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HEY AMERICA! LET'S GET SMART: THE NEED FOR A RELIABLE MODERN SMART ELECTRICAL GRID RESISTANCE TO CYBERATTACKS

Richard J. Kisielowski II*

“If Alexander Graham Bell returned to Earth today, the progress in telecommunications over the last 125 years would be mystifying. If Thomas Edison came back today, not only would he recognize our electricity system, he could probably fix it [when problems arise].”

—Robert Catell, chairman of the New York State Smart Grid Consortium¹

I. INTRODUCTION

Today, much of America's infrastructure is falling into disrepair and incidents of failure are increasing at alarming rates.² Thousands of miles of American roadways are crumbling and riddled with potholes;³ thousands of bridges

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¹ David Biello, *The Start-Up Pains of a Smarter Electricity Grid*, SCI. AM. (May 10, 2010), <http://www.scientificamerican.com/article/start-up-pains-of-smart-grid/>.

² See, e.g., Gary Stoller, *U.S. Roads, Bridges Are Decaying Despite Stimulus Influx*, USA TODAY (Jul. 29, 2013, 12:13 AM), <http://www.usatoday.com/story/news/nation/2013/07/28/roads-bridges-decaying/2594499/> (“Indeed, just 38% of the pavement on roads stretching miles across the USA is in “good” condition, according to the analysis, while about one in 10 of the nation's bridges are ‘structurally deficient.’”); Steve Kroft, *60 Minutes: Falling Apart: America's Neglected Infrastructure* (CBS television broadcast Nov. 14, 2014), <http://www.cbsnews.com/news/falling-apart-america-neglected-infrastructure/>; *The Water-Infrastructure Gap*, SUSTAINABLE WATER, <http://sustainablewater.com/the-water-infrastructure-gap> (last visited Aug. 24, 2015).

³ See Christopher Ingraham, *Where America's Worst Roads Are — And How Much*

are closed annually citing safety concerns;⁴ miles and miles of water pipes are rupturing everyday.⁵ One of the glaring illustrations is the poor condition of America's energy infrastructure.⁶ The American Society of Civil Engineers⁷ assessed the United States' electrical power grid and network and gave the system a "D+" grade in its most recent *2013 Report Card for American Infra-*

They're Costing Us, WASH. POST: WONKBLOG (June 25, 2015), <http://www.washingtonpost.com/news/wonkblog/wp/2015/06/25/why-driving-on-americas-roads-can-be-more-expensive-than-you-think>.

The shoddy state of the nation's roads cost the average driver \$515 in extra operation and maintenance costs on their car, according to the latest analysis from TRIP, a national transportation research group. . . . The numbers from TRIP show that 28 percent of the nation's major roadways—interstates, freeways, and major arterial roadways in urban areas—are in "poor" condition. This means they have so many major ruts, cracks and potholes that they can't simply be resurfaced—they need to be completely rebuilt.

Id.; see also generally *Bridging the Gap: America's Crumbling Infrastructure*, THE ECONOMIST, Jun. 28, 2014, at 23-24, <http://www.economist.com/news/united-states/21605932-country-where-everyone-drives-america-has-shoddy-roads-bridging-gap> (discussing decreased national budget cuts and spending on infrastructure).

⁴ See Mike Baker & Joan Lowy, *Bridge Safety: Many U.S. Spans Are Old, Risky and Rundown*, HUFF. POST (Nov. 16, 2013, 5:12 AM), http://www.huffingtonpost.com/2013/09/16/bridge-safety_n_3933317.html ("An Associated Press analysis of 607,380 bridges in the most recent federal National Bridge Inventory showed that 65,605 were classified as structurally deficient and 20,808 as fracture critical. Of those, 7,795 had both red flags.").

⁵ ALEX PRUD'HOMME, *THE RIPPLE EFFECT: THE FATE OF FRESHWATER IN THE TWENTY-FIRST CENTURY* 356-57 (2011).

In the United States, some 240,000 water pipes burst every year, according to the EPA [Environmental Protection Agency]. By another estimate, from the USGS [United States Geological Survey], 650 water mains break every day—at a rate of one every 2 minutes. . . . Many municipal water pipes are fifty to a hundred years old; some were built at the time of the [American] Civil War . . .

Id.

⁶ See generally Patrick J. Kiger, *'American Blackout': Four Major Real-Life Threats to the Electric Grid*, NAT'L GEO. (Oct. 25, 2013), <http://energyblog.nationalgeographic.com/2013/10/25/american-blackout-four-major-real-life-threats-to-the-electric-grid/> (outlining the effects of various enemy attacks on the existing U.S. electrical grid).

⁷ AM. SOC'Y OF CIV. ENG'RS, *2013 REPORT CARD FOR AMERICA'S INFRASTRUCTURE* 1 (2013), <http://www.infrastructurereportcard.org/a/documents/2013-Report-Card.pdf> [hereinafter ASCE, 2013 REPORT CARD].

The American Society of Civil Engineers, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 140,000 civil engineers in private practice, government, industry, and academia who are dedicated to advancing the science and profession of civil engineering. . . . ASCE advances professional knowledge and improves the practice of civil engineers as the focus point for development of research results and technical, policy, and managerial information. As such ASCE serves as the catalyst for effective and efficient service through cooperation with other engineering and related organizations.

Id.

structure.⁸ This report specifically noted that the antiquated grid has become increasingly vulnerable to physical and electronic sabotage, and is further stymied by delayed enactment of improvements and limited funding.⁹ Related sentiments and alarming calls for action have also been echoed in reports made by the U.S. Department of Energy,¹⁰ U.S. Department of Homeland Security,¹¹ the private sector,¹² and reports made to the United States Congress.¹³

America is rapidly approaching a vital turning point. Within the next ten years, many elements within the American electrical power grid system will begin to hit their equipment life expectancies and, therefore, will be working beyond their originally intended design life and capacity.¹⁴ Additionally, in-

⁸ *Id.* at 60.

⁹ *See generally id.* at 62-64 (“Over three times as many low-voltage line projects. . . were delayed in 2011, compared to high voltage lines. The result is that while new transmission lines are needed, many are being delayed due to permitting issues.”)

¹⁰ *See generally* Press Release, U.S. Dep’t of Energy, Energy Department Releases New Guidance for Strengthening Cybersecurity of the Grid’s Supply Chain (Apr. 30, 2014) (on file at <http://energy.gov/articles/energy-department-releases-new-guidance-strengthening-cybersecurity-grid-s-supply-chain>) (“The new guidance released today focuses on helping utilities and other energy sector organizations purchase technologies that include cybersecurity protections and features – improving the overall reliability and security of energy delivery systems and ensuring that the testing, manufacturing, delivery, and installation of new technologies emphasize cybersecurity requirements.”).

¹¹ *See generally Trustworthy Cyber Infrastructure for the Power Grid*, U.S. DEP’T OF HOMELAND SEC., <http://www.dhs.gov/science-and-technology/csd-tcipg> (last visited Apr. 3, 2015).

The Nation’s electric power infrastructure, which depends on the health of an underlying computing and communication network, is at serious risk from both malicious cyber attacks and accidental failures. These risks may come from cyber hackers who gain access to control networks or create denial of service attacks on the networks themselves, or from accidental causes, such as natural disasters or operator errors.

Id.

¹² *See, e.g.*, Massoud Amin, Turning the Tide on Outages 2, 10-11 (Jul. 18, 2011) (unpublished manuscript) (on file at http://massoud-amin.umn.edu/publications/Turning_the_Tide_on_Outages_MA_Draft_07-18-2011.pdf) (“[T]he North American electricity infrastructure is vulnerable to increasing stresses from several sources. . . The present power delivery infrastructure cannot adequately handle those new demands of high-end digital customers and 21st century economy. It cannot support levels of security, quality, reliability, and availability needed for economic prosperity”).

¹³ *See* PAUL W. PARFOMAK, CONG. RESEARCH SERV., R43604, PHYSICAL SECURITY OF THE U.S. POWER GRID: HIGH-VOLTAGE TRANSFORMER SUBSTATIONS 2 (2014).

The various parts of the electric power system are all vulnerable to failure due to natural or manmade events. However. . . HV [high voltage] transformers are considered by many experts to be the most vulnerable to intentional damage from malicious acts. Congress has long been concerned about grid security in general, but recent security exercises, together with a 2013 physical attack on transformers in Metcalf, [California], have focused congressional interest on the physical security of HV transformers, among other specific aspects of the grid.

Id.

¹⁴ RICHARD J. CAMPBELL, CONG. RESEARCH SERV., R41886, THE SMART GRID AND CY-

creasing threats of cyberattacks by mischievous hackers and terrorists are a clear and present danger to the electrical grid—the nation’s primary source of electricity.¹⁵ Malicious computer and electronic viruses, like that of “Stuxnet,”¹⁶ have already been used against other nations, which clearly illustrates the vulnerability of infrastructure to cyberattacks.¹⁷ The system also unnecessarily risks the current “American Way of Life” as we know it today.¹⁸ This is a critically important issue due to the essential role that reliable energy plays in our economy, society, and readiness at home.¹⁹ As a result, this Comment advocates that America must prioritize the modernization of its electrical grid and implement a resilient smart electrical power grid that can intelligently handle the future demands of this nation.

It is widely recognized that the deployment of smart grid technologies will

BERSECURITY— REGULATORY POLICY AND ISSUES 2 (2011) [hereinafter CAMPBELL, SMART GRID & CYBERSECURITY].

