the high-voltage interstate Bulk Power System (BPS) and local distribution systems that supply lower-voltage power to individual end-users.[34]

It is important to note that, given the physics of electricity and electron flows, events at any location on an interconnection can affect the rest of the interconnection. Abrupt changes of electricity supply or consumption in a particular location, particularly those caused by outages or loss of system components, can cause voltage instability, component failure, cascading failures across the interconnection, and, if the problem is not corrected quickly—collapse of the entire interconnection. Although location matters – some transmission lines or substations or generation units within an interconnection are in important ways more critical than others—the integrity and balance of the whole system is of critical importance. The breadth of an interconnection adds resiliency to the BPS by allowing a stressed portion of the grid to draw upon on another portions to supply additional power or transmission capacity to make up for generation or transmission outages. At the same time, however, a large grid can be vulnerable to rolling blackouts, as occurred during the August 14, 2003 blackout, which began in Ohio and cascaded through Eastern Canada, New York, and New England.

To avoid and recover from blackouts, it is essential that the system have adequate generation and transmission capacity broadly dispersed within the interconnection. Both transmission and generation are critical electric infrastructure as defined by the Federal Power Act. The Act defines CEI as "a system or asset of the [BPS], whether physical or virtual, the incapacity or destruction of which would negatively affect national security, economic security, public health or safety, or any combination of such matters."[35] Interconnections are designed to withstand the loss of a single generator or other component, generation and transmission "assets" more broadly are central to this definition. It is important to understand that the generation "fleet" within an interconnection does not operate like a fleet of vehicles. Because each Interconnection is a single machine that must maintain a critical mass of various components and resources to keep running.

A. Resilience Depends on Generation Fuel Diversity Including Fuel-Secure Electric Generation Resources

Generation fuel diversity is a critical strategy to ensure that the Nation has the resilient electric grid required to promote national defense and maximize domestic energy supplies in times of severe stress to the grid. NERC stated in its May 2017 *Synopsis of NERC Reliability Assessments* that "[h]igher reliance on natural gas exposes electric generation to fuel supply and delivery vulnerabilities" and that "[p]remature retirements of fuel secure baseload generating

[34] FPA section 215 defines BPS as "(A) facilities and control systems necessary for operating an interconnected electric energy transmission network (or any portion thereof); and (B) electric energy from generation facilities needed to maintain transmission system reliability." [CITE 215 (a)(1)] The definition expressly excludes "facilities used in the local distribution of electric energy." Id. In the Eastern Interconnection, for example, there are ___ generation units, ___ miles of high-voltage***. [OP]
[35] FPA 215A(a)(2).

stations reduces resilience to fuel supply disruptions."[36] Therefore, according to NERC, **"[m]aintaining fuel diversity** and security provides best assurance for resilience."[37] Further, NERC concluded that "having a portion of a resource fleet with high reliability characteristics, such as low forced and maintenance outage rates and low exposure to fuel supply chain issues, is one of the most fundamental necessities of a reliable [baseload power supply]."[38] In particular, "[c]oal and nuclear resources . . . have low forced and maintenance outage hours traditionally and have low exposure to fuel supply chain issues."[39] Also, traditional baseload generation can help the system withstand such an event, because "[n]uclear and coal plants typically have advantages associated with onsite fuel storage."[40]

The 2017 NASEM Study also discussed the benefits of generation diversity. NASEM noted that the January 2014 Polar Vortex "focused attention on the vulnerability associated with increasing reliance on natural gas for electricity restoration."[41] NASEM concluded that the proportion of generation provided by natural gas has grown substantially over the past few years, and that this trend:

> not only exposes the industry to potential price volatility and supply chain vulnerability, but also raises the question of how utilities could restore electricity service if a major disruption to natural gas delivery occurred (*e.g.*, one or more critical pipelines are destroyed).... [S]tudies suggest that resilience can be enhanced through a diverse fuel portfolio, where a single interruption is less likely to impact a significant number of generators that cannot be overcome by reserve assets.[42]

In its 2017 Long-Term Reliability Assessment, NERC observed, "[c]onventional generation, including coal and nuclear, have unique attributes of low outage rates, high availability rates, and on-site fuel storage that provides secure and stable capacity to the grid."[43] In addition, NERC concluded

[36] NERC Reliability Synopsis, at 3.

