U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE

September 29, 2017

TO: Members, Subcommittee on Energy

FROM: Committee Majority and Minority Staff

RE: Hearing entitled "Part II: Powering America: Defining Reliability in a Transforming Electricity Industry"

I. INTRODUCTION

The Subcommittee on Energy will hold a hearing on Tuesday, October 3, 2017, at 2:00 p.m. in 2123 Rayburn House Office Building. The hearing is entitled, "Part II: Powering America: Defining Reliability in a Transforming Electricity Industry." The previously scheduled hearing was rescheduled into TWO parts. Part one of the hearing featured witnesses listed under Panel I and took place on Thursday, September 14, 2017, at 10:00 a.m. in 2123 Rayburn House Office Building. Part two of the hearing features witnesses listed under Panel II. Both hearings will examine how regulators and the industry are addressing reliability in the United States electricity system.

II. WITNESSES

PANEL I

- **Neil Chatterjee**, Chairman, Federal Energy Regulatory Commission (FERC);
- **Patricia Hoffman**, Acting Under Secretary for Science, Acting Assistant Secretary for the Office of Electricity, Department of Energy (DOE); and,
- **Gerry Cauley**, President and CEO, North American Electric Reliability Corporation (NERC).

PANEL II

- **Marty Durbin**, Executive Vice President and Chief Strategy Officer, American Petroleum Institute;
- **Paul Bailey**, President and CEO, American Coalition for Clean Coal Electricity;
- **Maria G. Korsnick**, President and CEO, Nuclear Energy Institute;
- **Tom Kiernan**, CEO, American Wind Energy Association;

- **Steve Wright**, General Manager, Chelan Public Utility District, *on behalf of* National Hydropower Association;

- **Abigail Ross Hopper**, President and CEO, Solar Energy Industries Association;

- **Kelly Speakes-Backman**, CEO, Energy Storage Association; and,

- **John Moore**, Director, Sustainable FERC Project, Energy & Transportation Program, Natural Resource Defense Council.

III. BACKGROUND

The United States' electricity system is undergoing a significant period of transformation driven by a variety of factors including changing fuel costs and generation mix, decreases in electricity demands, advances in technology, and evolving consumer preferences. As these changes occur, industry stakeholders have recognized the need to maintain grid reliability for a nation that is continuously dependent on the stable delivery of electricity. Reliability is generally defined as the ability of the electric system to deliver expected service through planned and unplanned events.[1] To maintain reliable operation, power systems must have the ability to respond to sudden changes in generation and consumption and balance the system in real time.[2]

The United States has approximately 7,700 operating power plants[3] that generate electricity from an array of primary energy sources and delivery infrastructure that includes over 700,000 miles of high-voltage transmission lines.[4] The nation's generation portfolio is diverse and includes resources such as coal, natural gas, wind, nuclear, solar, hydro, geo-thermal, cogeneration, biomass, and distributed energy resources.

Generators come in many forms and use different methods to convert a fuel or energy source into electricity. Electric system operators decide which generators to run based on their economic and operational characteristics or, in many regions, based on prices bid by competing generators. Generation is generally dispatched in order of cost (or bid) to meet load, unless reliability factors require otherwise. When load is at its peak, more expensive units generally are used to meet the increased demand and the overall cost increases. Since the amount of power needed to serve load constantly changes, electric system operators must schedule or "dispatch" production by the generators to meet changing demands. Scheduling usually occurs on an hourly basis, sometimes through the use of automatic generation controls to continuously match generation to actual demand.[5]

