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"U.S. Energy Security"
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Thank you Chairman Upton, Vice Chairman Olson, Ranking Member Pallone, Ranking Member Rush, and members of the Subcommittee for holding this hearing concerning the Department of Energy's role in energy security.

I. Rapidly Changing Energy Systems and Threat Environment

U.S. energy security must be placed in the context of the changing U.S. energy profile, the evolving threat environment, and the global security challenges facing both our country and our allies, partners and friends in various regional settings.

The U.S. is now the number one producer of liquid fuels in the world, although we remain a major importer of crude oil. However, net imports of oil and oil products have been reduced significantly and since 2014. Thus, by the traditional measure of energy security, namely oil imports, we are in a stronger position than we have been for decades.

Importantly, unconventional oil and gas are also being produced in unconventional locations with important implications for the transportation infrastructure to move these supplies to market, such as congestion and accidents on railroads, inland waterways and ports in recent years. 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. U.S. companies are also beginning to export crude oil and LNG, impacting global supply chains. This highlights our continuing linkages to global energy markets and exposure to global oil price volatility.

Renewable energy technology deployment is rising rapidly, as costs of wind and solar energy continue to fall. Energy efficiency policies and technologies are contributing to projected slow growth in demand for electricityand for oil. Natural gas recently replaced coal as the largest fuel source for power generation. These are among the factors challenging incumbent business models in the energy sector.

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; for example, integrated North American electricity grids and energy markets have increased the need for joint grid security strategies.

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. Threats include natural and manmade events such as severe weather, storm surges exacerbated by rising and warmer seas, natural disasters such as earthquakes and wildfires, electromagnetic pulses (EMPs), aging infrastructure, cyber threats, kinetic attacks on electricity substations, and growing infrastructure interdependencies. 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. There are now a range of laws, actions, and Presidential directives and orders designed to protect our citizens, economy and critical infrastructuresfrom those with malevolent intent.

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, so cybersecurity is and is likely to remain one of our highest priorities at DOE and in the energy industry.

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.

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 tool 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.

These events, trends and vulnerabilities have regional and at times national-scale impacts on our energy infrastructures. They have stressed our response capabilities and resources and underscored the interdependence of our critical infrastructures. As a result, public consciousness has been elevated about the need for the U.S.to substantially raise its game in addressing those vulnerabilities and highlight the need for comprehensive and coordinated emergency responses.

These issues also underscore the need for a re-thinking of energy security that reflects modern domestic and global energy markets and the collective needs of our allies. Within this new framework, the modernization of our energy infrastructures to enhance resilience, reliability, flexibility, and efficiency directly contribute to energy security. The challenge is to develop the appropriate measures to appropriately value such contributions.

II. Energy Security Principles

Changing oil and natural gas markets, the evolving threat environment, and geopolitical factors such as the Russian aggression in Ukraine combined with European dependence on Russian gas have underscored the need for a modern approach to energy security to help guide U.S. domestic and foreign policy. In June 2014, the G-7 leaders and the EU noted that "energy security is not only domestic — it is dependent on interaction in the global interconnected market." The focus on energy security as a collective responsibility is very relevant for the United States even though our domestic oil and gas production has increased dramatically: energy insecurity of our allies and friends can raise national security challenges for us. In an effort to articulate "a modern and collective definition of energy security," the leaders endorsed a set of seven energy security principles put forward by their energy ministers, summarized as follows:

1) Develop flexible, transparent and competitive energy markets, including gas markets;
2) Diversify energy fuels, sources and routes, and encouragement of indigenous sources of energy supply;
3) Reduce greenhouse gas emissions, and accelerating the transition to a low carbon economy, as a key contribution to enduring energy security;

4) Enhance energy efficiency in demand and supply, and demand response management;
5) Promote deployment of clean and sustainable energy technologies and continued investment in research and innovation;
6) Improve energy system resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks; and
7) Put in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.

These principles, with their focus on well-functioning and competitive energy markets, diverse sources and routes of energy supply, environmental protection, efficiency and infrastructure improvements, energy innovation, emergency response, and resilience are guiding the work currently being done by the Department of Energy and our interagency partners. For instance, DOE, in cooperation with the Department of State, is implementing the language in the FAST Act (PL 114-94), which calls for DOE and State to evaluate energy security of the U.S. and its allies with the intent of ensuring that government review of actions that affect energy security accurately capture their full benefits and costs.

