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Strategic Petroleum Reserve and Related Energy Security Issues
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Thank you Chairman Murkowski, Ranking Member Cantwell, and distinguished Members of the Committee. I appreciate the opportunity to be here today to discuss the Strategic Petroleum Reserve (SPR) and related U.S. energy security matters.

The International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price. Energy security has many dimensions: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and sustainable environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes within the supply demand balance." This definition helps to frame the issues I would like to discuss today. I would like to acknowledge that S. 2012, the Energy Policy Modernization Act of 2015, as marked up by this committee, includes a provision requiring the Department to complete a long-range strategic review of the Strategic Petroleum Reserve within 180 days of passage of the bill. The Department is currently actively engaged in just such a study.

U.S. energy security must be placed in the context of the current U.S. energy profile that has dramatically changed over the last several decades, accelerating in the last five or six years. We are now the number one producer of oil and gas in the world and 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 flat or declining demand for both oil and electricity. In response to low natural gas prices, industry has announced over $100 billion in new energy-intensive manufacturing projects. Carbon emissions are down as low-priced natural gas replaces coal-fired power generation.

Challenges remain, however, and many of them carry direct implications for our energy security. The April 2015 Quadrennial Energy Review (QER) concluded that in key areas, our energy and related infrastructures have not kept pace with changes in the volume and geography of oil and gas production. The expected growth over the next 30 years in the volume of imports and experts transported by sea, for example, has major implications for oil, natural gas and coal. Sixty percent of the oil Americans consume arrives in a U.S. port, including all of Alaska's crude. Overall marine freight by tonnage through coastal ports is expected to increase domestically between 2010 and 2020, while over the next 20 years, the total volume of imports and exports through U.S. ports could double. The surge in waterborne and rail shipments of crude may be a factor in delays at some inland and coastal ports and, as noted, port traffic is expected to grow over the next decades.

Also, extreme weather events are projected to increase; they have regional and possibly national-scale impacts including extreme heat waves, droughts, and wildfires that can damage electricity infrastructure or reduce transmission efficiency. U.S. temperatures are projected to continue rising in the coming decades. Electricity transmission and distribution systems carry less current and operate less efficiently when ambient air temperatures are higher. Case studies indicate that sudden, extreme heat can cause transformers to malfunction or stop working. Increasing temperatures also will likely increase electricity demand for cooling, which could increase utilization of transmission and distribution systems during peak demand periods. Increasing air and water temperatures also reduce the efficiency of power plant cooling, which increases the risk of partial or full shutdowns of generation facilities and loss of the grid services that they provide during heat waves.

Drought is also an extreme weather event. In 2014, California experienced its third driest year in 119 years of record keeping. As a consequence, California hydroelectric generation was significantly reduced. In June 2014, California hydroelectric generation was only 59 percent of the June average of the preceding 10 years. While earlier this year, the Energy Information Administration indicated that system reliability was not affected by the drought-related reduction in hydroelectric generation, this resource plays an important role in providing load leveling and energy storage for system operators; potential effects on system flexibility and rates should continue to be monitored. Sea level rise and storm surge is also a growing concern. Recent DOE modeling and analysis for the QER concluded that by 2030, a Category 1 hurricane in the Gulf of Mexico would increase the exposure of the region's electrical substations to storm surge and sea-level rise by over 30 percent, from 255 substations to 337; importantly, this region is also home to over 50 percent of the Nation's electricity-dependent refineries and the SPR.

There are also new non-weather related vulnerabilities for our energy systems including cyber and physical attacks on infrastructure. 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. Physical attacks on substations have exposed significant supply chain and reliability concerns with large transformers; the loss of critical large transformers can result in large electricity disruptions. Such a loss could be due to the customized nature of the components and the associated manufacturing requirements as well as physical attacks (such as the Metcalf incident). In addition, all of our critical energy infrastructures are reliant on electricity, placing a very high premium on a reliable, modern and hardened electric grid and raising new concerns about low probability-high consequence events such as electro-magnetic pulses and geo-magnetic disturbances.