Much of the infrastructure which serves the U.S. power grid is aging. The average age of power plants is now over 30 years; most of these facilities were originally designed to last 40 years. Electric transmission and distribution system components are similarly aging, with power transformers averaging over 40 years of age, and 70% of transmission lines being 25 years or older.

Id.

¹⁵ See KIM ZETTER, COUNTDOWN TO ZERO DAY: STUXNET AND THE LAUNCH OF THE WORLD’ FIRST DIGITAL WEAPON 371 (2014) [hereinafter ZETTER, COUNTDOWN TO ZERO DAY].

Just as we failed in the past to invest in the physical infrastructure of our roads, bridges, and railways, we have failed to invest in the security of our digital infrastructure, [paraphrasing what President Barack H.] Obama said. Cyber intruders, he warned, had already probed our electrical grid, and in other countries had plunged entire cities into darkness. “This Status quo is no longer acceptable,” he said, “not when there’s so much at stake.”

Id.

¹⁶ Kim Zetter, *An Unprecedented Look at Stuxnet, the World’s First Digital Weapon*, WIRED (Nov. 3, 2014, 6:30 AM), <http://www.wired.com/2014/11/countdown-to-zero-day-stuxnet/> (“Stuxnet, as it came to be known, was unlike any other [computer] virus or worm that came before. Rather than simply hijacking targeted computers or stealing information from them, it escaped the digital realm to wreak physical destruction on equipment the computers controlled.”).

¹⁷ Doug Nibbelink, *Protecting Critical Infrastructure Against the Next Stuxnet* 7-8 (Mar. 13, 2013) (unpublished M.S. dissertation paper, Davenport University) (on file with author).

¹⁸ See generally *America’s Crumbling Infrastructure and How to Fix It: Hearing Before the J. Econ. Comm. of the U.S. Cong.*, 113th Cong. 2, 5 (2013), http://www.jec.senate.gov/public/_cache/files/48fc2638-4bba-4611-807a-5871e6fb4690/rendell-testimony-embargoed-until-930am-on-july-24-2013-.pdf [hereinafter *Hearing*] (statement of Edward G. Rendell, former Governor of Pennsylvania).

¹⁹ See generally DANIEL YERGIN & SAMANTHA GROSS, WORLD ECON. FORUM, ENERGY FOR ECONOMIC GROWTH: ENERGY DIVISION UPDATE 2012, at 7-10 (2012), http://www3.weforum.org/docs/WEF_EN_EnergyEconomicGrowth_IndustryAgenda_2012.pdf.

produce substantial benefits for the management and operation of the distribution of electrical power in the United States.²⁰ However, reliance on smart electrical grid technology and infrastructure creates issues regarding the security of the system against penetration by unauthorized users and from cyberattacks.²¹ Current federal legislation and oversight, last updated in 2007, is unimpressive, largely ineffective, and does not adequately address the need to rapidly implement smart grid technology. Notably, Congress has done little more, in concrete terms, than to establish a simple public policy statement supporting a modern electrical power grid, where digital data will be used to “improve reliability, security, and efficiency of the electric grid.”²²

Congress has not expanded on this statement or provided a cohesive framework to ensure adequate oversight and simplified implementation; leaving in its wake, a statement that is too broad and deprived of any specific benchmarks for redevelopment moving forward.²³ Since 2007, various members of Congress have proposed legislative actions or called for hearings,²⁴ but efforts in previous Congresses have ultimately stalled.²⁵ Congress must therefore revisit this issue with the goal of enacting effective legislation that outlines our nation’s electrical power grid and establishes concrete benchmarks to ensure we have a resilient system.

This Comment will analyze legal and public policy issues affecting America’s current electrical grid, both as it presently exists and as it will exist after expected modernization efforts. Part I will discuss the key components of the electrical power grid and its modernization. Part II will examine the principal laws currently in place governing the grid at the federal level. Part III will discuss problems and failings with the current laws and oversight regime and argue how this regime constrains the nation’s ability to modernize the grid and improve its resiliency against real and present threats. Part IV will propose changes to current law and policies that would facilitate creation of a stronger smart electrical grid, including identifying the roles of key players, who should have a significant role in this new enforcement and oversight scheme. Finally,

²⁰ *Smart Grid*, U.S. DEP’T OF ENERGY, <http://energy.gov/oe/services/technology-development/smart-grid> (last visited Aug. 24, 2015).

²¹ ISAAC GHANSAH, CAL. ENERGY COMM’N, CEC-500-2012-047, SMART GRID CYBER SECURITY, POTENTIAL THREATS, VULNERABILITIES AND RISKS 8-9 (2012), <http://www.energy.ca.gov/2012publications/CEC-500-2012-047/CEC-500-2012-047.pdf>.

²² Energy Independence and Security Act of 2007 1301(1), 42 U.S.C. § 17381(1) (2012).

²³ *See, e.g., id.* §§ 17381-17386.

²⁴ *See, e.g.,* Terrorism Prevention and Critical Infrastructure Protection Act of 2015, H.R. 85, 114th Cong. § 3 (2015).

²⁵ *See* Rachel Huggins, *Pollster Urges GOP to Set ‘Positive Agenda’ In New Congress*, THE HILL (Jan. 4, 2015, 7:00 AM) <http://thehill.com/homenews/228424-pollster-urges-gop-to-set-positive-agenda-in-new-congress>.

Part V will evaluate the outlook, costs, and potential benefits of a renewed and improved electrical grid for the future and what this will mean moving ahead.

II. BACKGROUND & OVERVIEW

A. American Infrastructure Basics

Black's Law Dictionary defines “infrastructure” as “[t]he underlying framework of a system, [especially] public services and facilities...needed to support commerce as well as economic and residential development.”²⁶ This definition includes facilities and utilities such as highways, bridges, sewers, and water systems,²⁷ as well as systems supporting aviation, railways, seaports, pipelines, and electrical power systems.²⁸ Most elements of infrastructure, including electricity, are critical components of industrialized economies; as such, these vital elements are no longer mere luxuries, but rather every-day necessities that support life, ensure safety, and foster convenience.²⁹

America invests in infrastructure very differently than most other nations, especially compared to those in Europe and Asia. Most European and Asian governments shift responsibility and cost to private sector businesses, making infrastructure projects joint undertakings within their societies.³⁰ Meanwhile, in

²⁶ *Infrastructure*, BLACK'S LAW DICTIONARY (9th ed. 2009).

²⁷ *Id.*

²⁸ ASCE, 2013 REPORT CARD, *supra* note 7, at 6-8.

²⁹ See M.J. Logan, *Generators: A Necessary Appliance for Every Household*, NORWALL POWER SYS. (Jan. 11, 2013), <http://www.norwall.com/blog/news-and-updates/generators-necessary-household-appliance> (“In the beginning, electricity was an extravagant luxury used mainly for lighting. Later it became a convenience that was nice to have. Today, electricity is no longer a convenience, but a necessity. Homes depend on it to power various appliances that keep us and our property safe and secure.”); see generally Sarah Fenwick, *Electricity Is A Human Right, Not a Luxury*, LEGACY MAG. ONLINE, <http://legacy-magazine.eu/electricity-is-a-human-right-not-a-luxury> (last visited Aug. 17, 2015) (“I remain convinced that electricity is a human right and a necessity – not a luxury.”); Ashley Halsey III, *Nation's Aging Electrical Grid Needs Billions of Dollars in Investment*, *Report Says*, WASH. POST (Apr. 26, 2012), http://www.washingtonpost.com/local/trafficandcommuting/nations-aging-electrical-grid-needs-billions-of-dollars-in-investment-report-says/2012/04/26/gIQAEl12jT_story.html.

³⁰ See U.S. DEP'T OF TREASURY, OFF. OF ECON POL'Y, EXPANDING OUR NATION'S INFRASTRUCTURE THROUGH INNOVATIVE FINANCING 4 (2014), <http://www.treasury.gov/press-center/pressreleases/Documents/Expanding%20our%20Nation%27s%20Infrastructure%20through%20Innovative%20Financing.pdf> [hereinafter EXPANDING OUR NATION'S INFRASTRUCTURE]; see also generally Raffaele Della Croce & Juan Yermo, *Institutional Investors and Infrastructure Financing* 17 (Org. for Econ. Co-operation & Dev. Working Papers on Fin., Ins., Private Pensions, Working Paper No. 36, 2013), http://www.oecd.org/daf/fin/private-pensions/WP_36_InstitutionalInvestorsAndInfrastructureFinancing.pdf.

the United States, much of the infrastructure is largely funded and maintained by the government.³¹ Some scholars have remarked that America's infrastructure development and management is remarkably socialist for an otherwise capitalist-centric country.³² Congress, Executive Branch agencies, and both state and local governments, often plan and fund the vast majority of various infrastructure projects across the country.³³ Infrastructure projects are paid for at the federal level with tax revenues, while states and local governments frequently use a combination of state tax revenues, federal funding programs, and various bonds issued to the public.³⁴

Notably, energy and electrical infrastructure funding varies slightly from general infrastructure funding. While some government monies go towards various improvement projects, a significant portion of financing comes from private entities, which comprise and operate various portions of the electrical grid.³⁵ Other infrastructure entities that mirror this model include both telecommunication providers and freight railway operators.³⁶ For electrical grid development, it is estimated that some \$18 billion was spent on upgrades and

Over the last decades, public capital investment in infrastructure has on average declined in OECD countries...As the share of government investment in infrastructures has declined that of private sector has increased, with privatizations being an important driver...New business models with private sector participation, variants of public-private partnership models (PPPs)—often using project finance technique—have been increasingly used particularly in OECD countries, offering further scope for unlocking private sector capital and expertise.