DOE's energy technology programs have very direct roles in principles 3, 4, and 5. Moreover, certain DOE R&D activities that fall under Mission Inovation -- the global initiative aimed at accelerating clean energy innovation -- support principles 3, 4, and 5. For the purposes of this hearing, however, discussion in this testimony will focus primarily on the domestic and global dynamics relevant to principles 1, 2, 6 and 7, and the efforts by the public and private sectors in advancing these shared objectives.

III. Oil

The US is now the number one producer of liquid fuels in the world and within the last two years began producing more oil than it imports for the first time in decades. Crude oil production in the U.S. rose from an average of 5.1 million barrels per day in 2008 to 9.4 million barrels per day in 2015; these production increases and relatively flat consumption have resulted in the lowering of imports of oil by 3.5 million barrels per day (or about 30 percent).

Importantly, however, the U.S. still remains a large oil consumer and is a large oil product exporter; this directly ties us to global oil markets and oil price volatility. Energy security is a broad and collective responsibility, especially in light of America's unique global security posture. The energy situation in the U.S. enhances our energy security, as the global market is experiencing continued uncertainty generated by events in Africa, the Middle East, and Russia, raising the possibility of global oil price shocks. There is also reduced spare capacity in the world. Further, former Saudi oil minister Al Naimi recently indicated that it would take 90 days for the Kingdom to bring spare capacity fully online; during this interval, in combination with private inventories, and conservation incented by price signals, government-controlled strategic stocks could be essential for dampening oil price shocks.

Our security exposure goes beyond just volatility, but also to oil prices more broadly and the potential impacts of a major market disruption. DOE has held multiple workshops to examine oil market disruption scenarios. In August 2015, DOE convened a group of experts on the oil market for a discussion to analyze the potential origin and duration of large-scale supply disruptions that may necessitate an IEA coordinated emergency response, potentially in concert with the release

of strategic supplies from non-IEA partners. The group concluded that oil infrastructure is an attractive target for state and non-state adversaries, including terrorist organizations, as demonstrated by the 2013 attack against a gas facility near In Amenas, Algeria, and recent Islamic State operations targeting infrastructure in Syria, Iraq, and Libya.

DOE also convened a workshop in September 2015 which evaluated the likelihood of one or more foreign oil disruptions over the next 10 years. The risk assessment was conducted by leading geopolitical, military, and oil market experts who provided their expertise on the probability of different events occurring, and the corresponding implications for major disruptions in key oil market regions. The study concluded that over a 10-year timeframe (2016–2025):

- The probability of a net disruption of 2 MMbbl/d or more lasting at least one month is approximately 80%.
- The probability of a net disruption of 2 MMbbl/d or more lasting at least six months is approximately 63%.
- The probability of a net disruption of 2 MMbbl/d or more lasting at least 18 months is approximately 37%.
- The probability of a net disruption of 3 MMbbl/d or more lasting at least one month is 67%.
- The probability of a net disruption of 5 MMbbl/d or more lasting at least one month is 42%.

These expert assessments, which are substantively similar to those developed in the 2005 study on the same topic, suggest continued risk in the global market, notwithstanding supply-demand conditions at the time of writing or expanding North American oil production.

The Strategic Petroleum Reserve is an important insurance policy for the U.S. economy in the event of serious oil supply disruptions and the associated spike in petroleum product prices. In spite of the changes in the U.S. oil production profile, the U.S. economy will remain vulnerable to significant international oil supply disruptions in the future, and the SPR will remain an important aspect of our energy security strategy. At the same time, changes in the U.S. oil production profile have reduced the ability of the SPR to respond to a future disruption. The changing geography of U.S. oil production has led to major changes in the domestic oil pipeline system. Those new patterns of oil supply and demand among U.S. oil producers and refineries, along with associated changes in the U.S. midstream infrastructure, have significantly reduced the ability of the SPR to distribute incremental volumes of oil during oil supply interruptions.

In response to these changes, the Administration recommended and Congress authorized through the Bipartisan Balanced Budget Act of 2015 an investment of up to $2 billion in SPR facilities and marine terminal infrastructure as part of a SPR modernization program to ensure that incremental oil from the SPR can enter the global market in sufficient volumes to minimize the economic harm associated with disruption-related price spikes.

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, DOE 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 National Environmental Policy Act analysis in January 2017, pending receipt of a congressional appropriation to commence crude oil sales in the near term.

