially vulnerable to cyber-attacks on the grid and is why the Commander, U.S. Cyber Command and Director, National Security Agency, in testimony before the House Select Committee on Intelligence in October 2014, noted that "there should be no doubt in our minds that there are nation-states and groups that have the capability to enter our systems ...and to shut down...our ability to operate our basic infrastructures...whether its generating power, moving water and fuel".

With greater deployment of information and communication technologies to enhance the operational efficiency of our energy infrastructure, we are also witnessing a rise in intentional, malicious challenges to our energy systems. We are seeing threats continually increase in numbers and sophistication. This evolution has profound impacts on the security and resilience of the energy sector, which is why we have made cybersecurity one of our highest priorities at DOE.

The QER released in April 2015 noted that over half of the cyber incidents reported to DHS's Industrial Control Systems Cyber Emergency Response Team in 2013 related to energy installations, with the next highest percentage in the low double digits. The reliance of all of our critical energy infrastructures on electricity places a very high premium on a reliable, modern and hardened electric grid, as well as our efforts to understand, develop and evolve our emergency response capability to ever-changing and evolving cyber-threats.

In addition, we are seeing a rise in extreme weather events that are projected to increase in frequency and intensity. These events have regional and at times national-scale impacts on our

energy infrastructures and highlight the need for comprehensive and coordinated emergency responses. According to the QER, billion dollar weather events, especially severe storms, have risen dramatically in the last 15 years and are indicators of the vulnerabilities of our energy systems to climate change and costly disruptions. They have stressed our response capabilities and resources and underscored the interdependence of our critical infrastructures. Recent DOE analysis examining the effects of climate change on energy infrastructure exposure to storm surge and sea-level rise found that vulnerabilities are likely to increase for many energy sector assets, including electricity. Under the highest sea-level rise scenario, by 2030 the number of electricity substations in the Gulf of Mexico exposed to storm surge from Category 1 hurricanes could increase from 255 to 337; by 2050 the number would rise to roughly 400.

Further, our energy infrastructures are increasingly interdependent and all are dependent on electricity. Hurricanes Katrina and Rita, for example, downed 85,000 utility poles, 800 distribution substations, and thousands of miles of transmission lines. On the worst day of these sequential events, the Nation also lost almost 30 percent of its refining capacity. Three weeks after Rita hit, oil markets were still short around two million barrels a day. Hurricane Sandy knocked out power to 8.66 million customers. More than nine days after the storm, product deliveries from terminals in New York Harbor had returned to only 61 percent of pre-storm levels, forcing industry to seek work-arounds to resume supplies. Also during Sandy, power outages shut down gasoline pumps, demonstrating the interdependencies of energy infrastructures and our growing reliance on electricity. Within one week of Sandy's landfall, less than 20 percent of gas stations in New York City were able to sell gasoline. In part, this was attributable to the absence of backup electrical generation at gas stations and is a further demonstration of the interdependencies of energy infrastructures and their growing reliance on electricity. Moreover, the lack of transportation fuel hindered the ability of emergency personnel to respond to the crises.

Sea level rise, severe weather and storm surge are not, however, only about electricity. The Gulf Coast region is home to nearly 50 percent of the Nation's refining capacity, so damage to liquid fuels infrastructure in this region can lead to significant impacts on much of the rest of the country, as the Gulf supplies oil products to the Northeast, Midwest, Mid-Atlantic, and South Atlantic regions. Land subsidence also is a widespread issue throughout the Gulf Coast (and Mid-Atlantic coastal areas). During the past century, global sea-level rise has averaged about 1.7 mm/yr, though the rate in the Gulf has been faster (at 5–10 mm/yr, in part due to subsidence). Between now and 2030, the average global sea-level rise could accelerate to as much as 18 mm/yr in worst-case scenarios.

Relatedly, aging energy infrastructure presents challenges to citizen safety as well as reliable supply of power. The recent Southern California Aliso Canyon gas leaks are a prominent example of the challenges the U.S. faces in managing a system that was built decades ago and that has not been upgraded. Another important example is our Strategic Petroleum Reserve (SPR), which remains an essential tools of energy emergency response as the United States is still a significant oil importer. Its value however – and how that value gets translated into its use and operations – is dramatically different than when it was created in the 1970s. U.S.

dependence on this infrastructure is high, and public and private investment in it should match its benefits in order to ensure the resilience and responsiveness of our energy grid of the future. Later in this testimony I will describe progress that we have achieved, working closely with this Committee and other Congressional partners, in advancing the maintenance and modernization of the SPR.

DOE's Emergency Authorities

The Department of Energy has its origins in the Manhattan Project and the Atomic Energy Commission. Under the Atomic Energy Act, DOE has authority to acquire, transport, store, and dispose of nuclear material in emergency and non-emergency situations. This extends to special nuclear material, source material, and byproduct material, and the Department has long performed vital emergency preparedness and response roles in this mission space. For example, at the Olympics in Rio today, we have responders on the ground to address potential radiological incidents, in conjunction with other Federal partners and Brazilian authorities. The Department has been strengthened by the capabilities provided in this domain, and we have drawn upon the competence they have built and maintained to begin to fulfill the newer responsibilities for which we are now organizing ourselves.

