Testimony of John Moore
Senior Attorney and Director of the Sustainable FERC Project
at the Natural Resources Defense Council
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United States House of Representatives
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Part 2: Powering America: Defining Reliability in a Transforming Electricity Industry

Thank you for the invitation to appear before the Subcommittee on Energy to discuss important power grid resilience and reliability issues in a transforming electricity system. I would like to emphasize several points in my testimony:

- Reliability and resilience are related concepts. They should be defined and addressed in a way that avoids redundant compensation or regulation. To a significant extent, existing reliability standards and practices already include resilience considerations, and these concepts must continue to be viewed in a coordinated way. Notably, we have maintained and strengthened reliability during the ongoing transformation of the electricity system.
- Baseload power is not a technically-based reliability standard, unique grid service, or resilience attribute. Policies and investments preferencing "baseload" resources simply because they can run at a high, sustained operating level (including times when load is at a minimum) will increase customer costs and pollution without adding any resilience benefits.
- Resilience must not be used as a pretext for rent-seeking behavior by non-competitive generators. Yet the Department of Energy's ill-considered plan to subsidize coal and nuclear plants (released Sept. 29, 2017) is exactly this sort of pretextual rent-seeking proposal and should be rejected.
- Flexibility should be prioritized in market design.

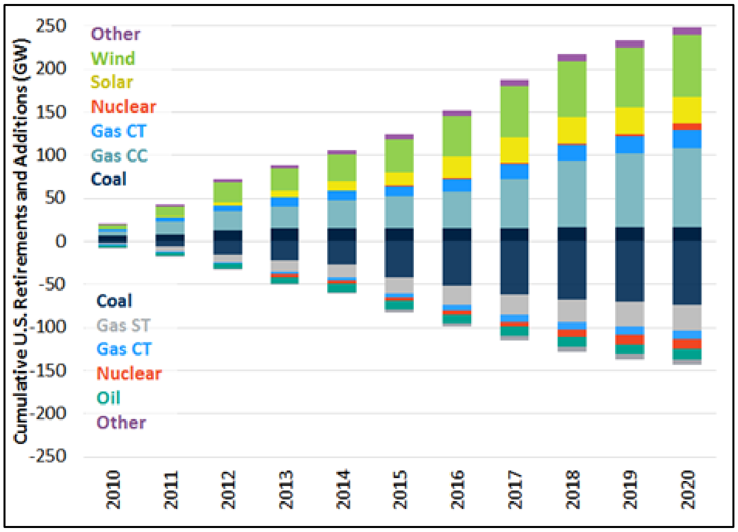
In summary, continuing the transformation of the nation's power grid to facilitate a low-carbon future will improve reliability and resilience in the long run by helping to prevent and reduce outages caused by the increase in extreme weather and other disruptive events.

Chairman Upton, Ranking Member Rush, and members of the Subcommittee, thank you for the opportunity to share the views of the Natural Resources Defense Council (NRDC) on electric power grid reliability and resilience. My name is John Moore, and I am a Senior Attorney at NRDC and the director of the Sustainable FERC Project.

NRDC is a national, non-profit environmental organization with more than 3 million members and engaged community participants. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC's top institutional priorities include curbing global warming and creating a clean energy future. The Sustainable FERC Project is an education and advocacy initiative housed within NRDC with a mission of removing ongoing barriers to the deployment of zero-carbon renewable energy and demand-side resources on, and accessible through, the nation's bulk electric power system. We focus on the regulatory policies of the Federal Energy Regulatory Commission (FERC) and entities subject to FERC jurisdiction.

NRDC supports a resilient, reliable, secure, and clean power grid. Since 2010, our nation has added approximately 200 gigawatts (GW) of new power plants (including many gigawatts of rooftop solar), while retiring 123 GW of older, dirtier, and costlier power plants, and many more GWs will continue to be added to our power system in the future:[1]

[1]Source: Brattle Group, Advancing Past Baseload to a Flexible Grid, at 13 (June 26, 2017), available at http://www.brattle.com/system/publications/pdfs/000/005/456/original/Advancing_Past_Baseload_to_a_Flexible_Grid.pdf?1498482432. Graph reflects Brattle Group analysis of data compiled by ABB, Inc., The Velocity Suite, June 2017. Gigawatts reflect nameplate capacity. Solar additions represent utility-scale solar. Future additions reflect units currently under construction, undergoing site preparation or testing, and permitted.