[37] NERC Reliability Synopsis, at 3. (emphasis added). Similarly, NERC concluded in its 2017 Long-Term Reliability Assessment (LTRA), "[a] diverse resource mix promotes a more reliable supply of electricity, but as more areas are dependent on natural-gas-fired generators, reliability hinges on adequate arrangements for fuel and access to it." North American Electric Reliability Corporation, *2017 Long-Term Reliability Assessment*, at 30 [hereinafter NERC LTRA]. In assessing "the reliability benefits of having a diverse resource portfolio" NERC determined that "[f]uel diversity provides a fundamental benefit of increased resilience. Without this diversity, the impact of rare events impacting availability of resources on the power system increases and are more likely the result of a common-mode failure impacting multiple generation or transmission facilities." NERC Reliability Synopsis, at 4.

[38] NERC Reliability Synopsis, at 4.

[39] *Id.*

[40] *Id.* The chief advantage of on-site fuel is the "reduction in the risk that a generator will be unable to operate when needed."

[41] NASEM Study, at 76.

[42] *Id.* at 82.

[43] NERC LTRA, at 13.

> [N]uclear retirements require additional attention from system planners and policy makers related to local transmission adequacy and the potential for reduced resilience. This is because of the unique ability of nuclear resources to operate despite a variety of potential fuel supply disruptions."[44]

Because it ensures adequate generation during major disruptions, a diverse fuel portfolio, including fuel-secure resources, is critical to national security.

B. Loss of Fuel-Secure Electric Generation Resources: A Tipping Point

Historically, the U.S. electric system has had a highly diversified "portfolio" of electric generation resources, including three broad types of generation: First is fuel-secure capacity—which means each unit has many days or weeks of fuel available on site: this includes coal, nuclear, hydro power and certain kinds of liquid fuel or dual-fuel natural gas units. Second are pipeline-dependent units with little or no on-site storage, which depend on "just-in-time" supply chains. Third are intermittent resources—wind and solar. This diversity, anchored by fuel-secure baseload power, has meant that each part of the system has its own strengths. No single disruption effectively could compromise the whole generation fuel supply chain.

Over the last several years, however, the balance has shifted away from fuel-secure resources toward a growing dependence on pipeline-dependent and intermittent resources. According to the Department of Energy's January 2017 *Quadrennial Energy Review*:

> Currently, the changing electricity sector is causing the closure of many coal and nuclear plants in a shift from recent trends. From 2000 through 2009, power plant retirements were dominated by natural gas steam turbines. Over the past 6 years (2010–2015), power plant retirements were dominated by coal plants (37 GW), which accounted for over 52 percent of recently retired power plant capacity. Over the next 5 years (between 2016 and 2020), 34.4 GW of summer capacity is planned to be retired, and 79 percent of this planned retirement capacity are coal and natural gas plants (49 percent and 30 percent, respectively). The next largest set of planned retirements are nuclear plants (15 percent).[45]

Further, the DOE Staff Report discusses the large number of traditional baseload units that have retired or are scheduled to retire.[46] Between 2002 and 2016, 531 coal generating units representing approximately 59,000 MW of generation capacity retired from the U.S. generation fleet.[47] Coal-fired plants comprise more than 80 percent of the 18,000 MW of electric generating capacity that retired in 2015.[48]

Nuclear plants have also been hard-hit. No new nuclear generation unit has commenced operation since [YEAR]. Since 1990, the U.S. has lost fifteen nuclear generation units, comprising

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[44] *Id.* at 14.
[45] QER, at 3-73 (citation omitted).
[46] *See generally* U.S. Department of Energy, *Staff Report to the Secretary on Electricity Markets and Reliability*, at 15-60 (Aug. 2017) [hereinafter DOE Staff Report].
[47] *Id.* at 22.
[48] *Id.*

[CAPACITY].[49] The pace of planned nuclear retirements has recently accelerated. From 2013 to 2016, 4,666 MW of nuclear generating capacity (about 4.7 percent of the U.S. total) went offline.[50] Following the retirement of Fort Calhoun in 2016, the United States has 99 commercially operating units at 61 nuclear power plants.[51] Since 2016, another twelve nuclear units—and additional 11,119 MW—have announced retirement.[52] ."[53] Analysts have predicted that as much as half of the remaining nuclear fleet is "under water."[54]