In the energy emergency domain, there is a range of authorities under which the Department can and does act. Statutes that govern DOE's emergency authorities include the Defense Production Act, the Energy Policy and Conservation Act, the Natural Gas Act, the Federal Power Act and the Natural Gas Policy Act.

DOE's authorities can be divided into categories: independent DOE authorities; DOE authorities requiring a Presidential finding; and authorities that require consultation with other agencies.

- The Department has independent authority to order temporary electricity connections and the generation and transmission of electric energy; make exchanges of crude oil or petroleum products from SPR, Northeast Gasoline Supply Reserve (NGSR), or Northeast Home Heating Oil Reserve (NEHHOR); assist entities to procure the necessary energy materials and services to maintain supply during an emergency or to restore their systems; control nuclear material and gather information.

- Emergency authorities requiring a presidential finding include grid security emergency orders to protect or restore the reliability of critical electric infrastructure; sales from the SPR, the Northeast Gasoline Supply Reserve, the Northeast Home Heating Oil Reserve; allocation of energy materials, services, and facilities in the civilian market; allocation and certain purchases of natural gas; and fuel switching electric power plants or major fuel-burning installations.

- DOE has a consultative role for Jones Act waivers and a concurrence role for fuel waivers.

Examples include:

***Electricity Supply*.** The Department has used its independent authority to connect, temporarily, electricity lines to restore power (Hurricanes Ike, Katrina, and Rita), to require a power plant to continue operating to ensure grid reliability (Mirant Corp.'s Potomac River facility), to require specific transmission functions (Cross-Sound Cable Co. operation during the Northeast blackout), and to require generators to provide electricity when an Independent System Operator was otherwise unable to meet system demand (California energy crisis).

***Petroleum Supply*.** DOE's exchange authority under EPCA authorized the loan of one million barrels from the SPR with Marathon Oil following Hurricane Isaac in 2012; 5.4 million barrels with Marathon, Placid, ConocoPhillips, Citgo and Alon USA following Hurricanes Gustav and Ike in 2008; 9.8 million barrels following Hurricane Katrina in 2005; and 30 million barrels in anticipation of a heating oil shortage in 2000. After Hurricane Sandy, the Department loaned approximately 120,000 barrels from NEHHOR to the Department of Defense's Defense Logistics Agency for use in emergency operations, primarily to fuel the vehicles of emergency responders.

If the President determines that a severe energy supply interruption exists, DOE can sell crude oil from the SPR, home heating oil (*i.e.*, ultra-low sulfur diesel) from the NEHHOR, or gasoline from NGSR. The last time a President authorized a sale in response to a domestic emergency was in 2005 after Hurricane Katrina when President Bush issued a finding of a severe energy supply interruption and directed the sale of 30 million barrels.

Natural Gas. If the President finds that a natural gas supply emergency exists or is imminent, the Department has been delegated authority under the Natural Gas Policy Act through Executive Order 12235 to allocate natural gas to meet priority uses and authorize certain natural gas purchases. This authority was used in 2001 (in combination with its Defense Production Act authorities) to respond to the California energy crisis.

Procurement Prioritization. In addition to authorities for responding to emergencies concerning the supply of electricity or liquid fuels, the President has delegated authority to DOE under the Defense Production Act to require performance on a priority basis of contracts or orders deemed "necessary or appropriate to promote the national defense." This authority was used during the California energy crisis of 2000-2001 to direct entities that had recently provided a utility with natural gas to continue to make similar volumes available to the utility on the same payment schedule as before.

Access to data for mission delivery: DOE has information-gathering authorities to compel energy sector entities to provide information that is relevant to DOE activities. For example, under section 13 of the Federal Energy Administration Act of 1974, the Secretary can order "[a]ll persons owning or operating facilities or business premises who are engaged in any phase of energy supply or major energy consumption" to make available energy-related information.
Power Marketing Administrations (PMA). The PMAs deliver power from federal hydropower assets, which can provide critical black start capabilities to reenergize the grid and support safe

nuclear plant shutdown. DOE has exercised these authorities in a variety of circumstances. In addition, three of the four PMAs, Bonneville Power Administration, Western Area Power

Administration and Southwestern Power Marketing Administration are active participants in utility emergency response programs. Crews and equipment are dispatched in support of emergency restoration and neighboring utilities.

Recent Emergency Authorities and Directives Related to Emergency Response

FAST Act. Last year, Congress recognized the growing complexities of the a rapidly evolving landscape and enacted important new energy security measures in the Fixing America's Surface Transportation Act (FAST Act) (P.L. No. 114-94). Part of the FAST Act provides DOE with a new authority to protect and restore critical infrastructure when the President declares a grid security emergency. This authority allows DOE to support the energy sector preparing for and responding to cyber, EMP, geomagnetic disturbance, and physical attack threats. These authorities do not apply, however, to natural disasters other than geomagnetic storms.