Importantly, the U.S. 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. I note that the current instability in the Middle East is not theoretical — we only need to look at events in Syria in the last week, where Russian military activity further increased geopolitical uncertainty. There is also reduced spare capacity in the world. Further, 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.

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, vulnerabilities, and needs.

Key Components of a Modern Energy Security Plan

Today, I would like to discuss key components of a 21st century energy security plan, tracking the definition of energy security I referenced earlier: a modernized Strategic Petroleum Reserve that has an infrastructure configured to enable drawdown and distribution capacity sufficient to defend the U.S. from economic harm associated with disruptions. I would like to discuss this in the broader context of energy infrastructure resilience and reliability including emergency response; and broader and more collective view of energy security, a concept that promotes the notion that our energy security is affected by the security of our allies, friends and partners, and is advanced by a set of principles and subsequent actions of the G-7 partners (the U.S., Canada, UK, France, Germany, Italy and Japan) and the European Union (EU). These components and many of the associated issues are analyzed in detail in the Administration's first installment of the QER, released last April. The QER included many recommendations related to these components of a modern energy security plan. I would like to discuss both the context and rationale for these recommendations, starting with the Strategic Petroleum Reserve.

The U.S. Response to Oil Supply Disruptions and the Strategic Petroleum Reserve.
The Strategic Petroleum Reserve was authorized in 1975 to mitigate oil supply disruptions that are "... likely to cause a major adverse impact on the national economy." The SPR is currently the Nation's most central energy security asset and should be treated as such.

Today's low oil prices, increased domestic oil production and reduced U.S. oil import dependency have led some to conclude that selling large volumes of oil from the SPR for purposes not related to energy security will have no impact on its energy security benefits. This view fails to recognize that the SPR remains an extremely powerful and valuable energy security tool.

Like much of the Nation's publicly-supported infrastructure, however, the SPR needs additional investment to maximize its value. The Reserve needs funding to enhance its value in three distinct areas:

- **Deferred maintenance**: Funding for routine maintenance has been repeatedly deferred. The President's budget for Fiscal Year (FY) 2016 included a significant down payment on the backlog of SPR deferred maintenance. The House and Senate appropriations bills would actually result in a further increase in deferred maintenance — to $58.8 million in the House bill and to $65.6 million in the Senate bill.

- **Life extension:** The SPR is almost 40 years old and is in need of a significant life extension program. The last life extension program was in the mid-1990s, with a 20 year time horizon, meaning the facilities are currently due for major life extension improvements. The scope of this life extension will likely include major improvements in the following areas: crude oil transfer; raw water; brine disposal; power distribution and lighting; physical security; brine drive caverns; and general infrastructure.

- **Modernization:** How oil supply moves in this country has changed since the SPR was authorized in 1975. The resulting focus of a modernization program should be to "invest to optimize the SPR's response capability…to increase the incremental distribution capacity of the SPR by adding dedicated marine loading dock capacity at the Gulf Coast terminus of the SPR distribution systems." I will discuss these needs in detail shortly.

Several factors should be considered when evaluating the energy security value of the SPR. The first is the nature of oil markets themselves that have evolved since the late 1970s when the SPR and its authorities were established. At that time, domestic oil prices were controlled, oil production was declining, there was no spot market, OPEC had recently imposed an oil embargo, and a global oil commodity market as we know it today did not exist.

Modern oil markets have evolved in several key ways:

- U.S. oil production has dramatically increased, our imports are declining, oil prices are de-regulated, and oil is the largest and most liquid traded commodity in the world.

- As the market has evolved, so too has the nature of the impacts of an oil supply disruption.

- In today's global market — to which we are linked by our oil consumption and growing levels of product exports — the U.S. is exposed to global price volatility and spikes; U.S. wholesale gasoline prices track *international* wholesale oil prices, as demonstrated by EIA analysis. When global prices spike, U.S. prices spike.

- In current markets — we don't expect this structure to dramatically change in the foreseeable future — it may be that the value of the SPR should be measured less by days of import protection and its ability to move physical supplies to inland and much more by its capacity during a major disruption to satisfy domestic demand while diverting imports into the global oil market in order to mitigate harm to the U.S. economy.