Retirements of fuel-secure generation show no signs of slowing down, and are accelerating overall.[55] NERC's 2017 Long-Term Reliability Assessment highlights similar circumstances and reaches similar conclusions. So far, "[c]onventional generation retirements have outpaced conventional generation additions with continued additions of wind and solar."[56] In PJM alone, "if formally submitted deactivation plans materialize, more than 25,000 MW of coal-fired generation will have deactivated between 2011 and 2020."[57]

1. The Grid Remains Dependent on Fuel-Secure Baseload Generation

In its January 2017 Quadrennial Energy Review, DOE stated, "today's electricity system is highly dependent on baseload generation."[58] Historically, "baseload" generation meant fuel-secure coal, nuclear, and hydropower units, while natural gas-fired units were used for peak load at higher prices.

Even as large-capacity coal and nuclear plants are announcing retirement in considerable numbers, the organized wholesale electricity markets remain dependent on coal and nuclear generation to meet peak load demand during winter cold snaps and summer heat waves.[59] For example, coal and nuclear generation accounted for more than half of PJM's installed generation capacity in 2017 —specifically, 33 percent coal, 19 percent nuclear, and 21 percent natural gas.[60] Moreover, according to an analysis by the National Energy Technology Laboratory (NETL), during the cold snap of December 27, 2017 to January 9, 2018, when demand approached record winter peak levels, coal accounted for 39.5 percent of PJM's power generation, and nuclear for 30.2 percent—thus, a combined total of just under 70 percent of PJM's generation load was

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50 *Id.* at 29.

51 https://www.eia.gov/todayinenergy/detail.php?id=28572

52 [CITE]

53 *Id.* at 30.

54 [CITE]

55 [CITE EIA data]

56 NERC LTRA at 5.

57 *Id.* at 58.

58 QER at 1-20.

59 For a map of the organized wholesale electricity markets, see Figure 1.

60 PJM RTO, Capacity by Fuel Type 2017, *available at* http://www.pjm.com/-/media/markets-ops/ops-analysis/capacity-by-fuel-type-2017.ashx?la=en (last visited May 11, 2018).

supplied by coal and nuclear.[61] Importantly, coal use increased by 49 percent, providing 74 percent of the increased demand. Oil, another fuel-secure source of generation, increased by 455 percent, providing 22 percent of increased demand. Natural gas use increased by only 2 percent, providing 2 percent of increased demand, and renewables declined in use, showing no resilience to increased demand.[62] In the New England ISO (ISO-NE), coal accounted for 6 percent of generation, and nuclear accounted for 27 percent during the severe cold weather from December 26, 2017 to January 8, 2018.[63] And yet, within PJM, numerous coal and nuclear units are slated to retire. In PJM, coal-fired generating units with a total of 2,722.4 MW of nameplate capacity are scheduled for deactivation as of June 1, 2018,[64] along with 2,306.5 MW of nuclear generation by May 31, 2020.[65] And in ISO-NE, the scheduled retirements of Pilgrim Nuclear Power Station (677 MW, June 2019)[66] and Bridgeport Harbor Station (coal, 383 MW, 2021)[67] will also eliminate significant fuel-secure baseload capacity in a short time frame. As these resources go offline, ISO-NE's President and CEO Gordon van Welie warns that "for the foreseeable future, New England will be dependent on stored and imported fossil fuels and imported electrical energy, which includes energy from hydro generators in Canada, to ensure system reliability when gas pipelines are constrained."[68]

2. The retirement and decommissioning process is complex and must be managed to take into account national security implications.

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[61] National Energy Technology Laboratory, *Reliability, Resilience and the Oncoming Wave of Retiring Baseload Units, Vol. I: The Critical Role of Thermal Units During Extreme Weather Events*, Exhibit 1-8, at 12 (Mar. 13, 2018).