Id.; see also Fareed Zakaria, *U.S. Needs an Infrastructure Bank*, CNN: GLOBAL PUBLIC SQUARE (June 13, 2011, 12:50 PM), <http://globalpublicsquare.blogs.cnn.com/2011/06/13/zakaria-u-s-needs-an-infrastructure-bank/>.

³¹ Zakaria, *supra* note 30.

³² Timothy B. Lee, *We're All Infrastructure Socialists*, FORBES (May 24, 2012, 7:31 AM), <http://www.forbes.com/sites/timothylee/2012/05/24/were-all-infrastructure-socialists/>; Zakaria, *supra* note 30 (suggesting that the United States' process for developing infrastructure is done in a socialist manner).

³³ See, e.g., Zakaria, *supra* note 30; see also, e.g., American Recovery and Reinvestment Act of 2009 § 3, Pub. L. 111-5, 123 Stat. 115; see also generally Pennsylvania Infrastructure Investment Authority Act §§ 961.1-961.12, 35 PA. CONS. STAT. §§ 751.1-751.20 (2015).

³⁴ EXPANDING OUR NATION'S INFRASTRUCTURE, *supra* note 30, at 4-6.

Americans have become accustomed to government provision of our roadway, transit, water supply, and wastewater treatment systems, and private sector provision of electrical power, telecommunications, and freight rail...The line separating public from private infrastructure is not always clear. Even for infrastructure projects like roads and schools, which are traditionally owned by the public sector, state and local governments have long obtained private debt financing through a well-developed municipal bond market that is unique to the United States.

Id.

³⁵ See *id.* at 3.

³⁶ *Id.*

modernization between the years 2010 and 2013.³⁷ The federal government provided \$8 billion towards this expenditure, with the energy sector funding the remainder.³⁸ It is also helpful to explicitly note these numbers do not include repairs or otherwise standard maintenance.³⁹

B. The Current Electrical Power Grid in America

The term “grid” is actually misleading to the extent that it implies a single cohesive network of power lines and facilities.⁴⁰ In fact, the contiguous United States electrical grid is comprised of three separate sectors—the Eastern Interconnection, the Electric Reliability Council of Texas, and the Western Interconnection.⁴¹ While these sectors adjoin one another, each is largely independent with little overlap in operation.⁴² There are also several different grid operators that manage and control the flow and wholesale costs of electricity within their sector of an interconnection.⁴³ Within each region and interconnection, there are hundreds of different power-line networks, with more than 450,000 miles of power lines throughout the United States.⁴⁴

The overall electrical grid is divided into three broad stages in which electricity must travel before reaching a given home, office, or school using the

³⁷ U.S. DEP’T OF ENERGY, 2014 SMART GRID SYSTEM REPORT: REPORT TO CONGRESS 2 (2014), <http://energy.gov/sites/prod/files/2014/08/f18/SmartGrid-SystemReport2014.pdf> [hereinafter USDOE, 2014 SMART GRID REPORT]

³⁸ *Id.* (noting that these years might ultimately become an outlier due to influx of government spending, which was the result of the American Recovery and Reinvestment Act of 2009, if further increase levels of government are ceased); see discussion *infra* Part II.

³⁹ See USDOE, 2014 SMART GRID REPORT, *supra* note 37, at 2 (noting that the money was spent on smart grid deployment which is defined as digitally based sensing, communications, and control technologies and field devices).

⁴⁰ See CHRISTOPHER GUO, CRAIG A. BOND, & ANU NARAYANAN, RAND CORP., THE ADOPTION OF NEW SMART-GRID TECHNOLOGIES: INCENTIVES, OUTCOMES, AND OPPORTUNITIES 1 (2015), http://www.rand.org/pubs/research_reports/RR717.html (explaining that the US electric grid is made up of “three almost-independent subgrids”).

⁴¹ *Id.* at 1-2 (adding that the Electric Reliability Council of Texas is also colloquially known as the “Texas Interconnection”).

⁴² *Id.*

⁴³ See generally *PJM’s Role as an RTO*, PJM INTERCONNECTION, LLC (Apr. 27, 2015), <https://www.pjm.com/aboutpjm/~media/43A8E145FDFD4AFEB8D8D85873D2CE1C.ashx> (noting that regional transmission organizations are chief grid operating entities “authorized by the federal government to manage the reliability of the electric transmission system and the operation of the wholesale electricity market in a defined control area”).

⁴⁴ AM. SOC’Y OF CIV. ENG’RS, FAILURE TO ACT: THE IMPACT OF INFRASTRUCTURE INVESTMENT ON AMERICA’S ECONOMIC GROWTH 19 (2011), http://www.asce.org/uploadedFiles/Issues_and_Advocacy/Our_Initiatives/Infrastructure/Content_Pieces/failure-to-act-economic-impact-summary-report.pdf [hereinafter ASCE, FAILURE TO ACT].

electrical power grid system—generation, transmission, and distribution. First, electricity is generated at a power plant.⁴⁵ Once generated, electricity enters transmission lines and is carried for a distance to various areas of population, whether that is to a nearby suburb or a faraway city or a lone rural farmstead.⁴⁶ Lastly, this electricity is delivered to the consumer via local power lines, called “distribution lines.”⁴⁷ Deployed throughout this system are a large number of electrical substations, which either increase the voltage to carry the electricity over long distances or decrease and regulate the voltage for local distribution.⁴⁸ Generally, power must be consumed as it is being generated, for there is currently no readily available or practical system of storing large amounts of excess energy generated.⁴⁹

The United States’ current power grid was not the production of some master plan, but rather, emerged as an elaborate “patchwork” of different components.⁵⁰ Each piece of equipment varies in the capacities it can handle as well as its current age and condition.⁵¹ The basic network of power plants, distribution lines, substations, and local power lines is virtually the same as the original system created in the late 19th century, albeit on a much grander scale.⁵² Currently, many of America’s 5,800 major power generation plants⁵³ are now over thirty years old.⁵⁴ These plants, however, were only designed to last for about forty years of use.⁵⁵ Power transformers, used to convert the voltage of the electricity, average forty years old.⁵⁶ Approximately 70% of transmission power lines have been in use for at least twenty-five years.⁵⁷ Much of the grid is rapidly approaching its designed “life expectancy,” which, without modernization, will likely lead to an increasingly unreliable electrical system in America.⁵⁸ By only making incremental improvements to its electrical grid as various elements and components continuously wear down and fail, the United

⁴⁵ See CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 1.

⁴⁶ *See id.*

⁴⁷ *See id.*

⁴⁸ CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 1 (noting that residential, commercial, and industrial all have different electricity requirements and specifications, even within each general type of users).

⁴⁹ *Id.* (stating that technology has not yet reached the point where excess generated power can be stored on a wide, public scale).

⁵⁰ ASCE, FAILURE TO ACT, *supra* note 44, at 19.

⁵¹ *Id.*

⁵² *See id.*

⁵³ *Id.*

⁵⁴ CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 2.

⁵⁵ *Id.*

⁵⁶ *Id.*

⁵⁷ *Id.*

⁵⁸ Halsey III, *supra* note 29 (citing the ASCE, who stated that the nation’s electrical grid “will break down unless [at least] \$673 billion is invested in it by 2020”).

States is playing a defensive game of catch-up.

C. Transitioning to a “Smart” Electrical Power Grid

“Smart grid” electricity has become a broad and ambiguous term used to generally define the next generation of electrical power network.⁵⁹ This term frequently invokes the idea of utilizing digital data in real-time, two-way communications between consumers and their suppliers.⁶⁰ Many advocates envision a practical and fully automated system, which is able to predict failure and quickly respond to various service issues and disruptions.⁶¹ Total smart grid technology would therefore work to completely revitalize and morph the electrical grid from how it exists presently.⁶²

Such an undertaking would require a massive modernization of equipment.⁶³ Power generating systems would need to be constructed and others would require retrofitting so that each accurately detects and reacts to consumer de-

⁵⁹ See GUO, ET AL., *supra* note 40, at iii (“This communication layer, its associated enabling technologies, and the infrastructure necessary to deliver electricity are collectively known as the smart grid”); MARC W. CHUPKA, ROBERT EARLE, PETER FOX-PENNER, & RYAN HLEDIK, EDISON FOUND., *TRANSFORMING AMERICA’S POWER INDUSTRY: THE INVESTMENT CHALLENGE 2010-2030*, at xi n.7 (2008), http://www.edisonfoundation.net/iei/Documents/Transforming_Americas_Power_Industry.pdf.

There is currently no standard definition of “Smart Grid” within the electric utility industry ...The “Smart Grid” vision is that the technologies will: 1) provide customers with information and tools that allow them to be responsive to system conditions; 2) ensure more efficient use of the electric grid; and 3) enhance system reliability.

Id.