The Bipartisan Budget Act of 2015 also required DOE to complete a long-term strategic review of the SPR and develop and submit to Congress a proposed action plan, including a proposed implementation schedule. DOE carried out the review required by the Act starting in May 2015 with completion and submission to Congress in August 2016.

This Long-Term Strategic Review (LTSR) provides an overview of the SPR and addresses key challenges that will impact the SPR's ability to carry out its energy security mission. Major topics examined in this report include the state of the SPR's surface and subsurface infrastructure, bottlenecks in the North American midstream infrastructure that impact the SPR's ability to move oil to the market, a discussion of some of the costs and benefits of various SPR sizes and other options, SPR modernization requirements for infrastructure life extension and the addition of dedicated marine terminals, and considerations associated with the SPR's authorizing legislation, the Energy Policy and Conservation Act (EPCA).

To address the myriad topics relevant to the SPR strategy, DOE sponsored studies by outside experts in fields including engineering, geology, petroleum logistics, economics, and geopolitics, among others. This review synthesizes these input projects and presents conclusions that will help inform decisions about the SPR going forward.

IV. Natural Gas

The increased production of natural gas in the U.S. has contributed in several ways to a more financially liquid and competitive international natural gas market, which has improved global energy security for U.S. neighbors, partners, and allies. The U.S. is also now the number one producer of natural gas in the world. According to the U.S. Energy Information Administration (EIA), the production of natural gas climbed from 20 Tcf in 2008 to 27 Tcf in 2015, which represents more than 98 percent of domestic consumption. The U.S. became a net exporter of liquefied natural gas (LNG) in February of this year and according to EIA, the U.S. will become a net exporter of all forms of natural gas by mid- 2017.

Abundant natural gas resources and large production increases have created significant global, regional and domestic natural gas market opportunities for U.S. producers. Indeed, U.S. exports of LNG can make a major contribution to the evolution of world gas markets. Historically there have been three regional natural gas markets: North America, Europe, and Asia. But increased production in the U.S. and the Middle East and significant investment in LNG facilities in Australia and the U.S. are re-shaping the regional nature of gas markets, creating the potential for their globalization. The share of LNG traded through shorter-term contracts, an indicator of a more competitive liquid gas market, increased from 18% in 2008 to 28% in 2015, according to EIA. Also, oil-linked natural gas prices in Asia fell significantly in 2015 and some LNG importers were able to successfully renegotiate their contracts with sellers—adding more flexibility to the market.

Significant investment in LNG facilities in Australia and the United States is also re-shaping the traditionally regional nature of gas markets. The International Energy Agency forecasts that between 2015 and 2021, global liquefaction capacity will increase by 33%, mostly from the United States and Australia. By 2020, the United States is projected to have the third-largest LNG export capacity in the world (after Qatar and Australia). This fundamental shift in the diversity of LNG supply sources along with increased liquidity in global LNG markets will place significant competitive pressures on other new sources of LNG.

While Europe is a particularly attractive market for new LNG supplies due to the flexibility of its gas system and well-developed spot markets, continued flat to soft European demand for natural gas suggests intense competition will develop among producers to retain or gain access to European customers.

In the Eastern Mediterranean region, there are competing proposals to develop pipeline and LNG infrastructure to support regional natural gas demand -- each with a unique set of challenges and each confronted by an increasingly competitive global supply for LNG. At present, the focus appears to be on developing regional gas pipelines.

Finally, it should be noted that the widening of the Panama Canal is taking place coincident to the growth of LNG exports from the U.S. This multi-billion dollar infrastructure improvement could help facilitate and lower transportation costs for the U.S LNG trade with Asia and possibly to destinations on the west coast of South America. We note that this has already been extremely helpful for U.S. LNG exports to Chile which is working with Cheniere to supply LNG to a Chilean offshore floating storage regasification unit. Also, the Panama Canal Authority (ACP) is interested in ways that U.S. LNG trade can provide energy to the region. Last year, the U.S.

Trade and Development Agency awarded a grant to the ACP that supports planning for a possible LNG import terminal and increased natural gas utilization in the area. This holds promise for additional markets for U.S. LNG in Panama and other countries in Central America.