It is important to consider what metrics are the most appropriate for determining the right size of the SPR; we are well above our international commitment on days of import coverage. There are, however, important concerns about a focus on days of import protection as the sole measure of an appropriate size for the SPR, including statutory requirements in the Energy Policy and Conservation Act; and the current U.S. obligation to provide 43.5 percent of the amount of a total coordinated response consistent with our fraction of global consumption levels; this commitment is unrelated to days of oil import protection.

These concerns about the harm to the U.S. economy from oil supply disruptions are well-founded. Previous oil price spikes have been typically followed by two to three years of weak, world-wide economic growth — four decades of data indicate that two to three years of slow economic growth have coincided with oil price shocks. High oil prices after the first Gulf War contributed to a drop in global GDP from three percent to one percent in a year, for example. According to the White House report, *The All-of-the Above Energy Strategy as a Path to Sustainable Economic*

Growth, (July 2014), "Historically, temporarily high oil price shocks arising from foreign supply disruptions have cut GDP growth and reduced employment. This link is not perfect, and not every oil price shock has led to an economic slowdown, but … the empirical evidence points to a negative link between oil price spikes and economic activity." The price elasticity of oil demand has become much lower and the reliance on oil from transportation has changed only marginally since the establishment of the SPR.

Another — and related — consideration for policy makers is the distinction between the SPR's size, its drawdown capacity and its distribution capacity. At roughly 695 million barrels, the SPR is the largest government-owned stockpile of oil in the world. But its size is only as important as its ability to move oil into the marketplace. The SPR has a design *drawdown capacity* — the ability to pump and move oil from its caverns — of 4.4 million barrels per day (mmb/d). However, the SPR's *distribution capacity* is the capability to *deliver* SPR oil to the marketplace via the network of commercial pipelines and marine terminals to which it is connected. New patterns of oil supply and demand among U.S. oil producers and refineries, along with associated changes in the U.S. midstream, have significantly reduced the ability of the SPR to distribute incremental volumes of oil during possible future oil supply interruptions.

To understand this degradation in distribution capacity, it is important to examine recent changes in the location and volumes of domestic oil production. Historically, oil and oil products in the United States have tended to flow from *south to north* to inland refineries. Recent and dramatic increases in domestic oil production and the location of that production have altered this pattern, with oil from Canada, the Bakken formation in North Dakota and Montana moving from *north to south* to the Gulf of Mexico. Canada is now our largest source of imports. Significant new quantities of crude oil from the Eagle Ford and Permian shale basins also are moving to Gulf Coast refineries. To accommodate these new volumes, pipelines which once flowed north have been reversed to flow south, with ramifications for the broader distribution system. In addition, the rapid growth of petroleum product exports from Gulf refineries has increased the commercial utilization of marine terminals in that region. U.S. exports of non-crude petroleum products from the United States averaged a record 3.8 mmb/d in 2014, a nearly four-fold increase over the last decade.

To optimize the impact and value of the SPR in the event of an emergency, the SPR's three distribution systems in the Gulf of Mexico need to be able to deliver oil to Gulf Coast refineries, as well as put crude oil onto ships to move it to east and west coast refineries. If the SPR cannot load oil onto barges and tankers without disrupting commercial shipments, SPR sales could be offset by a corresponding *decrease* in domestic crude oil shipments or exports of domestically produced petroleum products, neither of which is desirable for collective energy security. In this scenario, the available space for loading the SPR oil could affect the ability of the SPR to add *incremental* barrels to the market.

Concerns about SPR infrastructure limitations were analyzed in the QER. The conclusion: in order to ensure that the SPR is able to deliver incremental barrels of oil to the U.S. market in the event of an oil disruption and not simply back out domestic production, the SPR needs dedicated marine terminals. The effect of moving this incremental oil into US markets would be to re-route oil destined for the US, enabling it to go to other countries. This would effectively increase overall global oil supplies with a corresponding reduction of the negative impacts on the U.S. economy associated with global price spikes.

