Nuclear energy is a critical strategic and energy security asset for the United States, and continued U.S. leadership in the global nuclear energy market has important nonproliferation and safety ramifications. Nuclear generation units have the kinds of "guns, guards, and gates" and other physical and cyber-hardening measures that would be needed in the event of a major attack. As NERC has stated, "nuclear retirements require additional attention from system planners and policy makers related to ... 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."[97]

Without a strong domestic nuclear power industry, the U.S. will not only lose these energy security and grid resilience benefits, but will also lose its technical expertise, supply chain, and ability to influence international policy. It is in the Nation's strategic interest to preserve these assets in order to maintain and enhance American leadership and influence in the global nuclear market, including in the export of commercial nuclear technologies and systems. The entire U.S. nuclear enterprise—weapons, naval propulsion, non-proliferation, enrichment, and section 123 negotiations with the Kingdom of Saudi Arabia and other countries—depends on a robust civilian nuclear industry. To maintain U.S. nuclear leadership and secure supply chains for our nuclear enterprise, we must preserve our civil nuclear capacity and expertise.

It is widely acknowledged that a strong domestic nuclear industry sustains "our [N]ation's ability to advance a number of crucial objectives, particularly with respect to nonproliferation, military strength, and energy security."[98] According to a 2017 report issued by the Energy Futures Initiative (EFI) led by former DOE Secretary Ernest Moniz, "[n]uclear power and a robust associated supply chain (equipment, services, people) are intimately connected with US leadership in global nuclear nonproliferation policy and norms and with the [N]ation's nuclear security capabilities."[99] The EFI report notes the United States' historic leadership in setting the global standard for nuclear fuel cycle development consistent with nuclear nonproliferation objectives.[100] Atomic Energy Act section 123 agreements often set nonproliferation benchmarks that go beyond

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[97] NERC LTRA, at 14.

[98] Center for Strategic & International Studies, *Restoring U.S. Leadership in Nuclear Energy, A National Security Imperative* (June 2013), at 19, *available at* https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/130614_RestoringUSLeadershipNuclearEnergy_WEB.pdf [hereinafter CSIS Restoring U.S. Leadership in Nuclear Energy]; *see also* Energy Futures Initiative, *Moniz: The National Security Imperative for U.S. Civilian Nuclear Energy* Policy, *available at* https://energyfuturesinitiative.org/news/2017/7/12/moniz-the-national-security-imperative-for-us-civilian-nuclear-energy-policy.

[99] Energy Futures Initiative, *The U.S. Nuclear Energy Enterprise: A Key National Security Enabler* (Aug. 2017), at 6, *available at* https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/59947949f43b55af66b0684b/1502902604749/EFI+nuclear+paper+17+Aug+2017.pdf [hereinafter EFI U.S. Nuclear Energy Enterprise].

[100] EFI U.S. Nuclear Energy Enterprise, at 7 ("A pillar for doing so lies with Atomic Energy Act Section 123 requirements for bilateral agreements with countries that receive nuclear technology, services and/or know-how, supplemented by export licensing programs at the Nuclear Regulatory Commission (Part 110) and at the Department of Energy (Part 810) that regulate individual transactions within the 123 framework.")

the Nuclear Nonproliferation Treaty (NPT) requirements. Without the "historically unique capabilities in U.S. technology, services and know-how," the United States would not have had the leverage to accomplish this.[101]

However, other countries with less stringent requirements have gained significant ground and are capturing a sizable market share for new reactor construction globally. This includes the Middle East, "where recent U.S. 123 negotiations with Egypt, Jordan and Saudi Arabia have been unsuccessful. All three countries have signed agreements with Russia for reactor construction and fuel supply. In addition, Russia has finished construction of Iran's operating reactor, is committed to further construction, and supplies fuel. Russia also has an agreement with Turkey."[102] Further, although India signed an agreement in 2008 to build six plants using United States technology, it reportedly is considering Russian nuclear technology, with delays in construction at least partially due to questions about the United States' long-term commitment to civilian nuclear technology. DOE has been diligently engaging with India and a Strategic Energy Partnership (SEP) announced by the Administration in June 2017 affirms the strategic importance of energy cooperation as the centerpiece of a relationship between the countries. Through this new partnership, the United States and India are working to advance the shared goals of strengthening energy security, expanding energy and innovation linkages, bolstering our strategic alignment, and facilitating increased industry and stakeholder engagement in the energy sector. DOE has SEPs with many countries around the world.