As you know, the Natural Gas Act of 1938 (NGA) assigns DOE regulatory responsibility for the import and export of natural gas to or from a foreign country. The NGA, as amended, requires that any company that wishes to export LNG to any foreign country must first obtain authorization from DOE. For companies seeking authorization to export to non-free trade agreement (FTA) countries, DOE considers the economic, energy security, and environmental impacts of the proposed LNG exports, among other factors in order to make a public interest determination. As of June 2016, DOE has approved 19 LNG export applications for projects to export to non-FTA countries. By law, applications to export to FTA countries must be approved without modification or delay. According to EIA, five projects (with authorization to export 9.2 Bcf/d to non-FTA countries) are currently under construction or operational in the lower 48 states. As of September of this year, US LNG producers had exported 100 Bcf of LNG to 11 countries. More than 50% of the U.S. LNG exports thus far went to South America (Brazil, Argentina, Chile), followed by Asia (India and China), and the Middle East (United Arab Emirates, Kuwait, and Jordan), Dominican Republic, and a small volume to Europe (Portugal and Spain).

DOE's review of applications to export LNG to non-FTA countries is conducted through a public and transparent process. Upon receipt of an application, DOE issues a notice of the application in the Federal Register, posts the application and all subsequent pleadings and orders in the proceeding on its website, and invites interested persons to participate in the proceeding by intervening and/or filing comments or protests. Applicants are typically given an opportunity to respond to any such comments or protests and, after consideration of the evidence that has been introduced into the record, DOE issues an order either granting the application as requested, granting with additional terms or conditions, or denying the application.

Under the Natural Gas Act, DOE's orders are subject to a rehearing process that can be initiated by any party to a proceeding seeking to challenge DOE's determinations. Court review is available as well after the rehearing process is exhausted.

For applications requesting authority to export LNG to countries that do not have free trade agreements requiring national treatment for trade in natural gas, DOE conducts a full public interest review. While the NGA establishes a broad public interest standard and a presumption favoring export authorizations, the statute neither defines "public interest" nor identifies criteria that must be considered. In prior decisions, however, DOE's Office of Fossil Energy (DOE/FE) has identified a range of factors that it evaluates when reviewing an application for export authorization. These factors include economic impacts, international impacts, security of natural gas supply, and environmental impacts, among others. To conduct its review, DOE/FE looks to record evidence developed in the application proceeding. Applicants and interveners are free to raise new issues or concerns relevant to the public interest that may not have been addressed in prior cases.

Under current law and the procedures I have previously described, an LNG export application is ready for final action when DOE has (1) completed the pertinent National Environmental Policy Act review, and (2) sufficient information on which to base a public interest determination.

DOE's current process is to promptly conduct reviews of final authorizations once FERC has completed its regulatory process. The Department has clearly demonstrated a commitment to act expeditiously in its regulatory responsibilities and will continue to do so.

U.S. LNG producers are currently using innovative long-term contracts that increase the liquidity and competitiveness of the spot market. Specifically, U.S. contracts are structured to give buyers of LNG the option of paying only the liquefaction tolling fee if they determine, based on market conditions that they do not need to actually take delivery of the natural gas. This differs from many traditional long-term contracts for LNG on world markets that do not offer this level of flexibility for buyers or sellers. The design of the U.S. contract provides greater protection for buyers from falling natural gas prices, reduces transaction costs of reselling unneeded LNG, and enables a more active spot market. In addition, U.S. LNG contracts are supplied at Henry Hub prices, the most competitive in the world.

Physical exports of U.S. LNG started in February of this year after completion of Train One at Sabine Pass in Louisiana; four more facilities are currently under construction. In the context of today's hearing, it is worth noting that the first cargoes moving from Sabine Pass were purchased by Brazil's Petrobras. The U.S. entry into world LNG markets in a significant way (volumes are only exceeded by those of Qatar and Australia), will also put downward pressure on European gas prices, and the competition for customers could constrain the non-competitive practices of Russia. The U.S. entry into world LNG markets is consistent with the G7 principles for increased energy security.

V. Electricity

Today's U.S. power grid – the world's "largest machine" – is vast, complex and interconnected. It is comprised of around 7,700 operating power plants that generate electricity from a variety of primary energy sources; 200,000 miles of high voltage transmission lines; 55,000 substations; 5.5 million miles of local distribution lines; and 3,300 providers delivering electricity to 135 million customers. The value of the electricity supply chain (from fuel to generation to transmission to distribution) is about $1 trillion.

Today's electricity system is built on a century-old foundation of continuous reliable electricity service. It is, however, being pulled by new demands on the consumer side of the electricity supply chain, pushed by new technologies for both generation and distribution, and the need to address a new set of vulnerabilities. At the same time, the electricity sector must deal with high institutional inertia, a very complex jurisdictional environment, a mix of delivery service models (investor owned utility (IOU), public, international organization for standardization (ISO)/regional transmission organization (RTO)) with numerous forms of wholesale electricity organized markets, and increasingly complex grid operations to accommodate variable renewables, distributed energy resources and demand-side management.