Changing markets are not the only concern with the SPR. As noted, the SPR is nearly 40 years old. The Department is working to address deferred maintenance for regular operations and maintenance within the regular budget process, although this remains an ongoing issue.

Investment in facility life extension is also needed. The last SPR life extension program was completed in the mid- 1990s with a 20-year plan; two decades have now passed and some SPR infrastructure is nearing the end of its design life and major investments will be needed in the near future to ensure the SPR's reliability for the next 20 years. The infrastructure and equipment to support a drawdown — including storage caverns and wellbores — is both large and complex. Assuming the current size and configuration of the SPR, within five years, there will be challenges regarding cavern storage capacity for maintaining crude oil inventory levels. Already two caverns have been taken offline and removed from service due to operational issues. Most of the SPR wells were drilled in the late 1980s and early 1990s, although several of the wells are 60-plus years old. Informed by the SPR Strategic Review, these structural issues will need to be addressed in order to maintain the SPR's current operational readiness and drawdown capability.

Under the controlled conditions of the 2014 SPR test sale, a number of issues were identified, including the gap between the SPR's drawdown and distribution capacity. Concerns about this gap and its implications for energy security were analyzed in the QER. The QER underscored the need for an effective SPR modernization program that would address infrastructure issues and reflect current market and energy security conditions. While a detailed cost review is underway, top-line funding needs are understood. As outlined in the QER, investments for life extension and modernization in the range of $1.5 to $2 billion are necessary to ensure the SPR is able to protect the U.S. economy in an energy supply emergency. Of this amount, approximately $800 million is needed for life extension and $1.2 billion for adding dedicated docks and terminals to ensure that in an emergency, the SPR can put sufficient *incremental* barrels of oil into the market. Modeling and analysis supporting the QER also indicates that adding two million barrels per day of dedicated distribution capacity could avoid a very large loss to the U.S. economy in the event of a single severe international oil supply disruption.

The ability of the SPR to continue to provide strategic and economic security against foreign and domestic disruptions will remain diminished if investments to repair and replace aging infrastructure and modernize the SPR's capabilities are not made. To be sure, any changes in the configuration or size of this energy security asset must be done prudently. In the context of market response, the SPR needs to be large enough, its distribution capacity sufficiently decongested, and its authorities robust enough to optimize its value for mitigating economy-damaging oil and gasoline price spikes associated with an oil disruption. In this regard, the QER also recommends changes in the SPR's authorities that would strengthen the ability to respond to disruptions in a more timely and effective ways and to more closely reflect the evolution of global oil markets. Specifically, the QER recommends that SPR authorities be updated so that:

- the definition of severe energy supply interruption includes an interruption of the supply of oil that is likely to cause a severe increase in the price of petroleum products; and
- the requirement that a severe increase in the price of petroleum products *has* resulted from such an emergency situation be changed to a requirement that a severe price increase will *likely* result from such emergency situation.

These provisions are designed to make the definition of severe supply interruption consistent with the uses of the SPR and to enable faster action to mitigate harm to the U.S. economy. I will discuss product reserves later, but the Northeast Gasoline Supply Reserve operates under SPR authorities and the Northeast Home Heating Oil Reserve operates on its own statutorily-established authorities. These two facilities should be able to operate in concert but the triggers for their use are different; the QER recommends that they operate under a single authority to ensure coordinated actions if needed.

As the pending FY 2016 appropriations bills illustrate, current budget sequestration funding levels dramatically shortchange the very investments that are most essential to long-term economic growth, including infrastructure, research and development, training and education. It may be that we can create a net increase in the SPR’s energy security value by selling a small portion of its current crude oil inventory — raising the requisite $2 billion to cover the costs of life extension and modernization activities.

In addition, we have international obligations related to the SPR and its use. Consultation with the IEA and its member countries is important as we work to maximize the effectiveness of the SPR. I would also note that we have been actively encouraging other countries — IEA members and non-members — to build or increase strategic reserves. This should figure into our calculus as we develop policies for, or that affect, the SPR.

Energy Infrastructure Resilience, Reliability and Emergency Response.