The FAST Act (Sec. 61004) also noted the critical nature of large power transformers to the electricity grid. The law requires DOE in consultation with Federal Energy Regulatory Commission (FERC), the Electricity Subsector Coordinating Council (ESCC), Energy Reliability Organization (ERO), and owners and operators of critical electric infrastructure to submit a plan to Congress evaluating the feasibility of establishing a Strategic Transformer Reserve for the storage, in strategically-located facilities, of spare large power transformers in sufficient numbers to temporarily replace critically damaged large power transformers.

Balanced Budget Act of 2015. The 2015 Balanced Budget Act directly supports the findings of QER and states that "maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions." The Act directs DOE to establish a SPR modernization program to protect the U.S. economy from the impacts of emergency product supply disruptions and that this program may include infrastructure and facilities to optimize the drawdown and distribution capacity of the SPR." Congress also authorized the sale of up to $2 billion in SPR crude oil sales to fund the SPR modernization program subject to appropriation.

Presidential Policy Directive 21. Presidential Policy Directive-21: Critical Infrastructure Security and Resilience identifies DOE as the Sector-Specific Agency (SSA) for energy infrastructure. Within the Department, the authority and responsibility of the SSA are assigned to Office of Electricity Delivery and Energy Reliability, and play a pivotal role in ensuring unity of effort between private and government partners, including the Department of Homeland Security, Department of Defense, and Federal Bureau of Investigation, to improve preparedness and response to all hazards in the energy sector.

As the Energy SSA, we serve as the day-to-day Federal interface for the prioritization and coordination of activities to strengthen the security and resilience of critical energy infrastructure. This involves building, maintaining, and advancing collaborative efforts with the energy sector to bridge federal programs for sharing situational awareness information, modeling impacts, assessing vulnerabilities, conducting exercises, and promote innovation and research.

Emergency Support Function 12. In addition to enhancing security and reslience through our role as an SSA, the DOE enhances security and resilience by serving as the lead agency for Emergency Support Function 12 (ESF-12) under the National Preparedness System's National Response Framework. As the lead for ESF-12, we are responsible for facilitating recovery from disruptions to the energy infrastructure. During a response operation, the Department works with industry and Federal, state, and local partners to:

- Assess disaster impacts on local and regional energy infrastructure;
- Coordinate the response to expedite restoration;
- Monitor and provide situational awareness of impacts; and
- Provide regular situational awareness updates to key decision makers in the Administration and our government and industry partners.

To achieve these operational priorities, the Department deploys responders who work directly with affected utilities and local officials on the ground during a disaster. The responders provide expertise on a variety of energy issues, and have direct access to our subject matter experts throughout the Department, and at our interagency partners, to coordinate the appropriate assistance including waivers or special permits to expedite restoration efforts. Our response force is entirely voluntary, and we are training nearly 100 members of our staff to be prepared to deploy for all hazards contingencies.

Actions Taken Since 2014 to Increase Prevention, Resilience and Response Capabilities to Meet the Emerging Challenge

Over the past two years, the Deputy Secretary and I have led a deliberate effort to strengthen our emergency response capabilities and our critical partnerships with the energy sector. This included enhanced emergency preparedness/response collaboration with the Electricity Subsector Coordination Council (ESCC), the Oil & Natural Gas Subsector Coordinating Council (ONG SCC), and the National Petroleum Council (NPC) for strategic planning and operational exercising.

Partnering with Industry. DOE will continue to assist utility owners and operators and state and local officials across the country when hazards and threats emerge. With more than 80 percent of the Nation's power infrastructure privately owned and operated, coordinating and aligning efforts between the government and the private sector is the only viable path to increased resilience and effective emergency response.

When the power goes out, the local utility is the first to respond. Should any threat or emergency exceed jurisdictional resources or result in a Federal disaster declaration, DOE coordinates Federal resources as the lead as assigned under ESF 12. In collaboration with other Federal agencies, local governments, and industry, DOE facilitates access to impacted areas, actionable situational awareness information, regulatory waivers, and other tools to assist overwhelmed

jurisdictions. Together, we generate the actions that are needed to address the impact of the event and restore power.

Public-private emergency preparedness and response cooperation: Building on lessons learned from Superstorm Sandy, DOE has worked closely with the Electricity SubSector Coordinating Council (ESCC) – a national organization of major utility CEOs and industry associations – along with the Oil and Natural Gas Subsector Coordinating Council (ONG SCC) -- on a set of specific initiatives designed to strengthen the security and resilience of critical energy infrastructure. The Deputy Secretary and the ESCC meet at least three times per year to advance our work together, and focus on the sharing of relevant threat information (both before and during a crisis), conducting vulnerability assessments, developing and deploying new technologies, and exercising together.

For example, we are partnering with the ESCC and the Electric Power Research Institute (EPRI) on efforts to address the effects of an EMP attack. Additionally, we are working with the ESCC to help focus our R&D efforts and bring new technologies to market that will strengthen the security of the grid. In fact, we will be hosting a joint meeting of the ESCC and government officials this September at our Sandia National Laboratories to focus specifically on R&D issues. In addition, both the ESCC and the ONG SCC are part of a working group created by DOE and DHS that is focused on threats to the energy sector's manufacturing supply chain, and what government and industry can do together to improve the security of that supply chain. Most importantly, we work with the ESCC and the ONG SCC to prepare for, and respond to, major disasters or threats to energy infrastructure. Our partnerships span information sharing, supporting innovation, and exercising incident response.