The Quadrennial Energy Review: Electricity from Generation to End Use.
The second installment of the Quadrennial Energy Review (QER 1.2) will examine these trends and issues confronting the Nation's electricity system. This in-depth focus on electricity – from generation to end use – follows up on recommendations in the first installment of the QER (QER 1.1), which looked at electricity in the context of a broader examination of energy transmission, distribution and storage infrastructures. QER 1.2 will analyze key trends and make policy

recommendations on a range of electricity issues including: the changing generation mix; low load growth; increasing vulnerabilities to severe weather/climate change; the proliferation of new technologies, services and market entrants; emerging cyber/physical threats; aging infrastructure and workforce; the growing overlap between jurisdictions; value creation; and the growing need for an integrated North American electricity market.

An example of an area of analysis in QER 1.2 is the changing generation mix in the U.S. In 2016, natural gas is projected to surpass coal as the most-used fuel for U.S. power generation on an annual basis. Between 2005 and 2015, net generation from natural gas increased by 75 percent, while coal generation fell by 33 percent. Recent generation capacity additions have been dominated by natural gas and renewables. Natural gas net generation has increased from 19 percent in 2005 to 33 percent in 2015. As a percentage of net generation, wind increased roughly tenfold since 2005 to 4.7 percent of net generation in 2015. Non hydro renewables grew from 2 percent in 2005 to 7 percent in 2015, surpassing hydropower for the first time. Wind generation increases have been driven by improved turbine technologies, reduced cost of electricity production, and government policies that encouraged the development of renewable energy sources.

Also, geography and physics are inherent limitations in electricity markets. As such, the Administration has focused on the benefits of the integration of U.S., Canadian and Mexican electricity systems.

The U.S. is a major hub for technology development. The Department of Energy is the single largest supporter of civilian physical science R&D in the country, and our system of 17 National Laboratories is an energy innovation powerhouse. The work of our labs and programs, including those that support many partnerships, has helped develop technologies that: lower electricity bills; enable and enhance a modern economy that heavily relies on electricity; reduce electricity demand and decrease carbon emissions from power generation. Our technology programs support renewable and nuclear power generation and programs to decrease the costs of carbon capture technologies from coal and gas-fired power plants. Finally, an important issue for this hearing as well as the QER is the growing reliance of all of our critical infrastructures on electricity. As the nation reinvests and modernizes its infrastructure systems, the critical lifeline infrastructures, generally thought of as the energy, water, telecommunications, and transportation infrastructures, are all essential to the national defense, economic prosperity, and general well-being of the nation. From the electricity and energy perspectives, we are increasingly electrifying aspects of our economy, such as transportation, while also becoming more dependent on electricity through, for example, telecommunications. The benefits of this convergence are expected to include lower emissions, greater efficiency, and increased productivity. However, if not properly managed, such convergence has the potential to escalate societal risks as these formerly separable systems become more tightly linked.

Let me provide a few examples of the relationships among these sectors, and illustrate why these considerations are so important.

- As our nation enjoys the benefits of the increased shale gas production, the increased use of this gas for power generation introduces the potential for complications and

disruptions. These complications arise because just as the power sector is reliant on natural gas for the fuel to produce electricity, and the gas sector relies on electricity in segments of the production chain including for field gathering pumps, selected transmission pipelines, and gas processing stations. These interdependencies were illustrated in New Mexico in 2011 when gas shortages from cold weather and high demand produced power outages, which then further reduced gas production as field gathering pumps lost power (cite, QER, 2011 report).

- After Hurricane Sandy in 2012, utilities and the public were faced with massive outages and disruptions across their systems. As crews worked to get the systems back in order, they were hampered by difficulties communicating due to failures within the communications systems. Modern communications systems are almost entirely dependent on electricity, and as a result maintain varying degrees of backup within the system (generally 72 – 96 hours battery backup). However during Hurricane Sandy, the damage was so extensive and long-lasting that some of these backups began to fail.
- Among the critical infrastructures, water is not always thought of as a major component or point of vulnerability. However, water purification, movement, and treatment currently consumes roughly 2% of national electricity generation. In some regions, such as California this amount can be up to 10% of electricity generation. The key concern here is that not only do many water facilities lack sufficient power backup capabilities, they serve as critical elements necessary to supply cooling water to generation facilities.