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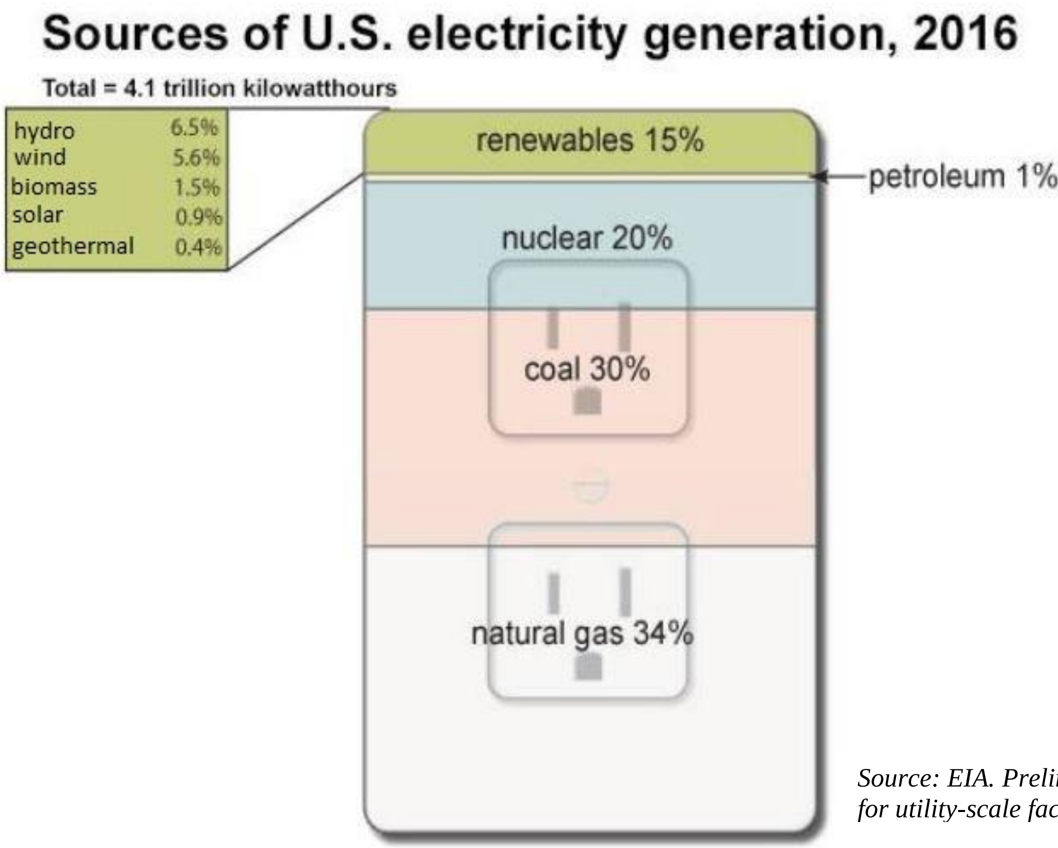
[1] U.S. Department of Energy (DOE), *Maintaining Reliability in the Modern Power System,* (Dec. 2016)
[2] MIT Energy Initiative, *Utility of the Future,* (Dec. 2016) http://energy.mit.edu/wp-content/uploads/2016/12/Utility-of-the-Future-Full-Report.pdf
[3] Energy Information Administration (EIA), *Table 4.1 Count of Electric Power Industry Power Plants by Sector, by Predominant Sources within Plant, 2005 through 2015*. https://www.eia.gov/electricity/annual/html/epa_04_01.html
[4] U.S. Department of Energy, *Quadrennial Energy Review – Second Installment: Transforming the Nation's Electricity System,* (Jan. 2017)
[5] Federal Energy Regulatory Commission, *Reliability Primer,* (Dec. 2016)



Source: EIA. Preliminary 2016 data for utility-scale facilities

Several governmental and non-governmental entities are charged with ensuring the reliability of the nation's bulk power system through standards and regulations. The Department of Energy (DOE), the Federal Energy Regulatory Commission (FERC), and the North American Reliability Corporation (NERC) each have unique roles in maintaining reliability across the nation's electric grids.

DOE's Office of Electricity Delivery and Energy Reliability (OE) leads the Department's efforts to ensure a resilient, reliable, and flexible electricity system.[6] OE accomplishes this mission through research, partnerships, facilitation, modeling and analytics, and emergency preparedness. DOE contributes to reliability efforts through its research and development in its *Quadrennial Energy Review*, a report on *Maintaining Reliability in the Modern Power System*, and most recently its, *Staff Report to the Secretary on Electricity Markets and Reliability*.

NERC is a non-profit international regulatory authority whose mission is to assure the reliability and security of the North American bulk power system. In 2005, Congress acted to establish reliability standards for the electricity sector by passing the *Energy Policy Act of 2005*, which amended the *Federal Power Act* and authorized FERC to select an Electric Reliability Organization (ERO) with the authority to establish and enforce reliability standards. In 2006,

[6] *See* U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability – Mission Statement

FERC designated NERC as the ERO. Among its responsibilities, NERC develops and enforces reliability standards, annually assesses seasonal and long-term reliability, monitors the bulk power system through system awareness, and trains and certifies industry personnel.[7]

FERC also plays a central role in overseeing the reliable operation of the nation's bulk power system.[8] Pursuant to section 215 of the *Federal Power Act*, FERC's authority requires that all "users, owners and operators" of the grid comply with reliability standards that are developed by an independent reliability organization (*i.e.*, NERC). After NERC develops the standards with input from industry stakeholders, they are proposed to FERC for review and approval. Upon review and approval by FERC, the reliability standards then become mandatory and legally enforceable. If an entity is found to have violated a mandatory reliability standard, FERC or NERC may propose a penalty or initiate an investigation. Within FERC, the Office of Electric Reliability and the Office of Enforcement serve as the primary offices responsible for ensuring compliance with the large number of technical reliability standards.