⁶⁰ See, e.g., USDOE, 2014 SMART GRID REPORT, *supra* note 37, at v; CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at v, 3; Michael Panfil, *Resiliency+: Smart Grid Technologies and the Benefits of Two-Way Communication*, ENVTL. DEF. FUND (Sept. 15, 2014), <http://blogs.edf.org/energyexchange/2014/09/15/resiliency-smart-grid-technologies-and-the-benefits-of-two-way-communication/>; BRANDON J. MURRILL, EDWARD C. LIU, & RICHARD M. THOMPSON II, CONG. RESEARCH SERV., R42338, SMART METER DATA: PRIVACY AND CYBERSECURITY 6 (2012).

⁶¹ See, e.g., USDOE, 2014 SMART GRID REPORT, *supra* note 37, at v (“Smart grid applications enable utilities to automatically locate and isolate faults to reduce outages, dynamically optimize voltage and reactive power levels for more efficient power use, and monitor asset health to guide maintenance”); CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 22 (noting smart grid could help mitigate the effects of natural disasters); Panfil, *supra* note 60 (noting smart meters would send out a “last gasp” call that would lead to better planning and response times of power outages); MURRILL, ET AL., *supra* note 60, at 1 (noting smart meters will allow suppliers to “collect, measure, and analyze energy consumption data for grid management, outage notification, and billing purposes”).

⁶² See generally ASCE, 2013 REPORT CARD, *supra* note 7, at 63.

⁶³ GUO, ET AL., *supra* note 40, at xi.

mands.⁶⁴ Modern transmission lines installed with monitoring equipment allow for automatic, instantaneous rerouting of electricity around service disruptions, both locally and regionally.⁶⁵ The rollout and implementation of “intelligent substations,” which can evaluate electrical failures within the system and determine when scheduled maintenance is needed, can prevent catastrophic and expensive equipment failures.⁶⁶ This would result in vastly more efficient distribution networks that not only better protect the grid’s integrity and its consumers, but also aims to be more energy efficient through storage or by producing only the amount of energy needed.⁶⁷ Eventually, the implantation of “smart meters” on consumer buildings will allow for a fully network interconnect system through and through.⁶⁸

This Comment advocates upgrading the electrical grid, with a keen initial focus on transmission and distribution lines. Transmission and distribution lines, which lie between power plants and users,⁶⁹ are likely to be the best segments to focus initial redevelopment.⁷⁰ Transmission and distributions lines are often considered the “backbone” of the system.⁷¹ This portion is likely the easiest to make modifications to since it does not involve consumer or personal privacy issues, like that of smart meters.⁷² Furthermore, this segment will likely be less contentious because the power lines are already largely in place; there-

⁶⁴ *Id.* at 37; see also Patricia A. Hoffman, *How Synchrophasors are Bringing the Grid into the 21st Century*, U.S. DEP’T OF ENERGY (Apr. 16, 2014, 12:10 PM), <http://energy.gov/articles/how-synchrophasors-are-bringing-grid-21st-century> (“A synchrophasor is a sophisticated [mailbox-sized] monitoring device that can measure the instantaneous voltage, current and frequency at specific locations on the grid. This gives operators a near-real-time picture of what is happening on the system, and allows them to make decisions to prevent power outages.”).

⁶⁵ CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 4-5.

⁶⁶ DR. R. A. SHOURESHI ET AL., ELECT. POWER RES. INST., No. 1008821, INTELLIGENT SUBSTATION 3-1 (2003), <http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000001008821> [hereinafter EPRI, INTELLIGENT SUBSTATION].

⁶⁷ USDOE, 2014 SMART GRID REPORT, *supra* note 37, at vi.

⁶⁸ MURRILL, ET AL., *supra* note 60, at 1-2.

⁶⁹ *Illustrated Glossary: Transmission Lines*, U.S. DEP’T OF LAB., https://www.osha.gov/SLTC/etools/electric_power/illustrated_glossary/transmission_lines.html (last visited Aug. 17, 2015).

⁷⁰ See generally C. GELLINGS, ELEC. POWER RES. INST., No. 1022519, ESTIMATING THE COSTS AND BENEFITS OF THE SMART GRID 5-1 (2011), <http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000001022519> [hereinafter EPRI, ESTIMATING COSTS] (“The high-voltage transmission system is the “backbone” of the power delivery system.”).

⁷¹ See *id.*

⁷² U.S. GOV’T ACCOUNTABILITY OFF., GAO-12-926T, CYBERSECURITY: CHALLENGES IN SECURING THE ELECTRICITY GRID 15-16 (2012) [hereinafter GAO: CYBERSECURITY CHALLENGES] (noting federal regulations largely govern transmission lines, however these lines could become blurred if additional technology such as “smart meters” are installed on consumer homes and business, which interfere with distribution lines, systems, or equipment).

fore, much of the upgrade will involve running new electrical lines and simply installing new components at existing locations already owned or occupied by the electric grid.⁷³ Lastly, the transmission lines are one of the vital parts of the electrical grid to preserve and revive because these lines and equipment are currently believed to be especially susceptible to cyberattacks.⁷⁴

III. CURRENT FEDERAL LAWS AND REGULATIONS AFFECTING THE ELECTRIC GRID

A. Energy Independence and Security Act of 2007

The Energy Independence and Security Act of 2007 (“EISA”) was the first significant piece of legislation to address the notion of a smart grid.⁷⁵ Congress passed EISA with limited bipartisan support and President George W. Bush signed the bill into law on December 17, 2007.⁷⁶ The newly passed legislation worked to establish new policy initiatives and reforms, such as increasing federal investments in alternative energy sources, phasing out traditional incandescent light bulbs, and raising vehicle fuel economy standards.⁷⁷ Title XIII of EISA briefly described a broad public policy that sought the modernization of

⁷³ Compare MURRILL, ET AL., *supra* note 60, at 7-13 (noting that 4th Amendment issues and questions of privacy arise) with GUO ET AL., *supra* note 40, at 39-41 (noting that transmission and distribution lines are treated as public goods, but also acknowledging allocation of funding may be contentious, between government and non-government sources).

⁷⁴ Cf. GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 8 (“Threats to systems supporting critical infrastructure—which includes the electricity industry and its transmission and distribution systems—are evolving and growing.”); CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 21 (“The current Smart Grid cybersecurity discussions largely focuses on the security of central station power plants and transmission systems.”).

⁷⁵ Energy Independence and Security Act of 2007, 110 Pub. L. No. 140, 121 Stat. 1492 (2007) (codified throughout 42 U.S.C.).

⁷⁶ U.S. Senate Roll Call Votes 110th Congress - 1st Session, U.S. SENATE (Dec. 13, 2007),

http://www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=110&session=1&vote=00430; FINAL VOTE RESULTS FOR ROLL CALL 40, U.S. HOUSE OF REP. (Dec. 6, 2007), <http://clerk.house.gov/evs/2007/roll040.xml> (recognizing support was mostly by Democratic members of Congress with some Republican member joining in); Press Release, Off. of the Press Sec’y, Fact Sheet: Energy Independence and Security Act of 2007 (Dec. 19, 2007) (on file with author) (“[Republican] President [George W.] Bush signed the Energy Independence and Security Act of 2007.”).

⁷⁷ See generally Energy Independence and Security Act of 2007, 110 Pub. L. No. 140, 121 Stat. 1492 (codified in scattered sections of 42 U.S.C.) (describing notable policy reforms in “TITLE I—ENERGY SECURITY THROUGH IMPROVED VEHICLE FUEL ECONOMY,” “TITLE III—ENERGY SAVINGS THROUGH IMPROVED STANDARDS FOR APPLIANCE AND LIGHTING,” [and] “TITLE VI—ACCELERATED RESEARCH AND DEVELOPMENT”).

America's electrical power grid network.⁷⁸

Initially, EISA tasked the U.S. Department of Energy ("DOE") and its Office of Electricity Delivery and Energy Reliability ("OD") to help oversee efforts to develop and establish a nationwide smart grid system.⁷⁹ Congress created two new collaborative organizations, "The Smart Grid Advisory Committee" and "The Smart Grid Task Force," making the former responsible for establishing a technical framework to put into place and tasking the latter with disseminating information to third-party agencies within government and non-government sectors.⁸⁰ The newly formed organizations are complexly organized and require the involvement of members from the National Institute of Standards and Technology ("NIST"), Federal Energy Regulatory Commission ("FERC"), and the U.S. Department of Homeland Security ("DHS").⁸¹ The remaining statutory provisions aimed to enact programs for the research and development of smart grid technologies,⁸² the development of a smart grid "interoperability framework,"⁸³ and the establishment of a grant program for smart

⁷⁸ See *id.* § 1301, 42 U.S.C. § 17381.

It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid:

- (1) Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
- (2) Dynamic optimization of grid operations and resources, with full cybersecurity.
- (3) Deployment and integration of distributed resources and generation, including renewable resources.
- (4) Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.
- (5) Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
- (6) Integration of "smart" appliances and consumer devices.
- (7) Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
- (8) Provision to consumers of timely information and control options.
- (9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- (10) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Id.

⁷⁹ *Id.* § 17382.

⁸⁰ *See id.* § 17383.

⁸¹ *See id.* §§ 17382, 17383.

⁸² *See id.* § 17384.