Energy infrastructure resilience and reliability, including emergency response, are a growing concern and a key component of a modern energy security strategy.

By the IEA’s definition of energy security and many other measures, enhancing the resilience and reliability of our energy infrastructures, systems and components is an increasingly important. President Obama highlighted the fundamental need for resilient and reliable energy infrastructures in Presidential Policy Directive 21, in which energy infrastructures were described as “uniquely critical,“ and as noted in the QER, “the consequences of ...hazards to infrastructure broadly affect social welfare. They go beyond the ability of a system to operate and address the vitality of our naitonal safety, prosperity and well-being.”

Ensuring energy infrastructure resiliency and reliability is challenging. The transformation of our energy landscape — dramatic increases in oil, gas, renewable energy resources — requires new infrastructures, and our existing infrastructures are not always well-matched to new sources of supply. Our energy infrastructures are aging — the gas main that tragically downed two apartment buildings and resulted in eight deaths in New York City last year dated back to the 1880s. The imperatives of climate change and increases in extreme weather event strongly suggest that we need to simultaneously harden and modernize our energy systems. These critical systems also face new and growing vulnerabilities, including cyber and physical incidents, and there is a growing interface between energy and IT systems; this could create new cyber vulnerabilities at the same time it enables real-time responses to supply and demand and helps improve system operations.

In addition, 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 lost almost 30 percent of its refining capacity. Three weeks after Rita hit, oil markets were still short around two million barrels a day.

Billion dollar weather events, especially severe storms, have risen dramatically in the last 15 years — indicators of the vulnerabilities of our energy systems to climate change and costly disruptions — and are a major indicator for energy security needs and requirements in the modern context. East coast hurricanes are on our minds this week. Hurricane Sandy killed 159 people and knocked out power to 8.66 million customers. Nearly two weeks after the storm, product deliveries from terminals in New York Harbor had only returned to only 61 percent of pre-storm levels, forcing industry to seek work-arounds to resume supplies. Hurricanes also pose a threat to 4,000 offshore rigs and refineries in the Gulf of Mexico. Power outages from weather events have gone from five to 20 per year in the mid-1990s to 50 to 100 per year in the last five years. Drought is affecting the water needed to cool thermoelectric plants. Importantly, the greenhouse gas emissions associated with our energy systems contribute to many of the threats to their reliability and resilience.

The vulnerabilities of our energy systems not only have an impact on our energy security, they have an impact on our national security as well. A Defense Science Board Task Force noted in 2009 that "….any assessment of the risk to military missions from grid failure must also take into account the ability of the national pipeline system to provide fuel to installations where it critically warrants." That same year, a Department of Defense paper noted that "energy security programs...are valued as investments in long term US national security..."

Several of the QER's findings on energy infrastructure resilience and reliability bear repeating:

- **Mitigating energy disruptions is fundamental to recovery and resilience.** Mitigating energy disruptions is particularly important because other critical infrastructures rely on energy services to operate, and these interdependencies are growing. Should disruptions occur, it is essential to have comprehensive and tested emergency response protocols to stabilize the system and begin recovery.

- **TS&D infrastructure is vulnerable to many natural phenomena.** These include hurricanes, earthquakes, drought, wildfires, flooding, and extreme temperatures. Some extreme weather events have become more frequent and severe due to climate change, and this trend will continue. Sea-level rise resulting from climate change, coupled with coastal subsidence in the Mid-Atlantic and Gulf Coast regions, increases risks and damages to coastal infrastructure caused by storm surge.

- **Threats and vulnerabilities vary substantially by region.** In many cases, a particular natural threat or infrastructure vulnerability will be region specific (e.g., Gulf Coast hurricanes threatening refineries), diminishing the utility of national, one-size-fits-all solutions for reliability and resilience. Regional solutions are essential

- **Recovery from natural gas and liquid fuel system disruptions can be difficult.** Although liquid fuels and natural gas disruptions are less likely than electricity disruptions, it is relatively more difficult to recover from disruptions to these systems than electric systems. Recovery from natural gas disruptions is particularly difficult because of the need to locate and repair underground breakages and restore pilot lights for individual customers.