Where much of the new interest in nuclear power stems from countries and regions that may not share America's interests and priorities in the areas of nonproliferation and global security, this creates a significant national security concern. Only if U.S. companies can offer the technologies, services, and expertise these countries need to operate a successful nuclear program can the United States continue to effectively leverage to influence those nations' nuclear programs.[103]

In addition, a strong domestic nuclear industry is also critically important for military requirements.[104] Defense programs require a domestically owned, unobligated and unencumbered source for enriched uranium, and the U.S. no longer has this capability.[105] Current supplies will

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[101] *Id.*
[102] *Id.*
[103] *See* CSIS Restoring U.S. Leadership in Nuclear Energy, at xi.
[104] EFI U.S. Nuclear Energy Enterprise, at 27; *see also* CSIS Restoring U.S. Leadership in Nuclear Energy, at xii ("A healthy domestic nuclear infrastructure also serves our national security interests by supporting the nuclear propulsion program of the U.S. Navy, which operates a fleet of 83 nuclear-powered submarines and aircraft carriers. While the Navy is careful to develop sources of supply that can weather short-term ups and downs in the commercial industry, a sustained decline in the commercial industry could have a direct and negative impact on the naval program.").
[105] DOE, *Tritium and Enriched Uranium Management Plan Through 2060*, Report to Congress, Oct. 2015 at 11. [Recent/Upcoming] Congressional testimony from the NNSA's Brent Park further underscores this point: "The Nation's stockpile of Highly Enriched Uranium (HEU) material is repurposed and downblended to meet the enrichment uranium requirements listed above; however, that supply is finite and, at present,

be depleted by the mid-2030s, though technology development may deplete them sooner, and at that point, defense programs will need U.S. enrichment to have been reestablished. If the only client for an enrichment facility is defense programs, this becomes a much more expensive endeavor for the federal government. In addition to ensuring we have the expertise and infrastructure to maintain our nuclear deterrent, a significant portion of our naval fleet relies on nuclear power. The Navy has over 100 nuclear reactors in ships and submarines, and if civilian capabilities were to deteriorate further, U.S. nuclear defense capabilities (infrastructure, supply chain and expertise) will similarly suffer. Importantly, the civil nuclear industry supports the navy as a synergistic partner for personnel and supply chain. University nuclear engineering programs supply both the nuclear navy and civil nuclear industry with highly trained personnel, and the civil nuclear industry provides an attractive employment opportunity following military service. Absent a vibrant civilian industry, university programs contract or collapse. The civil nuclear industry helps support the supply chain of over 700 companies in 44 states, which are also relied upon by the nuclear navy.

In light of these facts, the civilian nuclear energy industry is a critical strategic and energy security asset for the United States. Without a strong domestic nuclear power industry, the U.S. will not only lose the energy security and grid resilience benefits, but will also lose its technical expertise, supply chain, and ability to influence international norms, all of which are imperative to the United States' national defense.[106]

V. All U.S. Critical Infrastructure Depends on Fuel-Secure Electric Generation

A. All Critical Infrastructure Sectors Depend on Energy

Beyond the electricity subsector, electric outages affect national security, the economy, and public health and safety.[107] As FERC has stated, "Modern society has come to depend on reliable electricity as an essential resource for national security, health and welfare, communications, finance, transportation, food and water supply, heating, cooling, and lighting, computers and electronics, commercial enterprise . . . in short, nearly all aspects of modern life."[108] Infrastructure sectors recognize their dependence on electricity and have invested resources in mitigating the effects of power outages. However, prolonged outages negatively impact the remaining fifteen critical infrastructure sectors and the important services they provide to the public and the

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irreplaceable." Statement of Dr. Brent Park, Deputy Administrator for Defense Nuclear Nonproliferation, National Nuclear Security Administration, U.S. Department of Energy, Before the Subcommittee on Energy, U.S. House Committee on Energy and Commerce (May 22, 2018).