The foundation of our partnerships is sharing appropriate information as true partners. Our success depends on it. One of the challenges here is speed. It is critical that all parties share information about dynamic threats expeditiously to protect our nation. DOE's solution is to provide tools and information to companies so that they can become aware of risks as soon as they're identified, and can take action.

The Cybersecurity Risk Information Sharing Program (CRISP) is a public-private partnership, co-funded by DOE and industry. The purpose of CRISP is to collaborate with energy sector partners to facilitate the timely bi-directional sharing of unclassified and classified threat information and to develop situational awareness tools that enhance the sector's ability to identify, prioritize, and coordinate the protection of critical infrastructure and key resources. CRISP leverages advanced sensors and threat analysis techniques developed by DOE along with DOE's expertise as part of the National Intelligence Community to better inform the energy sector of the high-level cyber risks. Current CRISP participants provide power to over 75 percent of the total number of continental U.S. electricity subsector customers.

Further, as part of the Administration's efforts to improve electricity subsector cybersecurity capabilities, DOE and industry partners developed the Electricity Subsector Cybersecurity Capability Maturity Model (C2M2) to help private sector owners and operators better evaluate their cybersecurity capabilities. The C2M2 evaluation helps organizations prioritize and improve cybersecurity activities. This is a comprehensive and credible approach that all energy sector

companies can use to improve their cybersecurity posture. DOE also released versions of the C2M2 for the oil and natural gas subsectors and for industry at large.

In addition, we have worked closely with the National Petroleum Council (NPC) to identify opportunities to strengthen emergency preparedness. At my request, the NPC conducted a comprehensive study on this topic and presented me, in December 2014, with an Emergency Preparedness Report, which included a number of recommendations for strengthening how the Department and the oil and natural gas industry work together to respond to emergencies. Over the past year, DOE has made progress implementing the recommendations contained in the report. For instance, DOE is now using the National Incident Management System (NIMS) and Incident Command System (ICS) to ensure that we can easily integrate with other emergency management organizations around the country. DOE's Infrastructure Security and Energy Restoration (ISER) team now has Energy Information Administration experts embedded in its emergency response organization, so they have the benefit of their insights into the oil & natural gas industry during emergencies. In addition, the Department is working more frequently with the oil & natural gas industry on disaster preparedness exercises. In fact, the NPC was one of the Department's key partners in the development of the Clear Path IV exercise, which I will describe shortly.

Partnering with the Federal/State/Local/Tribal Government. We are also supporting preparedness efforts by working to provide Federal, state, local, and tribal officials with programs and tools that help in their energy emergency preparedness activities, including, planning, training, tabletop exercises and research and development.
In early February, I signed an updated Energy Emergency Assurance Coordinators (EEAC) Agreement with the National Association of State Energy Officials, National Association of Regulatory Utility Commissioners, National Governors Association,, and National Emergency Management Association. This updated EEAC Agreement lays out concrete items to improve our collective ability to share information, which is essential for making sound response and restoration decisions during emergencies. To support this effort, DOE and state officials will develop information-sharing protocols and processes to streamline response operations. We will also test these processes and information-sharing mechanisms through regular drills and exercises.

With the EEAC agreement in place, we are planning to enhance our state, local, tribal, and territorial governments program with robust training and exercising that brings stakeholders together to address planning for shared regional hazards. Many of today's lifeline sectors depend on reliable energy supplies. A vital element of providing uninterruptable energy is building resilience by developing regional plans to rapidly restore energy and identify specific needs to resolve energy disruptions. Lessons learned from these collaborations will be shared with other communities to leverage the effort across the Nation.

The President's FY 2017 Budget Request included $15 million for a State Energy Assurance program to foster regional hazard preparedness. This program would focus on providing state, local, tribal, and territorial governments with analysis, training, and exercising of shared regional risk factors where entities depend on each other for energy supplies and must work together to resolve energy disruptions to restore energy.

This new program would be facilitated through competitive regional cooperative assistance awards to state and local partners. DOE would support planning, training, and exercising with expertise from across the enterprise including the HAMMER Federal Training Center and National Laboratories. The expertise and capability of the whole Department would be available to each consortium of awardees to enhance preparation and allow for real-world energy emergency support. Lessons learned would be shared with other communities to leverage the program across the nation and help improve resiliency planning.

Supporting Innovation. One of DOE's core missions is to support the innovation that will help us enhance our nation's energy security today and into the future. As the sector-specific agency in charge of supporting and facilitating the security of our electric grid, we are focused on growing our partnerships with academia and the private sector and leveraging the wide-ranging science and technology capabilities of our 17 National Labs in order to modernize our grid and make it more secure and resilient.

The Department continues to invest in long-term strategic R&D and testing capabilities throughout the National Laboratory complex to achieve these goals.