⁸³ *See id.* § 17385(a) (outlining the need to develop protocols so that appliances and

grid investments.⁸⁴

B. American Recovery and Reinvestment Act of 2009

While EISA established policy, subsequent appropriations helped make some parts of EISA's public policy efforts a reality.⁸⁵ Roughly a year later, Congress temporarily bolstered funding for smart grid initiatives in the American Recovery and Reinvestment Act of 2009, otherwise known as "The Recovery Act."⁸⁶ The primary purpose of this legislation was to inject emergency government stimulus funding into the economy during the height of the Great Recession, rather than to modify federal energy policy in a substantial way.⁸⁷ The Recovery Act⁸⁸ has been a meager victory for smart grid technology, and has helped to make initial progress in its implementation.⁸⁹ However, the main goal of the Recovery Act was to "jumpstart" the economy, rather than a long-

other devices can communicate with the grid); *see generally* Christopher Bosch, *Securing the Smart Grid: Protecting National Security and Privacy through Mandatory, Enforceable Interoperability Standards*, 41 *FORDHAM URB. L.J.* 1349, 1353 (2014) ("[G]ranteeing the appropriate regulatory entities the authority to develop and institute mandatory, enforceable interoperability standards is the most appropriate means to achieving effective Smart Grid cybersecurity.").

⁸⁴ *See* 42 U.S.C. § 17386(a).

⁸⁵ *See Federal Energy Requirements*, ENVTL. PROTECTION AGENCY (Nov. 5, 2012), <http://www.epa.gov/greeningepa/energy/fedreq.htm>; *see also* Omnibus Appropriations Act of 2009, Pub. L. No. 111-8, 123 Stat. 524 (2009).

⁸⁶ *See generally* American Recovery and Reinvestment Act of 2009 § 405, 42 U.S.C. § 17384; *see also* *The Recovery Act*, RECOVERY.GOV, http://www.recovery.gov/arra/About/Pages/The_Act.aspx (last visited on Apr. 9, 2014).

On February 13, 2009, in direct response to the economic crisis and at the urging of President Obama, Congress passed the American Recovery and Reinvestment Act of 2009—commonly referred to as the "stimulus" or the "stimulus package.") Four days later, the President signed the Recovery Act into law. The three immediate goals of the Recovery Act were:

- (1) create new jobs and save existing ones
- (2) spur economic activity and invest in long-term growth
- (3) foster unprecedented levels of accountability and transparency in government spending.

Id.

⁸⁷ *See generally* American Recovery and Reinvestment Act of 2009 § 405(1)(A).

⁸⁸ *See About the Recovery Act*, WHITEHOUSE.GOV, <https://www.whitehouse.gov/recovery/about> (last visited Aug. 20, 2015).

⁸⁹ Silvio Marcacci, *DOE Smart Grid Funds Created \$6.8 Billion Economic Boost, 47,000 Jobs*, CLEAN TECHNICA (May 3, 2013), <http://cleantechnica.com/2013/05/03/doe-smart-grid-funds-created-6-8-billion-economic-boost-47000-jobs/> ("An analysis from the US Department of Energy (DOE), 'Economic Impact of Recovery Act Investment in the Smart Grid,' reports smart grid projects funded through the American Recovery and Reinvestment Act created nearly \$7 billion total economic output, nearly 50,000 jobs, and over \$1 billion in government tax revenue.").

term funding source for smart grid implementation.⁹⁰

C. Presidential Policy Directive No. 21 & Executive Order 13636

On February 12, 2013, President Barack H. Obama promulgated Presidential Policy Directive No. 21 relating to “Critical Infrastructure Security and Resilience.”⁹¹ Presidential Policy Directives, sometimes referred to as “Presidential Directives,” are similar to an Executive Order, but are typically released in conjunction with the activities of the President’s National Security Council.⁹² Presidential Policy Directive No. 21 was specifically issued to all vital and important forms of infrastructure and called for collaboration among the different levels of government to strengthen weaknesses within the various current infrastructure systems.⁹³ The initiative was designed to be a proactive effort, citing general physical and cyberattack threats against the dated national infrastructure.⁹⁴

This Directive reasserted DHS as the primary actor tasked with managing the security for all key areas of infrastructure, including “energy.”⁹⁵ DHS’s role is two-fold: (1) to cure any points of vulnerability and (2) to facilitate cooperation and information sharing between interested governments and agencies.⁹⁶ Meanwhile, the Directive restated the call for various agencies that handled infrastructure to research, plan, and develop security and resiliency plans to protect against both physical and cyber-threats.⁹⁷

President Obama, realizing that a Presidential Policy Directive alone was insufficient, subsequently issued an accompanying Executive Order on the same subject matter only a week later, on February 19, 2013.⁹⁸ Executive Order 13636 largely restates Presidential Policy Directive No. 21, while also ordering

⁹⁰ See generally *The Recovery Act*, *supra* note 86; see also *Post-Award/Closeout/Oversight*, FED. TRANSIT ADMIN., http://www.fta.dot.gov/about/12835_9327.html (last visited Aug. 20, 2015).

⁹¹ Press Release, Off. of the Press Sec’y, Presidential Policy Directive—Critical Infrastructure Security and Resilience (Feb. 12, 2013) (on file with author), <http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil> [hereinafter Critical Infrastructure Security and Resilience].

⁹² See generally *Presidential Directives and Where to Find Them*, LIB. OF CONG. (Oct. 22, 2014), <http://www.loc.gov/rr/news/directives.html>.

⁹³ Critical Infrastructure Security and Resilience, *supra* note 91.

⁹⁴ See *id.*

⁹⁵ *Id.*

⁹⁶ *Id.*; see also CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 10, 15 (noting the involvement of the Department of Homeland Security within electrical power grid, but citing to additional statutory authority for involvement within infrastructure).

⁹⁷ Critical Infrastructure Security and Resilience, *supra* note 91.

⁹⁸ Exec. Order No. 13636, 78 Fed. Reg. 11739 (Feb. 19, 2013).

various elements of the Executive Branch to undertake new and related duties as well as specifying personnel assignments and relevant logistics.⁹⁹

D. Subsequent Administrative Findings & Regulations

There are few regulations in place regarding the implementation of, or standards for, the smart grid in the United States, especially at the federal level.¹⁰⁰ Following EISA, many agencies were tasked with new assignments to promote the smart grid—but none have offered any solid regulatory guidance.¹⁰¹ The few regulations that have emerged are a set of “voluntary standards” and measures that energy companies and state public utility commissions are encouraged, but not required, to adopt.¹⁰² These voluntary regulations impede rapid development of the electrical grid.¹⁰³ This is largely the result of the Energy Policy Act of 2005,¹⁰⁴ which supported an industry model where energy companies were urged to self-regulate.¹⁰⁵ However, self-regulated natural monopolies, such as electrical power companies, may become less inclined to invest, modernize, and innovate when continuing with business as usual will maximize their earnings.¹⁰⁶ As a result, and notwithstanding EISA, Presidential

⁹⁹ *Id.*

¹⁰⁰ See ASCE, 2013 REPORT CARD, *supra* note 7, at 63.

¹⁰¹ See, e.g., Availability of North American Energy Standards Board (NAESB) Smart Grid Standards as non-mandatory guidance, 18 C.F.R. § 2.27 (2015); U.S. DEP’T OF ENERGY, DATA PRIVACY AND THE SMART GRID: A VOLUNTARY CODE OF CONDUCT 1 (2015), http://www.energy.gov/sites/prod/files/2015/01/f19/VCC%20Concepts%20and%20Principles%202015_01_08%20FINAL.pdf; *Federal Smart Grid Task Force*, SMARTGRID.GOV, https://www.smartgrid.gov/federal_initiatives/federal_smart_grid_task_force/departments_of_homeland_security (last visited Apr. 9, 2015); GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 6 (“As a result, any standards identified and developed through the NIST-led process are voluntary unless regulators use other authorities to indirectly compel utilities and manufacturers to follow them.”).

¹⁰² See Bosch, *supra* note 83, at 1377 (“In an industry as fast-moving as the Smart Grid, mandatory interoperability standards must be established early if they are going to be established at all. Instead, a voluntary adoption regime persists to the potential detriment of citizens and businesses.”).

¹⁰³ See *id.* (“The separate regulatory relationship established between NIST and the Federal Energy Regulatory Commission (FERC) under the EISA to implement interoperability standards is too burdensome and inactive to appropriately account for the fast-moving nature of Smart Grid development.”).

¹⁰⁴ Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (codified in scattered sections of 16 U.S.C.).

¹⁰⁵ Bosch, *supra* note 83, at 1377.

¹⁰⁶ See generally TIMOTHY MOUNT, AM. PUB. POWER ASS’N, INVESTMENT PERFORMANCE IN DEREGULATED MARKETS FOR ELECTRICITY: A CASE STUDY OF NEW YORK STATE 9 (2007), <http://www.publicpower.org/files/PDFs/StudyMountEMRIreportNYISOCapacity09-07.pdf> (“In a deregulated market, a large part of the net revenue earned above the operating costs is fungible and does not necessarily go toward the capital costs of generating capacity in a

Directive No. 21, or Executive Order 13636, has had little real development towards implementing a secure smart grid. While overly burdensome regulation would be detrimental, a healthy balance of structured regulation and autonomy must be achieved to encourage and incentivize the transition to a modern, smart grid system.