[62] *Id.*

[63] Gordon van Welie, ISO New England State of the Grid: 2018, Remarks and Slides, Slide 23, at 14 (Feb. 27, 2018), *available at* https://www.iso-ne.com/static-assets/documents/2018/02/02272018_pr_remarks_state-of-the-grid.pdf [hereinafter ISO NE State of the Grid]. Van Welie, President and CEO of ISO New England noted that "coal and oil power plants rarely run most of the year, but they are still needed during extreme weather events. Nuclear power is also a key contributor." *Id.* Further, he disagreed with persons who suggest that the power system is "fine" and "can handle extreme cold weather." *Id.* He warned, "This view misses several significant factors.... In the future, many of the resources we relied on this winter may not be around when extreme weather limits natural gas availability." *Id.*

[64] PJM Generation Deactivations webpage, *available at* http://www.pjm.com/planning/services-requests/gen-deactivations.aspx (last visited May 17, 2018). The coal units to be deactivated are Crane 1 (190 MW), Crane 2 (195 MW), Killen 2 (600 MW), Stuart 2 (580 MW), Stuart 3 (580.4 MW), and Stuart 4 (577 MW).

[65] *Id.* (last visited May 17, 2018). The nuclear units to be deactivated are Oyster Creek Nuclear Generating Station (607.7 MW, Oct. 1, 2018), Three Mile Island, Unit 1 (802.8 MW, Sept. 30, 2019), and Davis Besse, Unit 1 (896 MW, May 31, 2020).

[66] ISO-New England Inc., Grid Resilience in Regional Transmission Organizations and Independent System Operators, FERC Docket No. AD18-7, Attachment A, at 13 (Mar. 9, 2018) (attachment dated Jan. 17, 2018), https://www.iso-ne.com/static-assets/documents/2018/03/ad18-7_iso_response_to_grid_resilience.pdf.

[67] https://www.iso-ne.com/about/key-stats/resource-mix/ (last visited May 17, 2018).

[68] ISO New England State of the Grid, Slide 19, at 12.

The length, complexity, and growing inertia of closure plans requires the Department to ensure that sufficient baseload, fuel-secure power generation is available, before its effort becomes too little, too late. For units whose announced retirement dates are fast approaching, immediate action is needed to stop the units from being deactivated. For those units, however, that have announced retirements one or more years away, it is important to act now to forestall the retirement process before [additional actions are taken.] Coal and nuclear plants spend substantial time and resources in evaluating whether to close and initiating planning activities prior to public announcements. Owners must plan every aspect of the transition, including possible future use of the site, tax consequences, maintenance and repair needs, and new contractors needed to assist with the decommissioning and waste removal. Further, the plan must carefully consider the timing of decommissioning to coordinate it with any expiring environmental permits, licenses, leases, and other contracts.

Once the decision to close is made and an announcement is made public, there are immediate impacts even though the plant may not shut down for several months or years. Before shutting down, plants must coordinate with federal, state, and local regulators and others impacted by the closure (e.g., elected officials, as well as the plant's contractors, suppliers, and employees) to address concerns, ensure that legal and contractual requirements are met, and allow these entities to make other arrangements for power. RTOs/ISOs, plant employees, local communities, and other stakeholders immediately take steps to address how they will be impacted and make alternative arrangements. Insofar as plants are the source of tax revenues and jobs for local communities, this is a critical problem that must be addressed by these communities as far in advance as possible.

Additional factors can accelerate the decommissioning process, removing financial incentives to keep units online.. As the time gets closer to shutdown, even where the plant has years before its NRC operating license expires, there is less incentive to order new fuel or to renew necessary permits and contracts. No longer purchasing fuel is particularly critical for nuclear plants because plants need new fuel every 18-24 months and the process to obtain new fuel begins approximately two years in advance and costs millions of dollars.