[106] *See* 50 U.S.C. § 4502(a)(7) ("much of the industrial capacity that is relied upon by the United States Government for military production and other national defense purposes is deeply and directly influenced by—(A) the overall competitiveness of the industrial economy of the United States; and (B) the ability of industries in the United States, in general, to produce internationally competitive products and operate profitably while maintaining adequate research and development to preserve competitiveness with respect to military and civilian production").

[107] *See* National Research Council of the National Academies, *At the Nexus of Cybersecurity and Public Policy: Some Basic Concepts and Issues* (2012).

[108] FERC Staff, Reliability Primer at 9. [undated]

economy. The *2015 Energy Sector Specific Plan,* as required by the *National Infrastructure Protection Plan* (NIPP) (See Section 3.1.3), details a number of specific interdependencies between the energy subsectors and other critical infrastructure sectors, including communications, transportation, financial services, and water.[109] Impacts to interdependent sectors may occur at the outset of an outage or, as may be the case where backup systems are deployed, within hours or days of initial power loss as backup systems fail, battery power is diminished, or fuel supplies for generators are depleted.

For example, electricity is among the most vital of all services for the healthcare and public health sector. The loss of power impacts the delivery of healthcare services in inpatient healthcare facilities, outpatient care settings, and the homes of at-risk populations.[110] Similar to other critical infrastructure sectors, the healthcare sector has taken a number of steps to reduce its vulnerability to power disruptions, such as having backup generators onsite at healthcare facilities. During long-term power outages, healthcare facilities are likely to face limited fuel for backup generation and have difficulty sourcing new fuel supplies to supplement hospital stockpiles, which, according to one study, most often provide only enough fuel to run generators for eight hours.[111]

B. Defense Installations Depend on the Commercial Electric Power Grid

The power grid has an oversized vital role to national defense and homeland security. As defense and security capabilities have evolved, so has their reliance on electricity to operate. Across the Nation, the Department of Defense (DOD) relies on the electric grid to support military operations at home and abroad.[112] In 2008 a Defense Science Board report stated that DOD installations are 99% dependent on the commercial power grid.[113] Last year, DOD stated,

> DOD relies on commercial power to conduct missions from its installations and these commercial power supplies can be threatened by natural hazards and other events. DOD recognizes that such events could result in power outages affecting critical DOD missions involving power projection, defense of the homeland, or operations conducted at installations in the United States directly supporting warfighting missions overseas. Therefore, it is critical for installation commanders to understand the vulnerabilities and risk of power disruptions that can impact mission assurance.[114]

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[109] *See* Department of Homeland Security, *Energy Sector-Specific Plan* (2015), *available at* https://www.dhs.gov/sites/default/files/publications/nipp-ssp-energy-2015-508.pdf

[110] *See* Department of Health and Human Services, Department of Homeland Security, *Healthcare and Public Health Specific Plan*, 11 (May 2016); Lin CJ, Pierce LC, Roblin PM, Arquilla B, "Impact of Hurricane Sandy on hospital emergency and dialysis services: a retrospective survey," *Prehosp Disaster Med. 4*, 374-9 (2014), *available at* https://www.ncbi.nlm.nih.gov/pubmed/25068276.

[111] *See* Chaamala Klinger, Owen Landeg, and Virginia Murray, *Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011–2012*, PLoS Currents Disasters 1 (2014).

[112] QER, at 1-35.

[113] *See* Supplement at note xi.

[114] Department of Defense's FY 2016 Annual Energy Management Report, at 39.

As a result of this continued dependence, in February 2017, the United States Army issued a directive requiring it to "reduce risk to critical missions by being capable of providing energy and water for a minimum of 14 days."[115] The reason cited in the directive was that "[v]ulnerabilities in the interdependent electric power grids, natural gas pipelines, and water resources supporting Army installations jeopardize mission capabilities and installation security, and the Army's ability to project power and support global operations."[116]

The Defense Science Board has noted that "DOD's key problem with electricity is that critical missions, such as national strategic awareness and national command authorities, are almost entirely dependent on the national transmission grid."[117] DOD has discussed its reliance on commercial power supplies, noting that "DOD recognizes that such events could result in power outages affecting critical DOD missions involving power projection, defense of the homeland, or operations conducted at installations in the U.S. directly supporting warfighting missions overseas."[118] As DOD pursues increasingly advanced capabilities, such as remotely piloted aircraft and precision guided munitions, its ability to execute critical missions increasingly depends upon a vast and complex network of ground-based communications networks, radars, data centers, and command-and-control nodes that rely on electricity to operate. This dependence makes electric grid resilience vitally important for national defense.