At the same time, our nation is increasing the efficiency of our energy use to reduce our power consumption. Newer resources like energy storage in all its forms and demand-side management also are taking root.

1. The importance of distinguishing between reliability and resilience

Reliability and resilience are complementary but different concepts. Both are essential needs, but they should be defined and provided for in a manner that avoids redundancy and confusion. A *reliable* grid can withstand sudden disturbances such as short circuits or loss of generation, transmission, and other system components without a loss of load. A *resilient* grid minimizes the magnitude and duration of outages when grid disruptions occur. The term resilience is also sometimes used to describe the ability of the system to withstand severe weather and other events. Aspects of resilience overlap with reliability, which focuses on the ability of the system to continue running during unexpected events. So, to a large extent, consideration of resilience is not new, and it has historically been part of the existing reliability roles of FERC and the North American Reliability Corporation (NERC).

In defining and regulating reliability and resilience, it makes sense for system operators, FERC, and NERC to account for not only the need to stay running (reliability), but also the resilience concepts of limiting the magnitude and duration of outages. Doing so, as opposed to a narrower focus only on the frequency of system outages, enables a system that satisfies customers at the lowest cost.

While the tradeoffs are complex, one can intuitively understand that many of us would rather have the power go out at our house for 5 minutes once every three years than experience a power outage once every 10 years but have that outage sustained for weeks on end. Planning for both reliability and resilience in this way allows regulators to make these tradeoffs in an intelligent way while prioritizing the way markets channel customer dollars.

However, in considering the second aspect of resilience—the ability to keep the lights on during severe weather events and other grid disruptions—these entities need to be extremely careful to avoid redundant compensation mechanisms, operating standards, or regulations. Part of the core responsibility of ensuring reliability is setting a standard by which extreme events (such as a heat wave) only cause outages very infrequently. Separate 'resilience' and 'reliability' standards, if formulated under this overlapping usage, could cause inefficiencies or even result in paying resources twice for providing the same service.

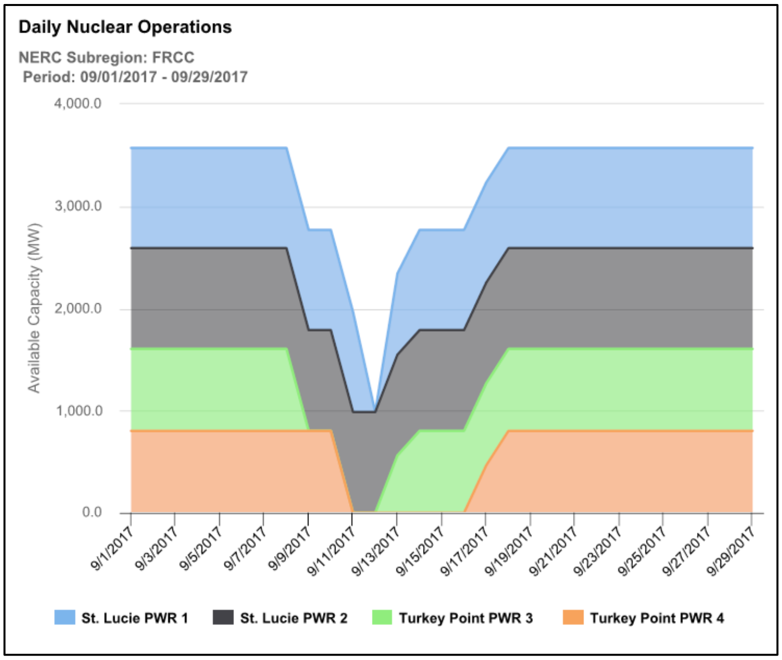
NERC with FERC oversight, identifies, implements, and refines reliability standards to maintain service and reduce outages. With FERC approval, NERC currently oversees over 100 mandatory standards related to the operation and planning of the grid, representing 1,500 discrete requirements. They were developed by technical experts, and they are approved and enforced by NERC and FERC. NERC also investigates system resilience, especially in the wake of major grid disruption events.