- **Cyber incidents and physical attacks are growing concerns.** Cyber incidents have not yet caused significant disruptions in any of the three sectors, but the number and sophistication of threats are increasing, and information technology systems are becoming more integrated with energy infrastructure. There have been physical attacks; while some physical protection measures are in place throughout TS&D infrastructure systems, additional low-cost investments at sensitive facilities would greatly enhance resilience.

- **High-voltage transformers are critical to the grid.** They represent one of its most vulnerable components. Current programs to address the vulnerability may not be adequate to address the security and reliability concerns associated with simultaneous failures of multiple high-voltage transformers.

- **Shifts in the natural gas sector are having mixed effects on resilience, reliability, safety and asset security.** The addition of onshore shale gas infrastructure benefits natural gas resilience by decreasing the percentage of infrastructure exposed to storms. The Energy Information Administration reports that the Gulf Coast percentage of natural gas production went from 18 percent in 2005 to 6 percent in 2013. On the other hand, overall reliance on gas for electricity has gone up, creating a new interdependence and grid vulnerability. Furthermore, additional export infrastructure resulting from the gas boom would increase vulnerabilities to coastal threats, such as sea-level rise.

- **Dependencies and interdependencies are growing.** Many components of liquid fuels and natural gas systems—including pumps, refineries, and about 5 percent of natural gas compressor stations—require electricity to operate. The interdependency of the electricity and gas systems is growing as more gas is used in power generation.

The private sector, States, and the Federal Government all play crucial roles in ensuring that energy infrastructures are reliable, resilient, and secure. There is also a temporal aspect to maintaining energy system resilience and reliability. Severe weather, aging infrastructures, maintenance issues, and physical attacks on energy infrastructures require emergency responses and continuous planning/exercises for such events. In this regard, under the Department of Homeland Security's National Response Framework Emergency Support Function 12 (ESF-12), DOE is responsible for coordinating emergency responses for the energy sector with all of these entities.

There were several lessons learned from Hurricane Sandy that inform DOE's responsibilities under ESF-12. First, fuels distribution is a key element of an effective emergency response; in an emergency, consumers need refined products, not crude oil, and they need it quickly. An example was seen in the aftermath of Hurricane Sandy. After one week of Sandy's landfall, less than 20 percent of stations in New York City were able to sell gasoline. In part this was attributable to the absence backup electrical generation at gasoline stations. The City had to prioritize fuel distribution, starting with emergency responders and those responsible for repairing infrastructure. In its post-Sandy analysis, the City recommended that it "Explore the creation of a transportation fuel reserve to temporarily supply the private market during disruptions." DOE subsequently established a gasoline reserve in the Northeast, in locations and with contract provisions that would help expedite distribution of gasoline in the event of a supply disruption.

Another important lesson underscored by Sandy and seen in several previous hurricanes is the need to more fully understand and manage energy infrastructure interdependencies, especially reliance on electricity, as this is critical to, among other things, providing and moving fuels in an emergency. In Sandy, fuel distribution was hampered by the reliance of pumps on electricity. Backup generation, microgrids and other options could help mitigate these distribution problems.

The damage from extreme weather events can impose large costs on the energy industry, local communities and the Nation. The impacts of emergencies on energy consumers are significant. Hurricane Katrina caused three critical pipelines — which cumulatively transport 125 million gallons of fuel each day — to shut down for two full days and operate at reduced power for about two weeks, leading to fuel shortages and temporary price spikes. Addressing energy infrastructure resilience — ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions — is a longer-term component of an energy security strategy that should be designed to both harden existing infrastructure and make it more resilient over time, even as it adds capacity for supporting economic development.