In addition, blackouts directly impact the Department of Defense insofar as it is the largest single electricity consumer in the United States.[119] The number of utility outages related to DOD use in FY 2016 was 701, the majority of which were from electricity disruptions.[120] Further, "The collective financial impact of these utility outages was approximately $500,000 per day, largely impacted by single isolated events."[121] Therefore, even minor outages have significant implications for national defense.

C. Economic Costs of the Loss of Fuel-Secure Generation

As explained above, current regulatory constructs prevent market forces from valuing the national security benefits of generation fuel diversity. It should be noted that, rather than protecting consumers, current regulatory arrangements shift the risks of diminishing fuel diversity to consumers in several ways. Specifically, consumers are increasingly required to bear the following costs: (1) the economic costs of blackouts; (2) the public health and environmental costs of blackouts; and (3) the economic costs of excessive reliance of a single fuel in electric power markets.

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[115] Secretary of the Army, Memorandum for SEE Distribution, Army Directive 2017-07 (Installation Energy and Water Security Policy) at 1.

[116] *Id.*

[117] QER, at 1-35.

[118] *Id.* (*citing* the Department of Defense's *2015 Annual Energy Management Report).*

[119] QER, at 1-35.

[120] Department of Defense Annual Energy Management Report: Fiscal Year 2016, at 39, *available at* https://www.acq.osd.mil/eie/Downloads/IE/FY%202016%20AEMR.pdf (Data includes on-base utility outages on DOD-owned infrastructure.)

[121] *Id.* at 40.

1. Economic costs of blackouts.

The cost of a major power outage due to large-scale attack would be enormous, far outweighing any potential short-term cost impacts on consumers resulting from temporary protective measures to prevent retirements of critical generation resources.[122] A National Academies of Sciences, Engineering, and Medicine resilience study found that "[l]arge-area, long-duration electricity outages that leave millions of customers without power can result in billions of dollars of economic and other damages and cause risk of injury or death."[123] Another study projected that the economic losses from a two week power outage across 15 states caused by a cyber-attack could cost $248 billion.[124] Between 2003 and 2012, power outages due to severe weather cost the economy an average of between $18 billion and $70 billion dollars each year, disrupting the lives of millions of Americans.[125] Further, in 2016, the 143 million electricity consumers in the United States consumed 3,711 billion kWh of grid-based power and paid an average retail price of 10.28 cents per kWh.[126] In comparison, for outages lasting at least 16 hours and affecting a cross-section of United States customers, studies show that cost estimates range from a high of approximately $126 per unserved kWh to a low of approximately $1.70 per unserved kWh.[127] In addition, NETL's study of the cold snap of 2017-2018 reveals that "[l]ack of sufficient natural gas pipeline infrastructure and the surge in natural gas demand for heating led to sharp increases in natural gas spot prices exceeding 300% across the Northeast and Mid-Atlantic."[128] Further, it found that "[t]he spike was particularly acute in New York with Transco Zone 6 NY spot prices rising nearly 700% from December 28 ($17.65/MMBtu) to January 5

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[122] Studies also have shown that preservation of generation diversity provided by fuel-secure resources benefits consumers. For example, IHS Markit concluded, ''The current diversified US electric supply portfolio lowers the cost of electricity production by about $114 billion per year and lowers the average retail price of electricity by 27%'' compared with a ''less efficient diversity case'' involving ''no meaningful contributions from coal or nuclear resources.'' IHS Market, ''Ensuring Resilient and Efficient Electricity Generation: The Value of the current diverse US power supply portfolio", Sept. 2017, at 4-5. Accordingly, removing nuclear and coal units from the mix of resources likely may result in increased rates and costs to consumers. Further, as the Brattle Group study noted above, if the announced retirement of four nuclear plants in PJM proceeds, it would take less than four years "to reverse the entire 149 million MWh of zero-emissions electricity cumulatively produced over the last two decades by solar and wind in PJM, **negating billions of dollars of historical customer and taxpayer investment**." The Brattle Group, at 5 (Emphasis added.)