Resource Adequacy and Operating Reliability

NERC views reliability in terms of resource adequacy and operating reliability.[9] Resource adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the end-use customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.[10] Operating reliability is the ability of the grid to withstand sudden disturbances to system stability or unanticipated loss of system components.[11]

Demand for electricity varies depending on the time of day, season, and region of the country. For example, during warmer summer months, a greater amount of electricity is consumed through air conditioning compared with cooler spring or fall months. Resource adequacy is defined as having sufficient resources available on the electricity system to be able to meet peak demand.[12] Depending on the region, system operators and/or utilities are tasked with ensuring sufficient resources meet demand through long-term planning and forecasting. This occurs in both organized wholesale electricity markets and for those States not in organized markets. In the bilateral markets (regions not in organized markets), this role is accomplished through integrated resource planning conducted by electric utilities. When long-term needs for generation exceed the generating resources expected to be on the electric system, the deficit is met through the addition of new infrastructure such as power plants and transmission lines, and demand-side resources such as storage, and other distributed energy resources.[13]

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[7] North American Electric Reliability Corporation (NERC), *2016 Long-Term Reliability Assessment,* (Dec. 2016)
[8] In December 2016, FERC released a Reliability Primer – which provided an overview of the Commission's role in overseeing the reliable operation of the nation's bulk power system. *see* Federal Energy Regulatory Commission, *Reliability Primer,* (Dec. 2016)
[9] Analysis Group, *Electricity Markets, Reliability, and the Evolving U.S. Power System*, (Jun. 2017)
[10] *See* NERC's Glossary of Terms, available at http://www.nerc.com/files/glossary_of_terms.pdf
[11] *Id.*
[12] NERC defines resource adequacy as, "the ability of the electric system to supply the aggregate electric power and energy requirements of the electricity customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system components."
[13] Analysis Group, *Electricity Markets, Reliability, and the Evolving U.S. Power System*, (June 2017)

Beyond providing for resource adequacy, operational reliability depends on ensuring that the electric system operates in real time with high technical integrity. System operations are impacted by several factors, including the location of the resources, its fuel source, and operating characteristics. Other factors affecting electric system operations include – variations in load as demand changes, the sudden loss of a power plant or transmission line, changes in weather, or a sudden power outage.[14]

Reliability Requirements and Resource Attributes

The electric system operator is subject to certain requirements to ensure reliability of the electricity system. The Department of Energy lays out several rules[15] that summarize the numerous standards and regulations that govern reliability of the electricity sector. First, power generation and transmission capacity must be sufficient to meet peak demand. Second, electricity systems must have adequate flexibility to address variability and uncertainty of demand (load) and generation resources. Third, electricity systems must be able to maintain steady frequency and voltage within an acceptable range.

Generations resources, coupled with storage and demand response resources, have attributes that enable the electric system operators to meet these reliability requirements.[16] These attributes are divided into several categories – essential reliability services, fuel assurance, flexibility, and other factors – such as storage, demand response, and black start capability.

Essential Reliability Services

The NERC delineates certain reliability attributes as essential reliability services, which comprise a subset of resource attributes. Essential reliability services include frequency response, voltage control, and ramping.[17] Frequency of the alternating current (AC) power system is set to 60 cycles per second or 60 hertz (Hz). Failure to match generation to demand causes the frequency of the power system to fluctuate higher or the lower than the normal 60 Hz. When generation exceeds the load or demand to consume it, the system frequency increases; when there is less generation being produced than is needed to serve load, the frequency decreases. Large deviations in frequency can cause the rotational speed of generators to fluctuate, leading to vibrations that can cause damage to generator turbine blades and other equipment. Extremely low frequencies can trigger automatic under-frequency "load shedding" to enable frequency to increase, which takes customers off-line to prevent total collapse of the electric system.[18]

Voltage control is the ability of a generator to either inject or absorb "reactive power" either prior to or after a system disturbance in order to maintain or restore system voltages to prescribed levels. Reactive power cannot be transmitted long distances unlike real power, which means reactive power reserves must be geographically dispersed and located in proximity to