In addition, plants work with regulatory agencies such as the Nuclear Regulatory Commission in advance to increase the likelihood of approvals and speed the process along because they can obtain much needed funding set aside for decommissioning upon shutdown and the filing of: (1) certification of permanent cessation of operations; (2) certification of permanent removal of fuel from the reactor; and (3) post-shutdown decommissioning activities report.[69] Also, upon docketing of the certifications for permanent cessation of operations and permanent removal of fuel from the reactor vessel, or when a final legally effective order to permanently cease operations has come into effect, the license no longer authorizes operation of the reactor or emplacement or retention of fuel into the reactor vessel.[70] The license is amended to be a license for storage, eliminating the obligation to adhere to requirements needed only during reactor operation and the accompanying costs and resources necessary to meet such requirements. At that point, although systems and structural components are still intact, the plant becomes unacceptable for restart without a new license and an extensive costly and time consuming effort to reestablish

[69] 10 C.F.R. § 50.82(a)(8)(ii).
[70] 10 C.F.R. § 50.82(a)(2).

the safety and security integrity of the plant. Consequently, the point of no return for plants occurs far earlier than when systems and structural components may be removed from a site.

Once these and other fuel-secure units are retired, they will no longer be available to meet critical resilience demands, including potential multi-point attacks on the natural gas pipeline system. NERC has consistently identified "changing resource mix" as among its top "high priority risks."[71] NERC describes the "increased and accelerated rate of plant retirements, especially conventional synchronous generation, coupled with the increasing integration of renewable, distributed, and asynchronous resources," and warns that "[p]lanners and operators may not have the requisite time to reliably integrate these inputs and make necessary changes."[72] NERC describes "[i]ncreased risks with the transition from a balanced resource portfolio, addressing fuel and technology risks, to one that is predominately natural gas and variable resources."[73] Such risks include "[c]ommon mode or single points of failure, such as fuel delivery systems."[74] Importantly, NERC-wide natural-gas-fired on-peak generation has increased from 360 GW in 2009 to 432 GW today, and NERC has cautioned that "reliance on a single fuel increases vulnerabilities, particularly during extreme weather conditions."[75]

3. Causes of the loss of fuel-secure generation.

The causes of the retirements of fuel-secure units before the end of their useful life are primarily regulatory and economic. As the 2017 National Academies of Sciences, Engineering, and Medicine study *Enhancing the Resilience of the Nation's Electricity System* stated with respect to nuclear plants in particular, "[w]ith the cost pressures that nuclear plants are facing from inexpensive natural gas and subsidized renewables, and uncertainties about the cost and likelihood of life extension and relicensing, a number of plants have closed recently."[76]

These economic-regulatory issues are complex and will take additional time to resolve. Especially in light of the extensive comments filed in the Federal Energy Regulatory Commission ("FERC" or "Commission") RM18-1 proceeding in response to DOE's grid resilience proposal, DOE recognizes the complexity of the issues involved and the need for a thorough regulatory process concurrent with DOE's Directive. The Commission has taken numerous important regulatory actions to ensure that electricity markets properly value resources that contribute to the reliability and resilience of the electricity grid as part of its continuing initiative to improve price formation to support efficient investments in wholesale power markets and otherwise.

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[71] North American Electric Reliability Corporation, ERO Reliability Risk Priorities: RISC Recommendations to the NERC Board of Trustees, at 10 (Nov. 2016).

[72] *Id.* at 12, 14.

[73] *Id.*

[74] *Id.* at 14.

[75] NERC LTRA at 15. Batteries and other electricity storage technologies are important and maturing components of a resilient electricity system, both for customer-premises backup and grid-scale applications. DOE continues to study and fund research and development for such technologies as part of its Grid Modernization Initiative and other projects. [CITE] However, these technologies are not yet technologically or economically feasible as an alternative to fuel-secure baseload capacity, particularly for long-duration (multiple days or weeks) disruptions.

[76] NASEM Study, at 46.

For example, the Commission has ordered investigations of fast-start pricing practices in several areas. As the Commission stated, "without some form of fast-start pricing, some fast-start resources are ineligible to set prices, often due to inflexible operating limits. Even when fast-start resources can set prices, they may not be able to recover their commitment costs, such as start-up and no-load costs, through prices. As a result, prices may not reflect the marginal cost of serving load, muting price signals for efficient investments."[77] These orders include preliminary findings that certain current fast-start pricing practices in PJM and other organized markets are unjust and unreasonable.[78] The Commission continues to consider these issues carefully in the context of several open dockets. Despite terminating Docket No. RM18-1 initiated by the DOE NOPR,[79] FERC opened a new Docket No. AD18-7 the same day to seek and evaluate input on "the resilience of the bulk power system in the regions operated by regional transmission organizations (RTO) [*sic*] and independent system operators (ISO) [*sic*]."[80] The Commission has also taken action to improve the resilience of gas infrastructure by rapidly approving construction of pipeline infrastructure[81] and taking initial steps to address gas-electric coordination issues.[82]