Since the 2003 Northeast blackout, DOE has been proactive in advancing technologies to modernize the grid by making it smarter and more adaptive to the challenges posed by a range of reliability concerns. Enhanced situational awareness and control capabilities enable grid operators to monitor the status of the grid, predict potential impacts of a threat, and respond accordingly to mitigate or recover from a threat.

For example, PNNL has been developing new modeling and simulation capabilities that leverage data streams from synchrophasor technology to help analyze and prevent disturbances from growing into wide area outages.

DOE has worked with utilities across the country to develop and deploy a network of more than 1,300 high-speed sensors across the nation's power grid to provide real-time data on the state of the grid. This network helps utilities better share information and quickly detect and mitigate local disturbances and prevent these problems from cascading into larger systems impacts.

DOE has also co-funded work with utilities in areas across the US to deploy high-speed communications and control systems that sense grid outages and re-direct power flows to minimize impacts on consumers. These systems also greatly help restore power after a disruption whether caused by a hurricane, tornado, or even cyber-related events.

Since 2010, we have invested more than $210 million in collaborative cybersecurity research and development projects among industry, universities, and our National Labs. Those investments have led to work such as the Honeywell-led "Role Based Access Control" project. This project created role based access control (RBAC) technology for a Honeywell product suite. This is an energy delivery control system used extensively within the oil and gas industry. The new technology limits access to the least needed to perform a given task, helping to reduce the risk of unauthorized access, including by an insider.

Sandia National Laboratory has a cybersecurity research partnership with Chevron to develop a technology that will change the control system configuration moment-by-moment. This is especially exciting because it will make it very difficult for an adversary to map the network or stage an attack. It also makes it easier for responders to isolate malicious actors if they do gain access.

In another project that DOE supports, Schweitzer Engineering Laboratories Inc. (SEL) partnered with Sandia National Laboratories (SNL) and Tennessee Valley Authority (TVA) to develop a commercial solution that detects tampering with the kinds of field devices that you see attached to utility poles, and further strengthens their cybersecurity by guarding against any unexpected cyber-activity. Thousands have been sold and are being used throughout the energy sector today in all 50 states.

Energy storage is another key technology the DOE is supporting that helps to increase grid resiliency. In additional to supporting greater deployment of variable renewable energy resources, energy storage technologies can keep customers and communities up and running during outages by supplying power to affected areas. When integrated into microgrids, another focus area of the Department, energy storage technologies can work in tandem with distributed generation and other energy resources to meet the needs of critical loads such as hospitals, first responders, and water supplies for an extended period of time. These essential services are critical to the health and safety of communities during large scale outages.

Large power transformers (LPTs) are grid components that are ripe for innovation. These critical assets can weigh hundreds of tons, are expensive, and are typically custom made with procurement lead times of a year or more. A large number of damaged transformers from a hazard could result in long-term outages that can cripple the economy. The QER recognized the risks associated with the loss of LPTs and recommended that DOE work with other Federal agencies, states, and industry to mitigate these risks, including assessing the development of one or more strategic transformer reserves. As noted, the FAST Act required DOE to submit a plan to Congress evaluating the feasibility of establishing a Strategic Transformer Reserve for the storage, in strategically-located facilities, of spare large power transformers in sufficient numbers to temporarily replace critically damaged large power transformers. In January, DOE-OE awarded the analysis project to a team led by the Oak Ridge National Laboratory. The team includes researchers from the University of Tennessee-Knoxville, Sandia National Laboratories, the Electric Power Research Institute, and Dominion Virginia Power. DOE's analytical approach is focused on identifying high voltage substations and LPTs that most affect the grid's performance if lost. We are also analyzing the availability of spare LPTs, determining the nature of events that could produce significant outages, identifying equipment options, including numbers and types, for provisional LPT replacement, optimizing number and locations of spare LPTs and identifying policy options to address these issues.

In addition, DOE is supporting modeling and testing of transformers to better understand their vulnerabilities to geomagnetic disturbances and electromagnetic pulses, informing new design requirements. A funding opportunity announcement released in June 2016 aims to stimulate innovative LPT designs that are more flexible and adaptable so they can be readily used in different locations. This solicitation promotes greater standardization which will increase the

ability to share transformers and accelerate recovery in the event of the loss of one or more of these vital pieces of equipment.

Another example of DOE innovation is EAGLE-I (Environment for Analysis of Geo-Located Energy Information), which is a DOE-designed and operated web tool that automatically gathers electrical grid service status data from company websites every 15 minutes, and organizes it into an easy-to-read picture of electrical service status nationwide. Now covering 75 percent of all U.S. electricity customers, it provides real-time information about the grid – what is up, what is down, the number and location of outages, when service is restored – to DOE and, through our information-sharing efforts, with other Federal agencies.

In sum, our National Labs are powerful partners working with industry to secure our energy infrastructure. The Department has continued to build long-term strategic research and development capability at National Labs and academia. As a result, DOE helped create a national resource for experimental work in research and analysis of trustworthy power grid systems, both at the DOE Labs and universities.

The President's FY2017 Budget makes a strong first step toward our commitment to seek to double clean energy R&D funding under Mission Innovation, the international initiative to accelerate clean energy innovation. DOE's FY2017 request includes strong support for Mission Innovation, including a proposal for Regional Innovation Partnerships. DOE Mission Innovation work includes activities that support a strong foundation for addressing the infrastructure R&D needs discussed here, as well as activities that support the broader clean energy R&D needed for our economic, environmental and security goals.