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[14] Analysis Group, *Electricity Markets, Reliability, and the Evolving U.S. Power System*, (June 2017)
[15] Department of Energy (DOE), *Maintaining Reliability in the Modern Power System*, (Dec. 2016)
[16] The Brattle Group, *Diversity of Reliability Attributes – A Key Component of the Modern Grid* (May 2017)
[17] North American Electric Reliability Corporation, *Essential Reliability Services*, (Dec. 2016)
http://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/ERSWG_Sufficiency_Guideline_Report.pdf
[18] Federal Energy Regulatory Commission, *Reliability Primer*, (Dec. 2016)

customer load. If these reactive power reserves are not maintained locally, disturbances can result in instability and potentially localized or wide-area blackouts.[19]

Ramping is the ability of a generator to increase or decrease megawatts in response to changes in electric system load, interchange schedules or generator output, in order to maintain grid reliability and compliance with applicable NERC standards. Ramping includes regulation, contingency reserve, and load following. Regulation is the amount of energy reserves from a resource that is responsive to control and is sufficient to provide normal regulating margin and frequency control that is required. Contingency reserve is the amount of capacity that can be deployed to respond to a situation that results from a large imbalance between generation and demand, typically resulting from a loss of a generator. Load following, also known as dispatchability, is the ability of a generator to adjust their power output as demand for electricity fluctuates through the day.[20]

Resource Flexibility

Flexibility is the ability of a resource to cycle throughout a day (*i.e.*, the time required to start, minimum run time, and the maximum number of starts per day.) A generation source is considered flexible when it can come on or off-line and run for short periods of time when system load, interchange, or generator output is rapidly changing, which is most common during early morning periods or late afternoon periods. Reliability depends on flexibility during minimum load periods, peak load periods, periods of rapidly changing variable energy resources, during transmission or capacity emergency conditions, or due to real-time changes in load profile and/or unit availability after day-ahead resource commitments are communicated. Generation sources have different levels of flexibility, and this attribute varies by technology and/or fuel type.[21]

Electricity remains unique compared to other commodities due to its limited ability to be stored.[22] However, when distributed storage is aggregated, it can offer local electric system operators flexibility for managing system reliability and power quality.[23] Energy storage provides reliability attributes both on the supply and demand side, including energy, capacity, energy management, backup power, load leveling, and essential reliability services, over periods from seconds to hours or days.[24] Separately, demand response allows consumers to change their normal electricity patterns and is considered a flexible resource. Demand response is often used for load reduction and shaping, but also helps electric system operators offset generation variability.[25]

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[19] PJM Interconnection, *PJM's Evolving Resource Mix and System Reliability,* (Mar. 2017)
[20] *Id.*
[21] PJM Interconnection, *PJM's Evolving Resource Mix and System Reliability,* (Mar. 2017)
[22] U.S. Department of Energy, *Quadrennial Energy Review – Second Installment: Transforming the Nation's Electricity System* (Jan. 2017)
[23] *Id.*
[24] U.S. Department of Energy, Pacific Northwest National Laboratory, and the Brattle Group, *Valuation of Electric Power System Services and Technologies*, (Aug. 2016) http://www.brattle.com/system/publications/pdfs/000/005/389/original/Valuation_of_Electric_Power_System_Services_and_Technologies.pdf?1484183040
[25] U.S. Department of Energy, *Quadrennial Energy Review – Second Installment: Transforming the Nation's Electricity System* (Jan. 2017)

Fuel Assurance and Black Start Capability

According to PJM, fuel assurance, "considers the capability of the resource to store fuel on-site in order to limit the exposure to a single common event."[26] Fuel assurance is necessary in order to provide the power and reserves needed to maintain system reliability, independent of external delivery infrastructure or rapidly changing weather patterns. Black start capability is a generator resource that can start independent of an electric source and can supply electricity to an electric system for purposes of restoring power to both the grid and other generation resources following a widespread loss of power.[27]

IV. ISSUES

The following issues may be examined at the hearing:

- How reliability attributes of various types of generation sources ensure electric system operators are able to meet reliability requirements.
- How and whether existing electricity market rules, State policies, and Federal policies are encouraging a reliable electricity system.
- How the evolving United States electricity system is changing the way States and regulators ensure reliability.

V. STAFF CONTACTS

If you have any questions regarding this hearing, please contact Annelise Rickert, Jason Stanek, or Wyatt Ellertson of the Majority Committee staff at (202) 225-2927 or Rick Kessler on the Minority Committee staff at (202) 225-3641.

[26] PJM Interconnection, *PJM's Evolving Resource Mix and System Reliability,* (Mar. 2017)
[27] *Id.*