DOE supports the Commission's continued efforts in this regard, but too little progress has been made while the risk of high-impact events, especially those caused by intentional attacks, continues to grow. Under these circumstances, DOE—as the SSA for Energy—must prepare for a variety of potential major events. In particular, given the need to safeguard the existence of fuel-secure generation facilities to promote our national defense and to maximize domestic energy supplies, DOE is compelled to exercise its authorities to avert a serious supply disruption in the wake of a natural disaster, an adversarial attack, or some combination of the foregoing.

4. Resulting Vulnerability of Our Grid

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[77] Federal Energy Regulatory Commission, FERC to Investigate Pricing of Fast-Start Resources by Three Grid Operators (Dec. 21, 2017), *available at* https://www.ferc.gov/media/news-releases/2017/2017-4/12-21-17-E-2.pdf.

[78] *N.Y. Indep. Sys. Op., Inc.*, FERC Docket No. EL18-33-000, 161 FERC ¶ 61,294 at P 5 (Dec. 21, 2017) ("The Commission preliminarily finds that some of NYISO's practices related to the pricing of fast-start resources are unjust and unreasonable"); *PJM Interconnection, L.L.C.*, FERC Docket No. EL18-34-000, 161 FERC ¶ 61,295 at P 9 (Dec. 21, 2017) ("The Commission preliminarily finds that some of PJM's practices related to the pricing of fast-start resources are unjust and unreasonable"); *Sw. Power Pool, Inc.*, FERC Docket No. EL18-35-000, 161 FERC ¶ 61,296 at P 6 (Dec. 21, 2017) ("The Commission preliminarily finds that some of SPP's practices related to the pricing of fast-start resources are unjust and unreasonable").

[79] Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures, 162 FERC ¶ 61,012 (Jan. 8, 2018).

[80] *Id.* at P 1.

[81] In just eleven weeks, from January 18 to April 5, 2018, the Commission approved ten (10) projects adding approximately 235 miles of pipeline and more than 3.4 Bcf/day of capacity. *See* Approved Major Pipeline Projects (2009-Present), *available at* https://www.ferc.gov/industries/gas/indus-act/pipelines/approved-projects.asp (last visited May 11, 2018).

[82] *See, e.g.*, *Coordination of the Scheduling Processes of Interstate Natural Gas Pipelines and Public Utilities*, Order No. 809, FERC Stats. & Regs. ¶31,368 (cross-referenced at 151 FERC ¶ 61,049) (2015).

During the past two decades, an inextricable interdependency between natural gas and electricity generation has evolved that, along with benefits, also presents a serious vulnerability to the grid, and therefore, our national security. Importantly, NERC has warned about being too dependent on natural gas infrastructure:

> Natural gas provides "just-in-time" fuel; therefore, disruptions to the fuel supply can impact multiple generators that may be connected to the same supply chain. [S]ince natural gas does not generally have on-site storage, its supply is threatened to disruption by pipeline failure that potentially can lead to the loss of a substantial amount of capacity and threaten the adequacy of the electric system.[83]

Additionally, in its June 2017 State of Reliability Report (SOR), NERC echoed its earlier statements by warning that cyber and physical security risks "continue to increase and are becoming more serious."[84] It also noted the "increasing risk of fuel disruption impacts on generator availability from the dependency of electric generation and natural gas infrastructure as a single point of disruption," specifically, that the "increased dependence on natural-gas-fired capacity can lead to greater reliability risks due to the loss of natural gas or other fuel contingencies."[85] Confirming what NERC, DOE, and others have reported, the National Academies of Sciences, Engineering, and Medicine resilience study noted, "Constraints in natural gas infrastructure have resulted in shedding of electric load, and the growing interdependency of the two systems poses a vulnerability that could lead to a large-area, long-duration blackout."[86]