IV. PROBLEMS AND FAILINGS OF THE SMART GRID UNDER THE CURRENT LAWS AND POLICIES

A. No Overall Improvement

Despite recently enacted laws, specialized taskforces, promulgated policy initiatives, and supposed redirection of time and funding, the smart grid is still largely a blueprint almost a decade after EISA. The American Society of Civil Engineers (“ASCE”), in their quadrennial *2013 Report Card for American Infrastructure*, gave the energy and electrical sector a “D+” letter grade.¹⁰⁷ This score was identical to that in the *2009 Report Card for American Infrastructure*, which strongly suggests that, at least from the perspective of this group, the overall status of the electrical power grid was no better than four years earlier.¹⁰⁸ This 2013 report made the following key findings: (1) the current system can usually handle current demand, but will face severe capacity issues as demand and population are forecasted to increase; (2) the aging grid equipment has resulted in more service disruptions and cybersecurity vulnerabilities are becoming more of a risk; (3) there will be an “investment gap,” between funding needed and funding provided, if increased funding is not pursued.¹⁰⁹ Meanwhile, the ASCE did note some gains made in the previous four years by highlighting increased availability of funding, but still questioned its future.¹¹⁰

particular region.”).

¹⁰⁷ ASCE, 2013 REPORT CARD, *supra* note 7, at 7, 10.

About The Report Card: Methodology: The purpose of the *2013 Report Card for America's Infrastructure* is to inform the public of the current condition of America's infrastructure and to deliver the information in a concise and easily accessible manner. Using an easily understood school report card format, each of the 16 categories of infrastructure covered in the *Report Card* is assessed using rigorous grading criteria and the most recent aggregate data sources to provide a comprehensive assessment of America's infrastructure assets.

Id. at 10.

¹⁰⁸ Compare *id.* at 60, with AM. SOC'Y OF CIV. ENG'RS, 2009 REPORT CARD FOR AMERICA'S INFRASTRUCTURE 2 (2009), http://www.infrastructurereportcard.org/2009/sites/default/files/RC2009_full_report.pdf.

¹⁰⁹ ASCE, 2013 REPORT CARD, *supra* note 7, at 61-62.

¹¹⁰ *Id.* at 62-63.

Overall, the report labels the electrical grid “at risk,”¹¹¹ inadequate for future demand,¹¹² and a mismatched mix of equipment.¹¹³

B. Losing Global Competitiveness

International and global groups have also highlighted the inadequacy of America’s current grid. The World Economic Forum,¹¹⁴ in their 2008-2009 report, ranked the United States electrical supply 16th place in the world.¹¹⁵ In the 2013-2014 report, America’s rank fell to 30th in the world.¹¹⁶ This strongly suggests that America is being outpaced by other nations as the quality of its electrical infrastructure continues to remain outdated and further deteriorates.¹¹⁷ The data underlying this downward trend is both troubling and increasingly works to reveal the frailty of the nation’s currently existing grid.

¹¹¹ *See id.* at 11, 60.

¹¹² *Id.* at 61.

¹¹³ *See id.* at 60-61.

¹¹⁴ *Our Mission*, WORLD ECON. FORUM, <http://www.weforum.org/world-economic-forum> (last visited Apr. 9, 2015).

The World Economic Forum was established in 1971 as a not-for-profit foundation and is headquartered in Geneva, Switzerland. It is independent, impartial and not tied to any special interests, working in close cooperation with all major international organisations...[The World Economic Forum] engages political, business, academic and other leaders of society in collaborative efforts to improve the state of the world. Together with other stakeholders, it works to define challenges, solutions and actions, always in the spirit of global citizenship.

Id.

¹¹⁵ KLAUS SCHWAB & MICHAEL E. PORTER, WORLD ECON. FORUM, THE GLOBAL COMPETITIVENESS REPORT 2008–2009, at 390 (2009), <http://all4ed.org/wp-content/uploads/2008/01/globe.pdf> [hereinafter WEF, GLOBAL COMPETITIVENESS REPORT 2008–2009].

¹¹⁶ KLAUS SCHWAB, WORLD ECON. FORUM, THE GLOBAL COMPETITIVENESS REPORT 2013–2014: FULL DATA EDITION, at 438 (2014), http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf [hereinafter WEF, GLOBAL COMPETITIVENESS REPORT 2013-2014].

This year’s Report features a record number of 148 economies, and thus continues to be the most comprehensive assessment of its kind. It contains a detailed profile for each of the economies included in the study, as well as an extensive section of data tables with global rankings covering over 100 indicators. This Report remains the flagship publication within the Forum’s Global Competitiveness and Benchmarking Network, which produces a number of related research studies aimed at supporting countries in their transformation efforts.

Id. at xiii.

¹¹⁷ *Contra* WEF, GLOBAL COMPETITIVENESS REPORT 2008-2009, *supra* note 116, at 390; *see* WEF, GLOBAL COMPETITIVENESS REPORT 2013-2014, *supra* note 116, at 438.

C. Left in the Dark

Blackout incidents and service downtimes have continued to increase over the past several years. Between 2007 and 2011, the number of service interruptions has more than quadrupled,¹¹⁸ while the average total outage time also increased from 104 minutes to 112 minutes per year.¹¹⁹ It is important to note, however, that disruption times vary widely across the nation.¹²⁰ This has also increased the spending per customer by electric companies, which increased roughly ten percent between 2007 and 2011.¹²¹

Outages and threats of outages have caused a sizable segment of homeowners and businesses to invest in backup power generators, but only if they have the resources to do so.¹²² High profile, widespread outages—such as those caused by “Superstorm Sandy” in 2012¹²³—has spurred a small economic boom in the home backup generator market in recent years.¹²⁴ It is estimated that 1.25 million American households now have a permanent back-up generator connected to their home,¹²⁵ while many more households are estimated to have smaller, portable electric generators.¹²⁶ These are clear, unambiguous efforts by consumers to bypass the electrical grid and its frequent, inconvenient outages.

¹¹⁸ See ASCE, 2013 REPORT CARD *supra* note 7, at 61 (“Significant power outages have risen from 76 in 2007 to 307 in 2011. Many transmission and distribution system outages have been attributed to system operations failures, although weather-related events have been the main cause of major electrical outages in the United States in the years 2007 to 2012.”).

¹¹⁹ Jonathan Fahey, *U.S. Power Grid Cost Rise, but Service Slips*, YAHOO NEWS (Mar. 5, 2013, 2:19 PM), <http://news.yahoo.com/us-power-grid-costs-rise-144035112.html>.

¹²⁰ Amin, *supra* note 12, at 1 (“In an average year, outages total 92 minutes per year in the Midwest and 214 minutes in the Northeast.”).

¹²¹ See Fahey, *supra* note 119 (referencing chart within the article, which states that the average cost per customer in 2007 was just over \$200 and by 2011 had risen to \$232).

¹²² Ken Belson, *Power Grids Iffy, Populous Areas Go for Generators*, N.Y. TIMES, Apr. 24, 2013, at F8 (“‘It’s not cheap, but people look at it as a home improvement product, particularly as they age,’ said Aaron Jagdfeld, the chief executive of Generac Power Systems, which recently produced its one-millionth standby unit. ‘People are coming to the conclusion that power outages are becoming more frequent.’”).

¹²³ See *Hurricane Sandy Power Outage Map: Millions without Electricity on East Coast*, HUFF. POST (Oct. 31, 2012, 3:11 PM), http://www.huffingtonpost.com/2012/10/30/hurricane-sandy-power-outage-map-infographic_n_2044411.html.

¹²⁴ Bob Tita, *A Sales Surge for Generator Maker*, WALL ST. J., Nov. 6, 2012, at B10.

¹²⁵ *Id.*

¹²⁶ Caroline Winters, *Hurricane Sandy Boosts the Generator Makers*, BLOOMBERG BUSINESSWEEK (Nov. 5, 2012), <http://www.bloomberg.com/bw/articles/2012-11-05/hurricane-sandy-boosts-the-generator-makers> (“Only about 3 percent of U.S. homes currently have standby generators while about 15 percent have portables, according to Generac, which tracks industry sales, including those from competitors such as Briggs & Stratton [] and Kohler.”).

D. No Power, No Productivity

Failure to improve and modernize the electrical grid has far reaching economic implications. Blackouts and power disruptions siphon enormous amounts of money from the U.S. economy.¹²⁷ Without electricity, manufacturers are unable to make goods, retail outlets are unable to sell goods, companies are unable to render their services, and computer equipment and wireless networks cease all functionality.¹²⁸ Experts have argued the economic impact might range somewhere between \$80 billion to more than \$164 billion.¹²⁹ In the manufacturing and digital economic sectors, an hour-long outage costs approximately \$7,795 on average.¹³⁰ Short, intermittent outages, which are more commonplace than prolonged outages, also cost money and harm productivity, but the exact amount is difficult to accurately estimate.¹³¹ These costs can be significantly curtailed with the implementation of the smart grid, which would be better able to handle outages, minimize impact, and reroute power around affected locations.

E. Ineffective Oversight

Since the passage of EISA in 2007, Congress has effectively taken a backseat role on infrastructure redevelopment and investment. While EISA

¹²⁷ Fahey, *supra* note 119.

¹²⁸ See, e.g., Tony Rhodin, *35 Lehigh Valley Mall Stores Closed by Power Outage, Spokesman Says*, THE EXPRESS-TIMES, (Aug. 21, 2015, 6:11 AM), http://www.lehighvalleylive.com/lehigh-county/index.ssf/2015/02/35_lehigh_valley_mall_stores_c.html (demonstrating that lack of electricity lead to retail stores being unable to sell goods and companies unable to render services).