Many of NERC's reliability standards address system planning and other minimum requirements for ensuring the predictable and trouble-free operation for a system often described as the world's most complex machine. Some of NERC's reliability standards can be said to include an element of resilience by strengthening the ability of the grid to provide uninterrupted service. For example, grid operators design the system to withstand the failures of multiple elements of the system (N-1-1 contingency). They also plan for extreme events causing the loss of additional elements. NERC's design criteria recognize that a system element can fail for any reason, including equipment failure, line overloading, weather, falling trees, physical attacks, or even animals short-circuiting the line. In considering resilience, NERC and FERC must be careful not to duplicate these standards or create inconsistent rules.

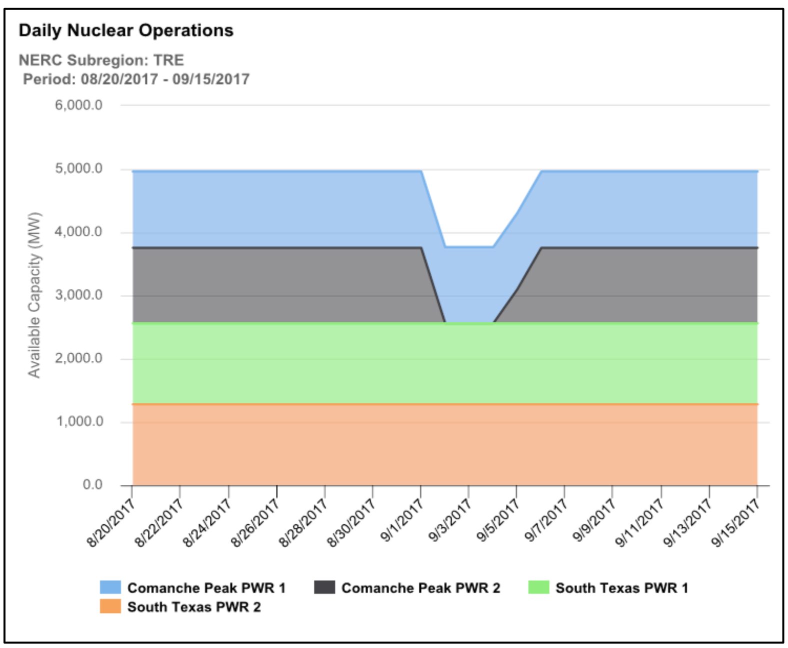
In view of the extremely active and ongoing work of NERC and other grid reliability authorities on reliability and resilience, we recommend that Congress leave the core responsibilities of defining and compensating reliability and resilience services to FERC and NERC. Congress can, however, ensure that DOE has adequate resources to research additional grid resilience and reliability improvements. Congress also should encourage DOE to continue to incent new technologies and grid structures, such as microgrids, that could achieve a reliable and resilient system at lower cost. Further, in providing aid to rebuild in the wake of disasters, such as the recent hurricanes impacting Texas, Louisiana, Florida, and Puerto Rico, Congress should consider how reconstruction can occur in a manner that best ensures future reliability and resilience.

Congress also should keep in mind at least two key facts related to resilience. **First, no type of central station power plant is immune to weather-related disruptions.** For example, several nuclear power plant units had to be taken off-line in preparation for Hurricane Irma and were out of service for up to six days:[2]

[2] Source: Data drawn from SNL Energy, "Daily Nuclear Operations" (*subscription required).*



Similarly, as a result of Hurricane Harvey, two units had to come off-line because of the intensity of the storm:[3]



[3] Source: Data drawn from SNL Energy, "Daily Nuclear Operations" (*subscription required).*

Also during Harvey, the onsite coal pile at the W.A. Parish plant in Texas became so saturated with rainwater that the coal could not be delivered into the storage silos, forcing the plant to switch to natural gas for the first time in 8 years.[4] In numerous cases, it was transmission lines, not generators, that were the point of failure due to storm damage. Finally, as is well-known, coal piles froze during the Polar Vortex. Conversely, wind has performed well during both cold and warm extreme weather events. For example, wind power plants near the Texas coast survived Harvey largely unscathed, despite facing 110 miles per hour winds. Also, demand response performed very well during the 2014 Polar Vortex.

Second, electrical distribution systems are responsible for over 90 percent of total electric power interruptions.[5] This is not surprising, since they are, by their very nature, more vulnerable to outages than the transmission system. Due to the high cost of redundancy, distribution systems are not designed with the same level of reliability and resilience as the transmission network.[6] This suggests that efforts to ensure reliability and resilience during extreme weather should focus largely on the distribution system rather than on any particular type of generation system. Transmission lines also suffer outages that exceed NERC reliability standards (as happened in Texas during Harvey), and in those instances, outages can be of significant duration and magnitude.