Making infrastructure more resilient in advance of a disaster will ultimately reduce the demand for, and the costs of, emergency, rapid response actions. As noted in the QER, a statistical study of FEMA mitigation awards, while not specific to energy projects, found that the awards had a benefit-cost ratio for mitigation investments of 4:1. A forward-looking investment strategy for critical energy infrastructure would benefit from more than just hardening — to spend investment dollars more wisely, it is essential to focus on modernizing energy transmission, storage and distribution infrastructures at the same time that they are being hardened. As a matter of policy, we also need to acknowledge that our energy systems cross state borders and that these systems include both public and private entities

There are over 60 actionable recommendations in the QER. The following are some highlights of its recommendations on policies and programs to enhance resilience, reliability and security of our energy infrastructures:

- Establishing a program to provide competitively awarded grants to states to demonstrate innovative approaches to TS&D infrastructure hardening and enhancing resilience and reliability. 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;

- Updating and expanding state energy assurance plans. DOE should undertake a multi-year program of support for state energy assurance plans, focusing on improving the capacity of states and localities to identify potential energy disruptions, quantify their impacts, share information, and develop and exercise comprehensive plans that respond to those disruptions and reduce the threat of future disruptions;

- Accelerating natural gas pipeline replacements to enhance safety and reliability and reduce methane emissions;

- Modernizing the grid with a major focus on establishing valuation frameworks for a range of services and technologies such as efficiency, capacity, distributed generation and storage;

- Establish a program to provide competitively awarded grants to states to demonstrate innovative approaches to transmission, storage, and distribution infrastructure hardening and enhancing resilience and reliability; and; and

- Analyzing the policies, technical specifications, and logistical and program structures needed to mitigate the risks associated with loss of transformers, including whether new Federal regulatory authorities or cost share are necessary and appropriate. Approaches for mitigating this risk should include the development of one or more transformer reserves through a staged process

Most of these recommendations include a strong state focus. Utility business models and jurisdictional limitations may not, however, advance the most comprehensive and effective approaches to our growing energy infrastructure vulnerabilities. There are few more important federal roles than ensuring that the public has reliable and affordable energy, there are rapid and effective responses to energy and related emergencies, and that the energy infrastructures of the future are resilient and secure.

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 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.

A Broader Approach to Energy Security.
Finally, I would like to turn to a brief discussion of collective energy security, an obligation that we have to our allies, friends and partners with benefits that ultimately accrue to the U.S. and its interests at home and abroad.

Until recently, the concept of energy security has focused on "oil security" as proxy for "energy security." The crisis in Ukraine and growing European dependence on a dominant supplier, however, has put a spotlight on the need for an expanded view of energy security that more broadly encompasses the needs of the U.S., our allies, and trading partners.

At the urging of President Obama, these linkages were advanced by the G-7 leaders at the Hague Summit in March 2014, at which G-7 energy ministers were instructed to address energy security issues in concert with the European Union (EU). In May 2014, the G-7 energy ministers and the EU articulated a set of principles that emphasized the importance of an updated, broad and collective approach to energy security, where it was noted that "energy security is not only domestic — it is dependent on interaction in the global interconnected market." Acknowledging the need for "a modern and collective definition of energy security," the G-7 Energy Ministers and EU representatives adopted this set of seven principles, summarized as follows:

- Develop flexible, transparent and competitive energy markets, including gas markets;
- Diversify energy fuels, sources and routes, and encouragement of indigenous sources of energy supply;
- Reduce greenhouse gas emissions, and accelerating the transition to a low carbon economy, as a key contribution to enduring energy security;
- Enhance energy efficiency in demand and supply, and demand response management;
- Promote deployment of clean and sustainable energy technologies and continued investment in research and innovation;
- Improve energy system resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks; and
- Put in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.

These principles were endorsed by the G-7 leaders a month later in Brussels, as was the concept of collective energy security where in the associated communique, the leaders noted, "energy security must be at the center of our collective agenda and requires a step change to our approach to diversifying energy supplies and modernizing our energy infrastructure." In May of this year, there was a follow-on meeting of the G-7 energy ministers in Hamburg. Once again, we affirmed our commitment to collective energy security and identified priority areas for collaboration.