NERC's concern about natural gas pipeline risks has remained such that it issued a report on the issue in November 2017, entitled "Special Reliability Assessment: Potential Bulk Power System Impacts Due to Severe Disruptions on the Natural Gas System."[87] This System Reliability Assessment (SRA) notes that "[s]ome areas within North America now meet their peak electric demand with greater than 60 percent of that sourced from natural-gas-fired electric generation."[88] NERC also warns that, for example, "in New England and Southwest California-Arizona, an outage of nearly any major natural gas facility (*e.g.*, one interstate pipeline, key compressor station, or LNG terminal) during electric summer or winter peak conditions would likely lead to some level of electric generation outages."[89] Further, NERC reports that its "power flow analysis

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[83] NERC Reliability Synopsis, at 4.

[84] North American Electric Reliability Corporation, *State of Reliability 2017*, at 3 (June 2017).

[85] *Id.* at 7, 8.

[86] NASEM Study at 82.

[87] North American Electric Reliability Corporation, *Special Reliability Assessment: Potential Bulk Power System Impacts Due to Severe Disruptions on the Natural Gas System* (Nov. 2017) [hereinafter NERC SRA].

[88] *Id.* at vii.

[89] *Id.* at vii; *see also id.* at 2 (noting that improving electric system resilience requires "[i]dentifying natural gas single-element contingencies and how those contingencies will impact the electric infrastructure," and "although most natural-gas-side contingencies will not impact the electric grid instantaneously they can be far more severe than electric side contingencies over time . . . this is because natural gas contingencies may impact several generation facilities").

determined that many areas in North America could incur power flow and stability issues if they were to experience significant losses of natural gas infrastructure."[90] In addition, NERC notes,

> the Aliso Canyon storage facility shut-down in Southern California in the winter of 2015 underscores the significant threats that a single point of disruption can pose to the reliability of the [baseload power supply]. **The rapid increase in the growth of reliance on natural gas for electric generation necessitates that system planners and operators fully understand their exposures to a potential natural gas disruption and have contingency plans in the event of disruption.**[91]

Adequate advance planning for disruptions is critical because natural-gas-fired generation mostly relies on "just-in-time" fuel delivery from the natural gas industry. Disruptions to the fuel delivery can quickly lead to multiple electric generating units becoming unavailable, and have the potential to disrupt large areas of the Nation, placing at risk our Nation's security, especially defense critical infrastructure.[92] This is compounded where multiple plants are connected through the same natural gas infrastructure. Disruptions to the fuel delivery can result from adverse events that may occur such as line breaks, well freeze-offs, hurricanes, floods, storage facility outages, or infrastructure attacks. Similarly, the pipeline system can be impacted by events that occur on the electric system (e.g., loss of electric motor-driven compressors). For example, during the recent 2014 Polar Vortex event, extended periods of cold temperatures caused direct impacts on fuel availability, especially for natural-gas-fired generation. According to NERC, "[h]igher-than-expected forced outages and common-mode failures were observed during the polar vortex due to the following: Natural gas interruptions (including supply injection), compressor outages, and one pipeline explosion[;] Oil delivery problems[;] Frozen well heads[;] Inability to procure natural gas[; and] Fuel oil gelling."[93] These natural gas pipeline performance issues were all the result of a single weather event. A cyber or physical attack could result in more substantial disruptions.

In light of these risks, NERC has taken steps to identify by region the capacity of generation units that are "dependent on major trunk lines or are restricted to one pipeline connection in various areas."[94] For example: in New England, more than 13,000 MW of natural gas generation depends on a single connection; in the Mid-Atlantic region, the figure is more than 12,000 MW; and in the Southeast, more than 46,000 MW is dependent on a single connection.[95] Consequently, it is vital that DOE act now to "take proactive steps to manage risk and strengthen the security and resilience of the Nation's critical infrastructure, considering all hazards that could have a debilitating impact on national security, economic stability, public health and safety, or any combination thereof."[96]

IV. Additional National Security Value of Civilian Nuclear Facilities

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[90] *Id.* at 27.
[91] *Id.* at 7 (emphasis added.)
[92] NERC LTRA at 15.
[93] *Id.*
[94] NERC SRA at 7.
[95] *See Id.*
[96] PPD-21 at 2.