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[4] https://www.platts.com/latest-news/electric-power/houston/harveys-rain-caused-coal-to-gas-switching-nrg-21081527.

[5] DOE, Quadrennial Energy Review, Second Installment (January 2017), at 4-2, available at https://energy.gov/epsa/quadrennial-energy-review-second-installment.

[6] Brattle Group, Electricity Baseline Report for the US Power System, at 4 (April 2015), available at http://www.brattle.com/system/publications/pdfs/000/005/393/original/Electricity_Baseline_Report_for_the_US_Power_System.pdf?1484245617.

In all cases, monetizing specific grid resilience services through market design changes should be avoided unless the need is clearly researched, defined and distinctly articulated as separate from reliability services that are already compensated through the market.

2. We have maintained reliability during a transforming electricity system

Through the continuing transformation of the system resource mix, system operators have been able to meet the industry's high reliability standards. This is not surprising since they did so during the expansion of coal and gas in the 1970s and 1980s and during the gas boom in the 2000s. In all cases, planners and grid operators identify needs to meet reliability standards and best practices, and they must develop planning, market, and operation solutions to meet those needs in a resource-neutral manner.

Experience in the United States confirms that high levels of renewables like wind and solar can be reliably integrated into the system while offering valuable grid services. The Brattle Group's 2017 report, Advancing Past "Baseload" to a Flexible Grid, supports this conclusion, noting that renewable integration efforts are stimulating innovations that bring additional system benefits. [7] These benefits are only achievable by moving past the status quo.

The Subcommittee also should be aware that comparatively little backup power in the form of reserves is necessary to integrate high levels of renewable energy into the grid. Indeed, grid operators often require more backup power for large baseload power plants than for wind and solar facilities. Why? Wind and solar units are collections of many individual turbines and panels, which means that the failure of one or two turbines or a set of panels will have little

[7] Brattle Group, Advancing Past Baseload to a Flexible Grid, at iii (June 26, 2017), available at http://www.brattle.com/system/publications/pdfs/000/005/456/original/Advancing_Past_Baseload_to_a_Flexible_Grid.pdf?1498482432.

impact on the facility's total output. In contrast, the electricity output changes from coal and nuclear power plants, though less frequent, are larger, abrupt, and sometimes unpredictable.

3. "Baseload" is not a reliability or resilience standard

Baseload power is not a technically-based standard. Policies and investments preferencing the "baseload" supply resources in the name of resilience, but on the sole basis of their status as "baseload", will raise consumer costs without commensurate resilience benefits. In the past, when coal and nuclear power were perceived to be the least costly way to supply power, grid operators planned around these large units to serve baseline system needs (referring to them as "baseload" units because they operated at a high, sustained output level that served the baseline load; i.e. minimum demand was served primarily by "baseload" resources). Operators built or contracted with more expensive "intermediate" and "peaker" units to meet variations in system need because the baseload units were inflexible and could not be ramped up and down to meet these changes. Because other units were also capable of contributing production during periods of minimum demand, the only compelling reason to have units dedicated to serving this "base load" was that the inflexible units were perceived to be cheaper.

But today, coal and nuclear units are frequently not the least expensive option. Low natural gas prices, flat electricity demand and more efficient energy use, declining renewables costs, and stronger climate and public health protections are all driving an irreversible shift in the underlying economics of the electricity industry. Because of these trends, Brattle Group, a global economics consulting firm, has concluded that describing generation as "baseload" is no longer helpful for purposes of planning and operating today's electricity system.[8] Economics frequently

[8] See Brattle Group, Advancing Past Baseload to a Flexible Grid, at 13 (June 26, 2017), available at http://www.brattle.com/system/publications/pdfs/000/005/456/original/Advancing_Past_Baseload_to_a_Flexible_Grid.pdf?1498482432.

dictate that a different mix of units serves the base load (minimum demand) at different times, so the term is confusing without providing any helpful information to grid planners.

A resource-neutral grid planning framework that focuses on services like providing power at times of peak demand is a better approach than preferencing resources because of labels like "baseload." For example, in regions with competitive markets, market prices dictate the cheapest mix of resources to meet needs at any given time, while reliability requirements ensure that enough units are available to ensure that a blackout never occurs. This framework rewards "baseload" plants only where they are truly needed, but prioritizes other resources when it is more cost-effective to do so.