This broader definition of energy security does not discount the importance of oil security. Indeed, the crisis in Ukraine — where fuel oil might help replace lost gas supplies for heat and some power generation in the winter — underscores the importance of oil and oil products to energy security. The crisis in Ukraine also highlighted the vulnerability of our European allies to increasing reliance on a single, dominant supplier for much of its energy supplies. This is not only true in regard to natural gas. A European Commission (EC) document released last year noted, "...the Commission recognizes that some European refineries are optimized for using Russian crude, that EU refining capacity is increasingly in the hands of (a shrinking number of) Russian owners, and that the EU is a net importer of Russian diesel."

Natural gas and nuclear power are a central piece of the energy security equation, particularly in Europe. This was underscored by Ukraine and the vulnerabilities this crisis has exposed for Europe in general, and specifically about increasing its reliance on Russia for its energy supplies. Europe currently meets about 30 percent of its natural gas demand with Russian imports; more important, however, is the fact that several EU members get 70 to 100 percent of their natural gas from Russia via Ukraine transit pipelines. Russia's efforts to expand the Nord Stream pipeline would further cement European dependence on Russian gas and increase Russia's political leverage over Europe. In addition, countries in Eastern Europe with Russian designed nuclear power plants currently rely exclusively on Russia for nuclear fuel and spent fuel disposal, despite the fact that at least one other fuel supplier has produced fuel that has been formally qualified for use in those Russian-designed reactors. Further, nuclear power and the trajectory of nuclear plant closures in Europe and Japan raise additional issues about energy security and climate goals that need to be incorporated into agendas that promote mid- to long-term energy security for the U.S.

and its allies and other friends. Finally, climate change mitigation and energy efficiency need to be included in any mid- to long-term energy security discussions.

Since May 2014, G-7 countries, including the U.S. and the EU, have been working on policies and programs to address the collective energy security principles articulated in Rome. U.S. actions related to collective energy security are significant and address all of the principles. A very short list of federal actions to address collective energy security, both domestically and internationally, include expediting the LNG export approval process; diplomatic support for the Southern Gas Corridor pipeline system to diversify sources of natural gas supply to Europe (characterized by the State Department as “an important contribution to global energy security”); budget requests for a grid modernization program, state emergency response grants, and efficiency programs; supporting an ongoing, U.S.-chaired Carbon Sequestration Leadership Forum to help reduce CO_2 emissions from fossil-fuel combustion (eight ministers will attend this forum in Saudi Arabia this November); and initiatives to harmonize North American energy laws and regulations. DOE also organized a recent workshop, which included European participants, to develop ways to measure and value energy security; work on this valuation initiative continues.

The QER itself reflects the Administration’s commitment to the G-7’s collective energy security principles; it highlights Administration actions and includes analysis and recommendations that address all of the seven energy security principles. DOE has briefed the EU and 31 countries ranging from Bangladesh to Bolivia to China to Bulgaria on both the substance of the QER and the process for its development.

Our G-7 and EU allies have also been actively promoting a collective approach to improving energy security. EU member states and contracting parties of the European Energy Community announced in May 2014 that they were conducting natural gas stress tests, which were released in October 2014; the quick turnaround of these analyses speaks to the priority that the EU and the Energy Community participants attached to the issue. With strong U.S. political support, the European Commission has refined its list of energy infrastructure "Projects of Common Interest" to advance the most important gas and power inter-connections among member states to create integrated, functioning gas and power markets throughout Europe. The EU also is developing a new directive on security of supply for natural gas that will likely encourage each member state to have at least three sources of gas supply. Finally, there is a new EU electricity market design directive under development that is expected to be completed in 2016.

I have been encouraged by the collective work on energy security with our allies, friends and partners and, as you can see, there is a significant amount of activity taking place in this arena. I have just returned from the G-20 meeting in Istanbul, where this dialogue continued and I look forward chairing an IEA ministerial in November focused on energy innovation, also on the list of key energy security principles. It is an important and sensitive time in this arena — a good time to send the right signals on our commitment to collective energy security and a bad time to send the wrong ones.

Madam Chair, Ranking Member Cantwell, members of the Committee, I appreciate the opportunity to share my thoughts on the Strategic Petroleum Reserve and related energy security matters and look forward to the Committee’s questions.