¹²⁹ See RICHARD J. CAMPBELL, CONG. RESEARCH SERV., R42696, WEATHER-RELATED POWER OUTAGES AND ELECTRIC SYSTEM RESILIENCY 8 (2012) [hereinafter CAMPBELL, POWER OUTAGES] (using 2001 as the basis for estimates, unadjusted for inflation or current dollar value); see also *Smart Grid Overview*, GEN. ELEC. DIG. ENERGY, http://www.gedigitalenergy.com/smartgrid_overview.htm (last visited Aug. 21, 2015); see also Brad Plumer, *Bad news: The U.S. Power Grid Is Getting Pricier, Less Reliable*, WASH. POST: WONKBLOG (Mar. 8, 2013), <http://www.washingtonpost.com/blogs/wonkblog/wp/2013/03/08/surprise-the-u-s-power-grid-is-getting-pricier-less-reliable/> (“Problems with the power grid now cost the economy some \$150 billion per year.”).

¹³⁰ CAMPBELL, POWER OUTAGES, *supra* note 129, at 7 (explaining these numbers were primarily from manufacturing and digital economy firms, but also adding that costs vary firm to firm, and noting that 5% of firms had a \$20,000 cost or more for an hour-long outage).

¹³¹ See *id.* at 7-8 (explaining “even short duration outages of a few minutes could have large costs” for firms).

outlined a shell of a plan of action for infrastructure redevelopment,¹³² the Legislative Branch has failed to establish any effective benchmarks for development or effective oversight.¹³³ Instead, EISA sketched a basic, broad public policy proposal and delegated assignments to various executive agencies and newly created collaborative organizations.¹³⁴ While Congress has periodically requested various reports and updates, these have only shown mixed results in moving towards a smart grid.¹³⁵ Nevertheless, Congress has neither reacted to this information nor proffered additional legislation to remedy this derailed attempt.¹³⁶

Since EISA's passage, these newly formed organizations and various agencies have conformed to the law;¹³⁷ however, according to the Government Accountability Office ("GAO"), progress in many areas has been challenging and lagging.¹³⁸ The GAO proposes Congress consider additional legislation or regulation to encourage and require a transition to a smart grid system, especially if existing agencies and entities cannot resolve coordination and regulation issues amongst themselves.¹³⁹ The GAO has also pointed out that weak voluntary standards are also likely hindering progress towards a renewed and resilient electrical power system.¹⁴⁰ The GAO has not been the only group to criticize this anemic progress; several academics have been skeptical as well.¹⁴¹ Therefore, Congress ought to actively work to establish clear goals and create a cohesive framework to ensure that these goals are met.

¹³² See 42 U.S.C. § 17381 (comparing Title I with Title XII).

¹³³ See *id.* § 17382 (2012) (observing no oversight requirement in Title XII).

¹³⁴ See *id.* §§ 17381-17386.

¹³⁵ See GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 14-19.

¹³⁶ See USDOE, 2014 SMART GRID REPORT, *supra* note 37, at 1 (noting under "Legislative Language" in this 2014 report only EISA of 2007).

¹³⁷ See U.S. GOV'T ACCOUNTABILITY OFF., GAO-11-117, ELECTRICITY GRID MODERNIZATION 12-14 (2011) [hereinafter GAO, ELECTRICITY GRID MODERNIZATION]; see also GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 5-6.

¹³⁸ See GAO, ELECTRICITY GRID MODERNIZATION, *supra* note 137, at 26-28; see also GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 14-18.

¹³⁹ GAO, ELECTRICITY GRID MODERNIZATION, *supra* note 137, at 26-27 ("To the extent that FERC [or any other involved entity] determines it lacks authority to address any gaps in compliance that cannot be addressed through this coordinated approach with other regulators, the Chairman should report this information to Congress.").

¹⁴⁰ See GAO, ELECTRICITY GRID MODERNIZATION, *supra* note 137, at 17-20; see also GAO, CYBERSECURITY CHALLENGES, *supra* note 72, at 14-15.

¹⁴¹ See, e.g., Joseph P. Tomain, Smart Grid Innovation: Policy, Politics and Law 5 (Nov. 25, 2011) (unpublished manuscript), <http://www.crnet.com/2011/d14c.pdf>; Bosch, *supra* note 83, at 1362, 1376-87; Ashira P. Ostrow, *Grid Governance: The Role of a National Network Coordinator*, 35 CARDOZO L. REV. 1993, 2026-30 (2014).

F. Who is In Charge Here?

EISA does not task a single executive agency to take the lead effort to upgrade and modernize the electrical power grid, which might explain why smart grid development has been so lethargic.¹⁴² The text of EISA establishes two commissions,¹⁴³ and involves nearly a half dozen different agencies, including the DOE,¹⁴⁴ DOE's OD,¹⁴⁵ DHS,¹⁴⁶ NIST,¹⁴⁷ and FERC.¹⁴⁸ Adding to the already complicated framework, each agency must complete different assignments, and at some points, they report to the DOE,¹⁴⁹ while at others they act autonomously.¹⁵⁰ This mosaic of agencies and piecemeal delegation has been largely ineffective. Therefore, any viable solution must address this unsuccessful sketch of an organizational hierarchy.

G. Risks Associated with a Piecemeal Electrical Grid

The current electrical grid is a hodgepodge of systems, components, and parts that vary greatly in age—with modern equipment installed alongside equipment first installed in the 1960s.¹⁵¹ Older equipment, while outmoded, is still functional, and thus considered part of the “legacy system.”¹⁵² Elements of the legacy system are being slowly replaced as they break down, become unusable, or scheduled for upgrade.¹⁵³ Meanwhile, other pieces are simply retrofitted, essentially an old piece of equipment with modern technology added on that works to monitor the performance of the legacy component.¹⁵⁴ This method is often pursued because it is cheaper than replacing the entire system, which often bears a significantly higher capital costs.¹⁵⁵

¹⁴² See GAO, *ELECTRICITY GRID MODERNIZATION*, *supra* note 137, at 26-27.

¹⁴³ See generally 42 U.S.C. § 17383 (establishing the Smart Grid Advisory Committee and Smart Grid Task Force).

¹⁴⁴ See generally *id.*

¹⁴⁵ Using the DOE acronym; however, note that the original EISA legislation refers to this office as “OEDER.”

¹⁴⁶ See generally 42 U.S.C. § 17382.

¹⁴⁷ See generally *id.*

¹⁴⁸ See *id.* §§ 17382, 17383(b)(1).

¹⁴⁹ See *id.* § 17384.

¹⁵⁰ See generally *id.* §§ 17382, 17385.

¹⁵¹ See ASCE, *FAILURE TO ACT*, *supra* note 44, at 19; see also CAMPBELL, *SMART GRID & CYBERSECURITY*, *supra* note 14, at 2, 14.

¹⁵² See GUO ET AL., *supra* note 40, at 8-9 (noting that “legacy system” is a term applied to grid system components that are outmoded, but still functional and in place today).

¹⁵³ See CAMPBELL, *SMART GRID & CYBERSECURITY*, *supra* note 14, at 6.

¹⁵⁴ See *id.* at 6.

¹⁵⁵ See *id.*

Part of the delay has been due to the long-lived nature of the capital assets which

These retrofitted or partly-upgraded, half-measures are considered by experts to be both among the weakest points in the system, as well as the point at which equipment failure can occur.¹⁵⁶ Typically, these retrofitted parts can meet capacity and basic functionality demands, but they often fail to meet current cybersecurity standards.¹⁵⁷ These jury-rigged systems are among the weakest links within the system, and ultimately can become a point of entry for hackers or malefactors.¹⁵⁸

H. Grid Integrity Issues

The greatest threat to United States' electrical grid, especially on a wide scale, is arguably infiltration and tampering by a hacker¹⁵⁹—an eventuality that has yet to be satisfactorily addressed or protected against.¹⁶⁰ Infrastructure has been attacked via malicious computer viruses and worms in the recent past—the most infamous of which being the “Stuxnet” attack.¹⁶¹ Stuxnet was released in mid-2009 as a hybrid computer virus and worm that spread via self-replication; its mission was to seek and sabotage specific Iranian computer equipment working on nuclear enrichment.¹⁶² Officially, it is unknown who

make up the industry. The power plants and other expensive components of the grid can function for many productive years if maintenance of the systems is kept up. However, much of the delay in modernization has been due to cost concerns, as many electric utilities seek to manage expenses by delaying replacement of aging systems as long as possible.

Id.

¹⁵⁶ *See id.* at 14 (“Legacy devices and systems...may represent as much of a vulnerability to cybersecurity as new Smart Grid components. They were not designed with cybersecurity in mind, and are often interconnected either via the Internet or by other, sometimes “unsecured” avenues.”).

¹⁵⁷ *See id.* at 6 (“Some legacy grid devices are being retrofitted with communications capabilities to allow them functionality in the smarter grid, or permit easier maintenance, potentially introducing grid vulnerabilities which may not have existed before.”); *see also* NAT'L ELEC. MFRS. ASS'N, POSITION STATEMENT ON CYBER SECURITY 4 (2010), https://www.nema.org/Policy/Energy/Smartgrid/Documents/Cyber_Security_Position_Statement.pdf

¹⁵⁸ CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 14.

¹⁵⁹ *See* ZETTER, COUNTDOWN TO ZERO DAY, *supra* note 15, at 389.

¹⁶⁰ *See id.* at 371.