The Department of Energy Staff Report to the Secretary on Electricity Markets and Reliability suggested a technology-neutral framework for "baseload generation," defining it as "power plants that are operated in baseload patterns," meaning "plants that run at high, sustained output levels and high capacity factors, with limited cycling or ramping."[9] But the report never explains why grid planners or operators should endeavor to classify this category of plants. In fact, the concept cannot be defended. There is no reason to meet load with plants that run at high, sustained output levels as opposed to a mix of units that run at variable levels but combine to serve system demand at any given time. The market can and will choose the mix of resources that meet load at lowest cost. If anything, the inflexible nature of units traditionally known as "baseload" is a negative feature that hampers their ability to serve system needs such as ramping. Giving "baseload" units different regulatory treatment, such as compensation solely on that basis, would increase costs for customers without providing any commensurate benefits.

[9] Department of Energy Staff Report to the Secretary on Electricity Markets and Reliability, at 5 (August 2017).

To be clear, this is not to say that “baseload” units do not provide valuable services to the grid. They do, and should be compensated accordingly. (There also may be historical reasons why baseload resources are more prevalent in some areas.) But, compensation for those services should be provided in a resource-neutral manner that addresses the specific need being served (for example, frequency response, production at times of peak demand), *not* because a plant happens to operate at a high, sustained output level, which, as noted earlier, is an arbitrary distinction. As Chairman Chatterjee affirmed in testimony before the Subcommittee last month, the Federal Power Act requires FERC to act in a fuel neutral manner, which means avoiding discriminating between types of generation.

This requirement prohibits compensation based on categorization of units according to criteria such as “baseload,” even if they are framed according to technology-neutral criteria such as the ones proposed by the Department of Energy Staff report. This is because those criteria are not linked to any specific grid services, meaning that the inherent purpose of such classification would simply be to prefer those types of resources that fell within the classification. Similarly, FERC could not create a “resource neutral” framework to provide special compensation to resources that operate during the day when the sun is shining, and then ramp down capability at night. Compensating units for the services that they provide should not involve developing a classification system for “baseload” or any other arbitrary category based on generation profiles, which would simply increase customer costs and discourage innovation.

Such compensation also would incur significant opportunity costs, since dollars spent on-site fuel storage or another asserted attribute are dollars not invested in other activities that could contribute much more to grid resilience. Said another way, mandating additional compensation for on-site storage without conducting a comprehensive comparison of options for enhancing grid resilience could interfere with much more important actions to improve grid resilience. By focusing instead on operational needs rather than specific fuels or technologies, grid operators and planners can leverage and incentivize the full range of resources capable of meeting those needs, thereby reducing costs and incentivizing innovation.[10]

4. Resilience must not be used as a pretext for rent-seeking behavior by non-competitive generators

Recently, market forces such as low natural gas prices have put resources traditionally known as "baseload" resources under economic pressure. But the question of whether resources have enough revenues to continue to operate or will retire is entirely different from the question of whether a specific unit is needed to maintain the reliability of the system (which is dealt for by FERC and NERC regulations). As certain types of units become uncompetitive, owners of those units may seek payments or other regulatory preferences under the pretext of reliability or resilience even when they are not the most reliable or economic way to supply reliability or resilience.

But preferencing any resource in markets by compensating or otherwise advantaging resources that display specific characteristics simply because of the perceived contributions of any one source to overall system reliability or resilience, begs the question of whether other units or technologies could provide the same level of resilience at a lower cost. Defining resilience and reliability services in a truly resource-neutral manner allows the market to answer that question.

Baseload resources are not necessarily resilient, as extreme weather events show. Indeed, even if the grid operator had paid the coal or nuclear resource premiums at the time of the event,

[10] It also is worth emphasizing that energy efficiency supports a resilient and flexible grid for the simple fact that more energy efficiency reduces the need for any supply resource and the attendant transmission infrastructure. Increasing end use efficiency extracts more energy value for each unit of power generated by any supply resources. Energy efficiency also brings other benefits, including lower consumer bills, lower peak demand, less water and air pollution, and fewer land use impacts.