Exercising Our Plans. Robust exercises are crucial to ensure industry and government are better prepared to work as a team during real world emergencies, such hurricanes, earthquakes, or cyberattacks. DOE leads preparedness exercises at the local, state, and national levels. In November 2015, for example, DOE led the Federal participation in the North American Electric Reliability Corporation's Grid Ex III, the largest electricity sector crisis response exercise ever. More than 350 government and industry organizations, as well as 4,500 participants played a role in testing and shaping the national response plan.

In April 2016, DOE led Clear Path IV in Portland, Oregon and Washington, DC. Clear Path IV was an interagency exercise focused on testing and evaluating energy sector response plans to address modeled impacts from a scenario depicting a Cascadia Subduction Zone (CSZ) 9.0 earthquake and tsunami. The devastation that would be caused by such an event was highlighted in a July 2015 *New Yorker* magazine article, titled "The Really Big One." As the *New Yorker* reported, a full-scale rupture of the subduction zone would cover a hundred and forty thousand square miles and impact an estimated seven million people. "When the next full-margin rupture happens," noted the *New Yorker*, "that region will suffer the worst natural disaster in the history of North America." These potential impacts help drive our decision to focus on the Cascadia Subduction Zone for the Clear Path IV exercise. Clear Path IV included representation from 10 Federal agencies, seven states, five local governments, 15 oil and natural gas companies, 18 electric utilities, six trade associations, and four state associations with more than 175 participants. Providing solutions to lessons learned will contribute to prepare the region to be

able to respond effectively to this kind of catastrophic event and improve DOE's ability to perform ESF #12 responsibilities.

Clear Path IV also served to enhance the energy sector's participation in Cascadia Rising, the national level exercise held in June 2016. Using the same Cascadia Subduction Zone scenario, the sector and DOE were able to test possible solutions to issues discovered during Clear Path and better inform our Federal partners what requirements are expected to restore energy. The collaboration between the two large, functional exercises are a model for the value of progressive exercise development.

Exercises like Clear Path and Cascadia Rising help the entire emergency management team – federal, state, local, and tribal governments, and industry – identify needs and resource requirements that will be required during an actual disaster. For instance, one of the lessons learned from Clear Path IV was the need to accelerate damage assessments immediately after a catastrophic event. The Department is working with DHS and Pacific Northwest National Laboratory to provide assessments through advanced algorithms that analyze aerial imagery, highlighting the role of science and technology solutions. To continue to fulfill our response mission, we innovate and provide practical solutions, including tools and new technologies, to facilitate quick energy restoration.

DOE Enterprise Solutions

Unique to DOE, we own critical assets in the sector we support. Our preparedness and response activities for our enterprise directly overlap with the broader energy sector with our PMA's, and this is why our internal and external emergency management activities must be unified. We are bringing together specialized talent across the Department including plants, sites, and our National Labs to strengthen how our team works together to respond to disasters and emergencies to our own assets as well as the broader energy sector.

Integrated Joint Cyber Coordination Center. We are further transforming the Department's cybersecurity culture and integrating cybersecurity coordination across the DOE enterprise through the Integrated Joint Cybersecurity Coordination Center (iJC3), which is funded by program contributions to the DOE Working Capital Fund. The iJC3 integrates cybersecurity across the Department in mutual, comprehensive defense of the DOE enterprise. The iJC3 will unify the breadth and depth of cyber technical expertise across DOE, remove redundancy, increase effectiveness, and holistically document and communicate cyber threats and leverage cyber capabilities DOE enterprise-wide.

The iJC3 is designed to both manage cyber risk across the Department using threat-informed cyber intelligence, and to mature and strengthen the Department's cyber posture and response. Previously independent cyber centers and specialized expertise will now be integrated in a collaborative, intelligence driven, enterprise distributed approach to cyber operations, defense, and response that engages DOE's full capabilities and protects the entirety of the DOE attack surface to include all program offices, national laboratories, plants, field offices, and the PMAs.

The iJC3 combines situational awareness of threats, operational status of networks, and indicators of known malicious activity to decrease discovery time and speed response time.

DOE Unified Command Structure (UCS). Last year, DOE established a Unified Command Structure (UCS) that has increased cooperation and coordination across the entire DOE enterprise – from our energy infrastructure team to our National Nuclear Security Administration, which responds to nuclear and radiological events. It ensures that the capabilities of the entire Department can be brought to bear in the face of any threat or scenario – regardless of whether that scenario involves one of our DOE facilities, requiring only internal coordination, or a large-scale incident involving portions of our Nation's energy infrastructure, which requires coordination with our industry and government partners.

Emergency & Incident Management Council (EIMC). To provide strategic guidance and direction for the UCS, we have also created an Emergency & Incident Management Council (EIMC) that is chaired by the Deputy Secretary and meets twice a month or more frequently when required. This Council serves as the primary DOE strategic coordination mechanism for senior Department leadership and enables us to prepare for and respond during significant emergencies that require the coordinated efforts of our entire Department or several of its components.