[123] NASEM Study at 12.

[124] Lloyd's and the University of Cambridge Centre for Risk Studies. "Business Blackout: The insurance implications of a cyber-attack on the US power grid." Emerging Risk Report – 2015, at 4.

[125] Executive Office of the President, *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, Aug. 2013, at 3, *available at* https://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf.

[126] IHS Markit, *Ensuring Resilient and Efficient Electricity Generation: The Value of the current diverse US power supply portfolio* (Sept. 2017), at 14.

[127] U.S. Dept. of Energy, *Valuation of Energy Security for the United States: Report to Congress*, Jan. 2017, at 204.

[128] National Energy Technology Laboratory, at 1.

($140.25/MMBtu)."[129] Also, NETL concluded that the increase in the cost of energy services over the two-week period from December 27 to January 9 was $288M per day, equivalent to $98 per MW, compared with costs from the preceding two-week period, and $225M per day, or $73 per MW, higher than the following two-week period that featured a short return of extreme cold.[130]

Although there is a lack of studies of the costs of regional long-duration outages due to the complex modeling required and inherent difficulty of separating economic costs from other disaster-related costs, studies of localized or shorter outages have determined billions in damage costs, even in single cities or limited regions. For example, the August 2003 outage affected 45 million people in the northeastern United States and parts of Canada, and they experienced a full outage for 16 hours, and gradually recovering to full restoration of power over 72 hours in total.[131] It was estimated to have cost the United States between $4 billion and $10 billion.[132] Anderson Economic Group (AEG) estimates that the likely total cost in the United States included $4.2 billion in lost income to workers and investors, $15 to $100 million in extra costs to government agencies (*e.g.*, due to overtime and emergency service costs), $1 to $2 billion in costs to the affected utilities, and between $380 and $940 million in costs associated with lost or spoiled commodities.[133] For Canada, gross domestic product (GDP) was down 0.7 percent the month of the disruption, 18.9 million work hours were lost, and shipments of manufacturing goods in Ontario were down about $2 billion.[134] In addition, in 2013, a study projected costs associated with power outages lasting from 24 hours to 7 weeks in downtown San Francisco, specifically for customers and tenants of customers (collectively, the "target population") served by PG&E's Embarcadero substation.[135] In total, a 24-hour outage among customers in the target population would result in an outage cost ranging from about $190 million to nearly $380 million, but as outage duration increases, the impact on the California economy was projected to become more severe.[136] At 3 weeks, the total outage cost ranges from $2.1 billion to over $4.2 billion, and if PG&E's Embarcadero substation lost power for 7 weeks, the total outage cost would range from $4.4 billion to nearly $8.8 billion.[137] Similarly, a study of a hypothetical outage in Los Angeles county for two weeks projected a total cost of $2.8 to 20.5 billion.[138]

Long duration outages affect virtually every aspect of people's lives and have a cascading effect on critical infrastructure, costs, and lives. The Sullivan study noted that foreseeable costs

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[129] *Id.*

[130] *Id. at 16.*

[131] Sullivan & Schellenberg, Downtown San Francisco Long Duration Outage Cost Study, (Mar. 27, 2013), at 99.

[132] U.S. Dept. of Energy, Valuation of Energy Security for the United States: Report to Congress, at 147.

[133] Anderson, Patrick, and Ilhan K. Geckil, *Northeast Blackout Likely to Reduce U.S. Earnings by $6.4 Billion*, Anderson Economic Group (AEG) Working Paper 2003-2 (Aug. 19, 2003), at 2-3, *available at*http://www.andersoneconomicgroup.com/Portals/0/upload/Doc544.pdf (accessed May 17, 2018).

[134] U.S. Dept. of Energy, *Valuation of Energy Security for the United States: Report to Congress*, at 147.

[135] *Id.* at 1. The substation serves over 27,000 customers. *Id.* at 108.

[136] *Id.* at 1.