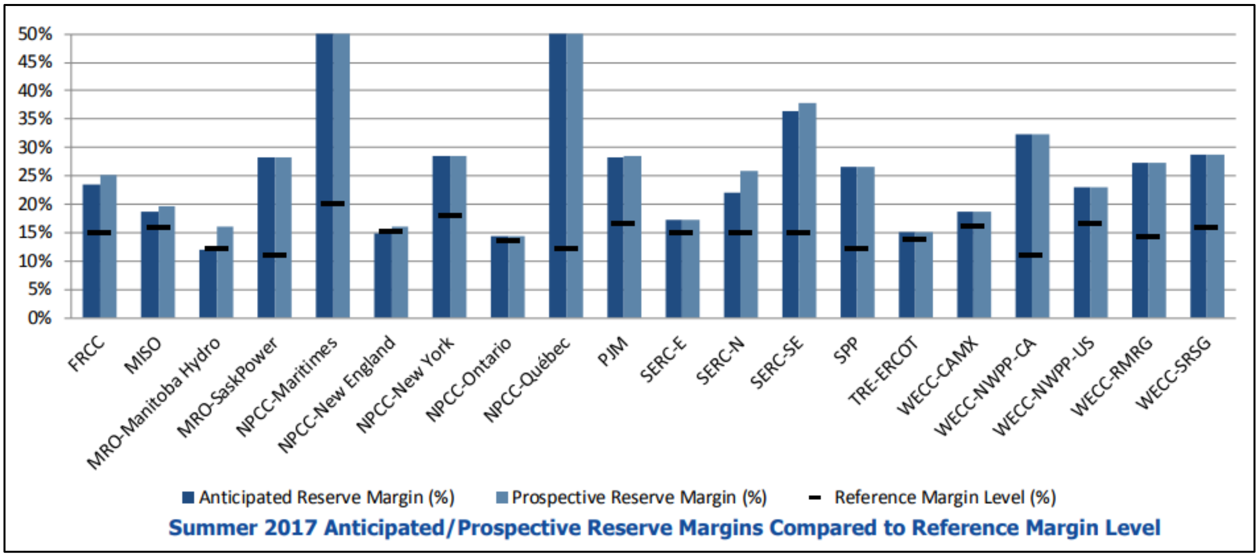
it is unlikely that they would have had any effect on assuring their performance and reducing their forced outage rate. In the case of PJM, it created new rules to improve the performance of their gas and coal fleet (such as requiring cold weather protections) precisely because they were more vulnerable to disruptions than wind, nuclear, and demand response in an extreme cold weather event. PJM first boosted the performance of its generators in extreme weather conditions through operational fixes and requirements, rather than by market enhancements, to improve operational reliability and reduce forced outages. These steps included:

- Performance verification or testing during and before cold weather;
- Better gas unit commitment, communication, and coordination;
- Validation of unit fuel source, operating limits, and outage types;
- Confirmation of the availability of resources outside of PJM able to supply energy and capacity into PJM.

PJM also made numerous improvements for performance in hot weather, including: more accurate estimates of synchronized reserves; better communication and notification protocols; more information on unit characteristics and limitations; updates to PJM's system modeling; and improvements to PJM emergency procedures tool. None of these changes required out-of-market compensation or premiums for specific resources.

Currently, there is little evidence of a resource adequacy shortfall. All regions of the country meet, and in some cases, substantially exceed their target reserve margin: [11]

[11] North American Electric Reliability Corporation, 2017 Summer Reliability Assessment, at 7 (available at http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/2017%20Summer%20Assessment.pdf.



Further, the interconnection queues of the three largest RTOs in the eastern interconnection (PJM, MISO, and SPP) reflect the continuing bullish investor and developer outlook on new generation builds, with over 166 GW of wind, solar, and natural gas projects in the queues.[12] MISO's queue, for example, includes 28.6 GW of wind, 14.9 GW of solar, and 11.5 GW of gas. Even if only a fraction of the resources are built (as is often the case), these high levels suggest confidence, not crisis.

Flying in the face of these facts, on September 29, 2017, DOE proposed a massive subsidy program for economically ailing coal and nuclear power plants.[13] The proposal requests FERC to issue a final rule within 60 days to prop up "fuel-secure resources," which must have "a 90-day fuel supply on site enabling [them] to operate during an emergency, extreme weather conditions, or a natural man-made disaster."