Consolidated Emergency Operations Center (CEOC). To advance the successful full implementation of our new approach that matches our evolving operational response mission, the Department has proposed the creation of a Consolidated Emergency Operation Center (CEOC) that will be designed for a full range of scenarios and incidents, and allow the UCS to operate in a single facility. When fully operational, the CEOC will eliminate DOE's fragmented emergency operations center system and provide a unified, inclusive, and effective emergency management enterprise modeled on best practices across the Federal government. We are currently working with the House and Senate Appropriations Committees to secure the funding and authority the Department needs to complete the development and eventual construction of the center.

Emergency Response Order 151.1. We have taken action to codify our emergency management enhancements and how they work together to achieve coordinated and comprehensive response activities in a recent revision to the Department's directive governing Emergency Response. The revised order 151.1 that I signed out earlier this month now has a dedicated section focusing on energy sector response, emphasizes an all-hazards approach to emergency management and planning, includes the EIMC as the senior-most body for emergency management, and embodies enterprise-wide stakeholder engagement to leverage unique capabilities across the Department, including our 17 national labs.

Deployable Crisis Expertise from National Labs

At the invitation of state and local authorities following the massive gas leak several months ago at the Aliso Canyon underground gas storage facility, DOE commissioned some of its National Laboratories to examine safety issues associated with existing oil and gas wells and related

underground storage facilities. This is the kind of on-call capability that we are able to field due to the deep bench of science and technology expertise located in our 17 National Labs.

Managing Federal Strategic Energy Resources.

The April 2015 Quadrennial Energy Review recommended that DOE invest to optimize the SPR's emergency response capability. It further stated that DOE should make infrastructure improvements in the SPR and its distribution systems to optimize the SPR's ability to protect the U.S. economy in an energy supply emergency." Implementing an effective and comprehensive modernization program will ensure that DOE will be able to move high volumes of incremental barrels of oil rapidly to successful bidders in case of a global supply disruption, thereby increasing supplies in global markets and enhancing the value of the SPR for meeting the Nation's strategic energy needs.

As noted, the 2015 Balanced Budget Act directly supports the findings of QER and states that "maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions." The Act directs DOE to establish a SPR modernization program to protect the U.S. economy from the impacts of emergency product supply disruptions and that this program may include infrastructure and facilities to optimize the drawdown and distribution capacity of the SPR." Congress also authorized the sale of up to $2 billion in SPR crude oil sales to fund the SPR modernization program.

We are moving forward on the SPR modernization efforts. DOE has identified two specific projects that will make up the SPR modernization program:

- *Life Extension Phase II* –The aging SPR infrastructure is further strained with a challenging budget environment that has resulted in an extensive, growing backlog in the SPR's major maintenance project account. As a result, unanticipated SPR-related equipment failures are occurring and impacting the Reserve's operational readiness capability. The new life extension project will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure that the Reserve is able to meet its mission requirements and maintain operational readiness for the next several decades. On October 30, 2015, Deputy Secretary Sherwood-Randall approved the mission need (Critical Decision 0), the first step in DOE's project management process, for the Strategic Petroleum Reserve, Life Extension Phase II Project.

- *Marine Terminal Distribution Capability Enhancements*—The SPR's effective distribution capability—the reserve's ability to deliver SPR oil to domestic consumers without displacing commercial oil shipments—is compromised by new patterns of oil supply and demand among U.S. oil producers and refineries and associated changes in the U.S. midstream, including overall capacity. This has reduced the ability of the U.S. to distribute incremental volumes of reserve oil to the domestic market during certain future oil supply disruption scenarios. The purpose of this project is to increase the effective distribution capacity of the SPR through the addition of dedicated marine

capacity. DOE has approved Critical Decision-0, Mission Need and we anticipate being able to commence work on the NEPA analysis in January 2017, pending ability to receive a congressional appropriation to commence crude oil sales this fall.

DOE will soon submit a report to Congress on DOE's long-term strategic review of the SPR, which will further articulate the need for modernization.

Conclusion

As you know, I was the Department of Energy (DOE) Under Secretary during the Clinton Administration. When I returned to DOE after a 13 year absence, I was struck by the imperatives of what is, in reality, a new and complex mission for the Department — energy infrastructure, resilience, reliability, security and emergency response with significant operational and cross-cutting aspects and requirements to ensure that these issues are effectively and appropriately addressed. The requisite energy system view is not reflected directly in DOE's organizational structure.

Let me deconstruct this concern by first defining the key goals of this mission area for energy infrastructure:

- **Reliability** refers to the ability of a system or its components to operate within limits so that instability, uncontrolled events, or cascading failures do not result if there is a disturbance, whether the disturbance is a disruption from outside the system or an unanticipated failure of system elements. Reliability is also used by industry to mean that a system's components are not unexpectedly failing under normal circumstances.
- **Resilience** refers to the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions. To the extent that actions improve a system's ability to withstand disruptions, they might be characterized as enhancing reliability, or resilience, or both. The ability to recover from a disturbance, however, is specific to resilience.
- **Safety** refers to achieving an acceptably low risk to life and health in the design, construction, operation, and decommissioning of a system. That level of risk is determined by taking into account the magnitude of potential consequences, the probability of those consequences occurring, and the costs of risk mitigation.
- **Security** refers specifically to the ability of a system or its components to withstand attacks (including physical and cyber incidents) on its integrity and operations. It overlaps, in part, with the concepts of reliability and resilience.