[137] *Id.*

[138] Rose, A., Oladosu, G., & Liao, S.-Y. (2007). Business Interruption Impacts of a Terrorist Attack on the Electric Power System of Los Angeles: Customer Resilience to a Total Blackout. Risk Analysis, 27(3), 513-531, at 528.

based on prior blackouts include: (1) disruption related to transportation interruption, such as traffic congestion and inoperable transit and rail, inoperable gasoline pumps; (2) damages from looting and rioting and the costs of the associated government response; (3) loss of businesses and employment, especially lost wages and reduced spending, which particularly impacts small businesses; (4) cost of alternative housing for displaced residents, in addition to the significant inconvenience and economic impact of leaving the area; (5) increased public expenditures, including assistance programs and emergency services; (6) loss of tax revenue; (7) increased costs related to public goods, such as hospitals, sanitation, and water treatment, if available at all; and (7) costs related to injury or the loss of life.[139] The study notes,

> At a certain point, a long-duration outage comes to resemble a natural disaster. If an outage stretches to several days or longer, new costs are incurred: government assistance monies are spent, tourism declines, cancelled transactions result in lost taxes and so on. Alternative generation may not be possible for many facilities beyond several days; keeping hospitals and water treatment facilities operational becomes significantly more costly. Lack of working water, sanitation and HVAC [heating, ventilation, and air conditioning] makes residences difficult or impossible to live in. Continued transportation system challenges shift traffic patterns and slow delivery of goods. While costs associated with emergency services may decrease, security and public safety labor costs are likely to remain elevated. Businesses relocate on an emergency basis, or else shut down; individuals may relocate as well on a temporary basis. A torrent of litigation and insurance claims ensue. In the long run, insurance premia may rise.[140]

2. Public Health and Environmental Costs of Blackouts

Long-term outages can have detrimental environmental and public health impacts primarily through the loss of services dependent on electricity to function. This can include hospitals and other health services, as well as drinking water and wastewater facilities. For example, during the three-day August 2003 Northeast Blackout, New York City alone experienced failure of hospital generators, increased food-borne illness, and the accidental release of 500 million gallons of untreated sewage into recreational waterways.[141] The EPA has concluded,

> Inoperable pumps at a drinking water utility can make firefighting difficult and cause local health care facilities and restaurants to close. A loss in pressure can result in contamination entering the drinking water distribution system from surrounding soil and groundwater. For wastewater utilities, losing [electrically-

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[139] Sullivan & Schellenberg, at 2-6, 107-08.

[140] *Id.* at 108.

[141] Mark E. Beatty, Scot Phelps, Chris Rohner, Isaac Weisfuse, "Blackout of 2003: Public Health Effects and Emergency Response," *Public Health Reports*, January-February 2006, vol. 121, pp. 36-44 at 36, 40.

> driven] pumps may lead to direct discharge of untreated sewage to rivers and streams or sewage backup into homes and businesses.[142]

Further, attempts to mitigate outages can also cause local air pollution issues. Backup diesel generators have been found to increase overall NOx and ozone emissions, and potentially cause local particulate matter hotspots.[143]

Blackouts also adversely impact the health of vulnerable populations. For example, the National Institute of Health studied the impact of the August 2003 blackout in New York City (only one city out of the vast area impacted by the 16-72 hour outage) and concluded that total mortality rose 28%, resulting in approximately 90 deaths were attributed to the blackout.[144] While all ages were affected, those age 65-74 years "were particularly susceptible."[145] Most deaths were from disease-related causes, and the study noted that the blackout complicated the management of illnesses, with most food sources and pharmacies closed, which is "a serious problem for diabetics and anyone low on prescription medicines."[146] Importantly, the study determined that some power-operated home medical equipment (e.g., ventilators, oxygen conservers) could not be used, ambulances responded more slowly than usual, and, because cellular phone service failed during part of the blackout, it was difficult to contact emergency services.[147] Further, researchers noted that other studies have reported increases during power outages of accidental deaths and injuries, including carbon monoxide (CO) poisoning, food poisoning, and hypothermia, as well as increased respiratory hospitalizations.[148] Similarly, the National Hurricane Center estimated that during Hurricane Sandy "[a]bout 50 deaths were the result of extended power outages during cold weather, which led to deaths from hypothermia, falls in the dark by senior citizens, or carbon monoxide poisoning from improperly placed generators or cooking devices."[149]

In summary, any potential socioeconomic or consumer costs of temporary preventative action are far outweighed by the benefits of such action.