DOE's unprecedented move is couched under a false premise that plants with fuel located on site are needed to guarantee the reliability of the electricity system. According to the proposal,

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[12] MISO (https://www.misoenergy.org/Planning/GeneratorInterconnection/Pages/InterconnectionQueue.aspx); PJM (http://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx); SPP (https://sppoasis.spp.org/documents/swpp/transmission/GENInterPAGE.CFM).

[13] https://energy.gov/articles/secretary-perry-urges-ferc-take-swift-action-address-threats-grid-resiliency.

“[t]he resiliency of the nation's electric grid is threatened by the premature retirements of power plants that can withstand major fuel supply disruptions caused by natural or man-made disasters.” But consistent with NERC’s findings noted above, DOE’s own grid study this year found that all regions of the country have an *excess* supply of energy resources needed to meet demand. Furthermore, while it included a brief discussion of the potential benefits of on-site fuel supply, it also highlighted examples of units with on-site fuel supply *failing*, such as coal plants that could not operate during the 2014 Polar Vortex when their fuel supplies froze in the extreme cold.

DOE’s proposal would be a radical departure from the way FERC currently regulates electricity prices. Under FERC’s system, electricity prices are governed by competitive market forces. A power plant is only insulated from this system by FERC under extremely limited circumstances, where a detailed examination of the grid reveals that the plant is needed for reliability purposes. The plant is then guaranteed its costs of operating only on a temporary basis, until a replacement for the unit can be constructed.

Moreover, if adopted, DOE’s proposal would wholly undermine FERC’s carefully-constructed market system. It would essentially ensure that coal and nuclear plants in regions encompassing most of the country continue to run even where they are too expensive to compete in the energy market. And it would saddle customers with higher costs, while posing obstacles to the integration of cleaner and less risky energy sources such as solar and wind.

More generally, interventions such as the DOE proposal have several major drawbacks and risks which make them so undesirable. Their problems include:

- Increasing carbon and other pollution;
- Increasing customer costs without offering corresponding benefits;

- Exacerbating the problem they seek to solve by undermining trust in market signals and destabilizing the investment climate for the future; and
- Creating oversupply, by reducing prices mutes the price signal for flexible supply and demand resource options.

5. Flexibility should be prioritized in market design

Studies demonstrate that encouraging flexible energy resources holds the potential to better serve customers while reducing system costs. Congress should encourage market designs that better compensate flexibility by funding Department of Energy studies to examine grid services and technologies capable of meeting these needs.

The Brattle Group's 2017 report, Advancing Past "Baseload" to a Flexible Grid, demonstrates how grid operators are reducing costs and more reliably serving customers by designing markets and planning procedures around more precise definitions of system needs.[14] As Brattle explains, studies demonstrate that "flexibility" -- the ability to deliver power and ramp-up supply or reduce demand quickly in response to system fluctuations – is increasingly valuable. An increased focus on flexibility holds the potential to improve reliability and reduce costs. A recent study of California's grid found that as flexibility increases, reliability improves and both production costs and emissions decrease.[15] Analysis of New Mexico grid operations reached a very similar conclusion, finding that over time, operational flexibility will be increasingly important in avoiding load curtailment and blackouts.[16]

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[14] Brattle Group, Advancing Past Baseload to a Flexible Grid (June 26, 2017), available at http://www.brattle.com/system/publications/pdfs/000/005/456/original/Advancing_Past_Baseload_to_a_Flexible_Grid.pdf?1498482432.

[15] Flexibility Metrics and Standards Project (January 2016), available at www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=9282.

[16] PNM Preliminary Reliability Analysis (April 2017), available at https://www.pnm.com/documents/396023/3306887/04182017-irp-mtg-reliability/66b6bdc0-d9d4-4f72-b1dc-076d8c5c74c2.

Coal and nuclear units are limited in their flexibility because they tend to have high start-up and shut-down costs, as well as operational limitations; so, they generally cannot provide the full suite of grid services offered by nimbler flexible resources like energy storage. While nuclear and coal do support system reliability, this value is not unique. Brattle's conclusion is that grid operators should let supply compete in a technology-neutral manner to provide grid reliability.

Conclusion

I want to again thank the Committee for inviting me to testify today on these important grid reliability and resilience issues. Continuing the transformation of the power grid to facilitate a low-carbon future will improve reliability and resilience in the long run by helping to prevent and reduce outages due to the increase in extreme weather and other disruptive events. A diverse and fuel-neutral mix of "flexible" resources will be a key ingredient in this transformation. I look forward to discussing them with the Committee during the hearing.