Each of these goals is related and has physical, temporal, operational, technology, regulatory and legal components. These all need to be understood – from a systems perspective -- for effective energy emergency response, for mitigating the costs of future emergency responses and for diminishing the overall need for emergency response over time.

We addressed many of these issues in the first installment of the Quadrennial Energy Review, which includes many analytically-supported recommendations on energy infrastructure

resilience, reliability, safety and asset security. Several of these recommendations are works in progress and some of them require new statutory authority.

Those that are in the process of being implemented and highly relevant to this discussion include:

- The development of comprehensive data, metrics, and an analytical framework for energy infrastructure resilience, reliability, and asset security: The purpose of this work will be to help inform, coordinate, set priorities for, and justify expenditures across Federal agencies to increase the resilience, reliability, and security of energy infrastructure.
- Analyzing the policies, technical specifications, and logistical and program structures needed to mitigate the risks associated with the loss of transformers as part of the Administration's ongoing efforts to develop a formal strategy for strengthening the security and resilience of the entire electric grid for threats and hazards. Approaches for mitigating this risk could include the development of one or more transformer reserves through a staged process.
- Undertaking updated cost-benefit analyses for all regions of the United States that have been identified as vulnerable to fuel supply disruptions. Additional or expanded Regional Refined Product Reserves could be supported, depending on the outcome of these studies.

QER recommendations that require additional authorities or appropriations that are highly relevant to the topic of today's hearing, and not discussed earlier, include:

- Funding of a multi-year program of support for state and tribal energy assurance plans, focusing on improving the capacity of states and localities to identify potential energy disruptions, quantify their impacts, and develop comprehensive plans that respond to those disruptions and reduce the threat of future disruptions. As part of these plans, states should also assess needs for backup electricity at retail gasoline stations along emergency evacuation routes.
- The establishment of a competitive grant program to promote innovative solutions to enhance energy infrastructure resilience, reliability, and security. A major focus of the program would be the demonstration of new approaches to enhance regional grid resilience, implemented through the states by public and publicly regulated entities on a cost-shared basis, incorporating lessons learned from new data, metrics, and resilience frameworks. An example of such a project is the NJ TRANSITGRID, which incorporates renewable energy, distributed generation, and other technologies to provide resilient power to key NJ TRANSIT stations, maintenance facilities, bus garages, and other buildings. Through a microgrid design, NJ TRANSITGRID will also provide resilient electric traction power to allow NJ TRANSIT trains on critical corridors, including portions of the Northeast Corridor, to continue to operate even when the traditional grid fails.
- Amending the trigger for the release of fuel from NEHHOR and from the Northeast Gasoline Supply Reserve so that they are aligned and properly suited to the purpose of a product reserve, as opposed to a crude oil reserve. The authorities of the President to

release products from RPPRs should be integrated into a single, unified authority; these two facilities operate currently under different authorities.

Implementing these recommendations will be critical for ensuring reliable, resilient safe and secure energy systems. They are not, however, enough.

As I noted, we continue to analyze organizational options to improve execution in this mission area in light of these complex, complicated, cross-cutting and evolving requirements. Emergency Management responsibilities that are currently assigned to other offices within the Department do not have separately identifiable budgets, and are dependent upon the ability to draw resources from other program budgets when needed to conduct emergency management activities.

Within our current budget of approximately $29 billion, funding for this mission area is embedded in the programs that execute it and there are two discrete budget line items that support specific aspects of emergency management --- a budget of $9 million for the ISER program in the Office of Electricity and a budget of $25 million for Emergency Management and Operations Center within the National Nuclear Security Administration (NNSA). The latter is primarily focused on radiological emergency issues but also plays a key role in energy-related emergency management. The President's FY 2017 budget proposed significant increases in both program budgets – ISER is proposed to increase from $9 million to $17.5 million, and the NNSA program is proposed to increase from $25.1 million to $34.8 million.

As part of our budget planning, I have initiated a comprehensive crosscutting budget review of our emergency management activities to ensure the Department is prioritizing it resources to effectively carry out its responsibilities going forward.

Intentional, malicious challenges and natural threats to our energy systems are on the rise. The manmade threats continually increase in sophistication. Our energy infrastructures are vulnerable to such threats, are aging, and increasingly interdependent and reliant on electricity. The electricity system end-to-end is the focus of the next major installment of the Quadrennial Energy Review, targeted for late this year.

DOE uses its expertise in transformative science and technology solutions to support and enhance our Nation's emergency response capabilities. Through our private and public partnerships, we apply these solutions to prepare for emergencies, mitigate risks, and expedite restoration and recovery from incidents impacting the energy sector. Looking ahead, Congress will be a key partner in ensuring that we strengthen our prevention and response capabilities.