3. Less generation diversity leads to higher consumer costs.

In addition to the impact on grid resilience from the retirement of fuel-secure coal and nuclear resources, there are various potential negative impacts on consumers. For example, DOE

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[142] EPA, *Power Resilience Guide for Water and Wastewater Utilities. Environmental Protection Agency* (Dec. 2015), at 0-1, *available at* https://www.epa.gov/sites/production/files/2016-03/documents/160212-powerresilienceguide508.pdf

[143] Cornell University Energy and the Environment Research Laboratory, *Diesel Backup Generators* (2015), *available at* http://energy.mae.cornell.edu/research-areas/distributed-energy-systems-and-the-environment/diesel-bugs/

[144] Anderson and Bell, *Lights out: Impact of the August 2003 power outage on mortality in New York, NY*, National Institute of Health, Mar. 1. 2013, at 3, *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276729/pdf/nihms348988.pdf

[145] *Id.*

[146] *Id.*

[147] *Id.*

[148] *Id.* at 1.

[149] Eric Blake, et al., *Tropical Cyclone Report Hurricane Sandy*, National Hurricane Center, Feb. 12, 2013, at 14

studied the effects of plant retirements resulting from environmental regulations and changing market conditions on the Eastern Interconnection, which serves eastern and mid-western states.[150] Using the fuel price and load growth assumption of the Energy Information Administration's 2015 Annual Energy Outlook, the study found that, by 2025, coal plant retirements related to the Environmental Protection Agency's Mercury and Air Toxics Standards could increase annual electricity costs by 50 percent and raise peak costs by 81 percent.[151] It also projected that substantial new capacity would be needed as early as 2020 and that the grid will be strained even with new capacity.[152]

Similarly, DOE also examined the PJM Interconnection RTO to determine infrastructure needs as coal plants retire and more natural gas-fired capacity is added, and it noted that the change in power generation "present[s] real risks of both higher energy costs – impacting the Nation's economy and the consumer – and reliability of the electric grid as natural gas becomes a more dominant fuel."[153] This study found that "new electrical generating capacity—beyond that which is currently accounted for as planned-certain—is projected to be necessary starting in 2020 in order to meet peak demand."[154] It also found that, while existing pipeline infrastructure was sufficient in 2014, the length of time required to build and obtain permits for new projects could result in increased short-term pipeline congestion.[155] DOE notes that this, in turn, could have significant negative impacts on consumer costs and national security.

DOE also has evaluated the effects, including costs, of the change in which coal-fired power plants have shifted to marginal operations rather than their historically favorable dispatch position.[156] It concluded that marginal operation will require more frequent startups, shutdowns,

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[150] *See generally* National Energy Technology Laboratory (U.S. Department of Energy, Office of Fossil Energy), *Coal Fleet Transition: Retirement Impacts in the Eastern Interconnection* (Feb. 22, 2015).

[151] *Id.* at 18.

[152] *Id.* at 41.

[153] National Energy Technology Laboratory (U.S. Department of Energy, Office of Fossil Energy), *Natural Gas and Electric Interdependencies Case Study: Near-Term Infrastructure Needs in PJM* (Feb. 12, 2015), at 3.

[154] *Id.* at 1.

[155] *Id.*

[156] National Energy Technology Laboratory (U.S. Department of Energy, Office of Fossil Energy), *Impact of Load Following on the Economics of Existing Coal-Fired Power Plant Operations* (June 3, 2015). Findings of this report focus on the changes to the O&M and fuel costs related to reducing generation through: (1) Decreasing the plant annual operating hours by increasing the number of plant shutdowns; and (2) Operating the plant below its design capacity, at a lower load factor. The scope of the report was limited to cold starts, which although there are variations in the definition of the term, it defined as "when the boiler and steam turbine have sufficiently cooled down, reaching temperatures less than 250°F. *Id.* at 1-2 & n.1. Generally speaking, this occurs after the unit has been off-line for more than 48 hours." The study noted that cold starts are expected to have a more significant impact on plant equipment per start then either warm or hot starts, but it noted that warm and hot starts "may be significant for units in which the number of these starts outnumber cold starts, and will be investigated in the future." *Id.* at 6.