These are just a few examples of the many interdependencies among our national critical infrastructures. To these examples, I'd like to add an additional thought to inform the larger discussion. One area of increasing concern relates to the interdependence among the electricity and telecommunications sectors, and computational data centers specifically. Such data centers consume roughly 2% of electricity nationally. The concern arises when, as expected with the evolving smart grid, increasing amounts of electricity generation becomes dependent on public communications networks and data storage in order to properly function. So far this has not amounted to a significant vulnerability, but it is an area for attention and focus.

In addition to the QER, the DOE's Grid Modernization Initiative (GMI) represents a comprehensive effort to help shape the future of our nation's grid by coordinating a portfolio of activities to help set the nation on a cost-effective path to an resilient, secure, sustainable, and reliable grid that is flexible enough to provide an array of emerging services while remaining affordable to consumers. The scope of the GMI focuses on the development of new architectural concepts, tools, and technologies that measure, analyze, predict, protect, and control the grid of the future, and on enabling the institutional conditions that allow for more rapid development and widespread adoption of these tools and technologies. Through its Multi-Year Program Plan (MYPP), the Department will help frame new grid architecture design elements, develop new planning and real-time operations platforms, provide metrics and analytics to improve grid performance, and enhance government and industry capabilities for designing the infrastructure and regulatory models needed for successful grid modernization. The MYPP, developed in close collaboration with a wide range of key external partners, lays out a blueprint for DOE's research, development, and demonstration agenda to enable a modernized grid, building on concepts and

recommendations from the first installment of the QER and Quadrennial Technology Review (QTR).

As part of the GMI, the Energy Department announced funding in January, 2016 of up to $220 million over three years for DOE's National Labs and partners. The Grid Modernization Laboratory Consortium funding will support critical research and development in advanced storage systems, clean energy integration, standards and test procedures, and a number of other key grid modernization areas. This effort recognizes regional differences and will strengthen regional strategies while defining a diverse and balanced national strategy.

A key dimension of these R&D efforts is our engagement with industry. Last week Deputy Secretary Sherwood-Randall hosted a day-long meeting of the Electricity Subsector Coordinating Council (ESCC) at Sandia National Laboratory that specifically focused on aligning government and industry research and development efforts to enhance grid security and resilience. The Council is comprised of chief executive officers from 21 energy companies and nine major industry trade associations, and it serves as the Federal government's principal liaison with the electric power industry. Through the ESCC, we meet along with several other key Federal departments and agencies three times a year to develop and coordinate government and industry efforts to prepare for and respond to major disasters and threats to the U.S. energy infrastructure (of which more than 90 percent is privately owned).

At Sandia, the participants toured three Sandia facilities that demonstrated relevant capabilities that derive from DOE's decades of nuclear weapons work, such as on the impacts of EMP and how to protect against/mitigate against EMP effects, and on cybersecurity. Following the tours, they discussed how we can strengthen the R&D grid security collaboration between government and industry to advance our shared goals. Specifically, DOE and ESCC members committed to more closely aligning research and development priorities through joint strategic planning and increased coordination. DOE will also continue its work to expedite the commercialization of new technologies developed by our labs. The goal is to ensure that we are maximizing the prospects for rapid deployment of technologies that can contribute to securing our Nation's energy infrastructure. In addition, we are committed to a deliberate handoff of the vital ESCC work streams to the next Administration.

VI. Emergency Authorities

With an updated framework of energy security, it is also worth noting the essential and expanded role DOE plays in energy emergency response.

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, we had 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 (EPCA), 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 to 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 resilience 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.

VII. Conclusion

Our energy security investments and policies should be viewed in a broad sense to value and include the resiliency, reliability and modernization of key energy infrastructures, energy efficiency, responses to climate change, and the collective needs of our allies and partners.

Such a view of energy security should not discount the importance of oil security. Indeed, the SPR remains a highly valuable tool for meeting US energy security needs in 21st century global energy markets.

It is time to take a fresh and comprehensive look at how we define and implement an energy security policy that is based on 21st century energy market changes, challenges and needs.

Chairman Upton, Vice Chairman Olson, Ranking Member Pallone, Ranking Member Rush, and members of the Subcommittee, I appreciate the opportunity to share my thoughts on DOE's role in national, economic, and energy security and look forward to your questions.