Just as we had failed in the past to invest in the physical infrastructure of our roads, bridges, and railways, we had failed to invest in the security of our digital infrastructure, [President] Obama said. Cyber intruders, he warned, had already probed our electrical grid, and in other countries had plunged entire cities into darkness.

Id.

¹⁶¹ *See id.* at 387, 389.

¹⁶² *Id.* at 13-17 n.15, 28-31 (“The Siemens software that Stuxnet sought wasn’t just used in industrial plants, it was also used in critical infrastructure systems... Iran was about to open a nuclear reactor at Bushehr, in the south of the country, which had been a source of great tension with Israel and the West for a number of years.”).

unleashed Stuxnet.¹⁶³ Although, it is widely speculated however, that America's National Security Agency and Israel collaborated to release this targeted virus.¹⁶⁴ First discovered in June 2010, Stuxnet remains one of the most complex computer viruses designed to date.¹⁶⁵ Stuxnet utilized rare, previously unknown vulnerabilities in Windows-operating computers and systems, called by experts "backdoors" or "zero days."¹⁶⁶

Some have remarked Stuxnet marks "the first shot across the bow" ushering in the dawn of cyber-warfare,¹⁶⁷ which could have huge ramifications and forever change how war is waged and who ends up impacted.¹⁶⁸ With Stuxnet out in the Internet, the fear is that the basic coding could be reprogrammed and retooled to target an array of infrastructure installations, including oil pipelines and electrical power grids, against any nation.¹⁶⁹ Since Stuxnet, there have been several lesser-known viruses such as "Wiper"¹⁷⁰ and "Flame,"¹⁷¹ which have also targeted Iranian nuclear development as well as its infrastructure.¹⁷² These

¹⁶³ See *id.* at 31-32.

¹⁶⁴ See *id.* at 30-31, 65-66, 247-48, 374.

¹⁶⁵ *Id.* at 3, 5, 26.

¹⁶⁶ *Id.* at 6.

Zero-day exploits, however, aren't ordinary exploits but are the hacking world's most prized possession because they attack holes that are still unknown to the software maker and to the antivirus vendors—which means there are no antivirus signatures yet to detect the exploits and no patches available to fix the holes they attack.

Id.

¹⁶⁷ *Id.* at 3.

¹⁶⁸ *Id.* at 371-72, 377.

Critical infrastructure has always been a potential target in times of war. But civilian infrastructure in the United States has long enjoyed special protection due to the country's geographical distance from adversaries and battlefields. That advantage is lost, however, when the battlefield is cyberspace. In a world of networked computers, every system is potentially a front line. There is "no 'protected zones' or 'rear areas'; all are equally venerable," Gen[eral] Kevin Chilton, commander of the US Strategic Command, told Congress.

Id.

¹⁶⁹ Thomas Ricker, *Stuxnet Source Code Could Open a Pandora's Box of Cyberwarfare*, THE VERGE (Mar. 5, 2012, 6:03 AM), <http://www.theverge.com/2012/3/5/2845848/stuxnet-source-code-opens-a-pandoras-box-of-cyberwarfare>; see also ZETTER, COUNTDOWN TO ZERO DAY, *supra* note 15, at 388.

¹⁷⁰ ZETTER, COUNTDOWN TO ZERO DAY, *supra* note 15, at 276-77 ("[A] virus began running wild on computers at the Iranian Oil Ministry and the Iranian National Oil Company, wiping out the hard drive of every system it touched. The damage was systematic and complete, destroying gigabytes of data at a time...Iranian officials dubbed it 'Wiper'.")

¹⁷¹ *Id.* at 280 ("[Flame] appeared to be a multipurpose espionage tool created to meet every need, depending on the mission...Each component was installed as needed...[from modules that were siphoning documents to one that was capturing keystrokes to another that was surreptitiously activating internal microphones to one that was secretly swiping peripheral devices' data via Bluetooth].")

¹⁷² *Id.* at 30-31 ("The attackers had to be aiming to steal intelligence about critical sys-

forms of cyberattacks are arguably the greatest risk to the American electrical power grid, especially in the foreseeable future.¹⁷³

The physical security of the electrical grid is also immensely important. In the United States, there have been attempts by criminals to knock the electrical grid offline within smaller, localized areas by attacking substations serving a particular region or population.¹⁷⁴ This becomes increasingly worrisome as some reports have stated power could be knocked out nationwide by simply targeting some nine critical locations across the United States.¹⁷⁵ However, if a smart grid system were implemented, troubled areas might be better isolated and the power might be reroute around downed equipment and areas.¹⁷⁶ This would mitigate the impact of power outages and could nearly eliminate the risk of widespread failures.¹⁷⁷

V. A NEW DIRECTION: POLICY RECOMMENDATIONS

A. Active Oversight by the U.S. Congress

Congress needs to address four key issues related to smart grid implementation. First, Congress must draft new legislation regarding the implementation of smart grid development that places the DOE as the commanding and point agency overseeing this project. Second, Congress must continue to appropriate increased levels of funding as well as offer incentives to the utility companies, which would encourage wider and faster adoption of smart grid technologies. This funding would assist with subsidizing energy utility companies and their deployment of smart grid technology by focusing on replacing legacy equip-

tems, perhaps with strategic political importance to the region. The Siemens software that Stuxnet sought wasn't just used in industrial plants, it was also used in critical infrastructure systems.”).

¹⁷³ See *id.* at 389 (“We believe it is only a matter of time before the sort of sophisticated tools developed by well-funded state actors find their way to groups or even individuals who in their zeal make some political statement do not know or do not care able collateral damage they inflict on bystanders and critical infrastructure,” [Former NSA Chief, General Keith B. Alexander] said.”).

¹⁷⁴ Rebecca Smith, *Assault on California Power Station Raises Alarm on Potential for Terrorism*, WALL ST. J., Feb. 5, 2014, at A8 (“The attack was ‘the most significant incident of domestic terrorism involving the grid that has ever occurred’ in the U.S., said Jon Wellinghoff, who was chairman of the Federal Energy Regulatory Commission at the time.”).

¹⁷⁵ See, e.g., *id.*; Davide Savenije & Ethan Howland, *Could Terrorists Really Black Out the Power Grid?*, UTIL. DIVE (March 24, 2014), <http://www.utilitydive.com/news/could-terrorists-really-black-out-the-power-grid/241192/>.

¹⁷⁶ GAO, *ELECTRICITY GRID MODERNIZATION*, *supra* note 137, at 4-6; see also PARFOMAK, *supra* note 13, at 6 (2014); see also GAO, *CYBERSECURITY CHALLENGES*, *supra* note 72, at 4-5.

¹⁷⁷ See GAO, *CYBERSECURITY CHALLENGES*, *supra* note 72, at 4-5.

ment that poses security risks to the grid, as a whole. Congress can also incentivize development by offering low-to-no interest loans to companies purchasing the equipment¹⁷⁸ as well as favorable tax regulations that allow utilities to accelerate the depreciation and writing-off the equipment purchases.¹⁷⁹

Third, Congress must instruct its committees and subcommittees to take on a more active role in oversight and investigations of related issues. Specifically, the House Transportation and Infrastructure Committee¹⁸⁰ and the Senate Committee on the Environment and Public Works¹⁸¹ ought be directed to maintain frequent oversight over smart grid implantation and make recommendations to Congress regarding any need for additional legislation that might help to foster this program. Further, these committees should seek the input of leading energy and technology experts, utility companies, consumers, and business owners to ensure this endeavor meets the vast majority of people's needs. The goal of Congress's involvement would be to ensure a smooth and effective transition towards a more reliable grid, while making reflective adjustments along the way, as needed.

Fourth, Congress should place a sunset provision in any additional smart grid legislation passed, which would require renewed legislation after four years. Such a provision would ensure that Congress, as a whole, could maintain active and more effective oversight regarding the rollout smart grid deployment and it forces Congress to address the issue of smart grid technology and its deployment more regularly. Such a measure would be beneficial over the next several years and could be phased out as substantial advancement is achieved. Lastly, this might prevent Congress from ignoring this issue for another decade, without addressing key issues and changes in progress.

¹⁷⁸ Cf. Cyndia Zwahlen, *Expansion of Utilities' Loan Program is Urged*, L.A. TIMES, (May 5, 2008), <http://articles.latimes.com/2008/may/05/business/fi-smallbiz5> ("California regulators want to expand a pilot program under which utilities offer interest-free loans to small businesses that want to buy energy-efficient gear.").

¹⁷⁹ See generally Ashlea Ebeling, *Depreciation Tax Extenders Big Bonus for Business Owners*, FORBES, (Dec. 18, 2014, 9:05 AM), <http://www.forbes.com/sites/ashleaebeling/2014/12/18/depreciation-tax-extenders-big-bonus-for-business-owners> (noting that President Obama signed tax extender legislation in order to continue "bonus depreciation" for businesses).

¹⁸⁰ See generally *History*, H. TRANSP. & INFRASTRUCTURE COMM., <http://transportation.house.gov/about/history.htm> (last visited Oct. 24, 2015) (highlighting the committee's history and oversight).

¹⁸¹ See generally *History and Recent Membership of the Committee on Environment and Public Works*, U.S. SEN. COMM. ON ENV'T & PUB. WORKS, <http://www.epw.senate.gov/public/index.cfm/committee-history-and-membership> (last visited Oct. 24, 2015) (highlighting the committee's history and oversight).

B. Actively Encouraging the Implementation of Smart Grid Technology

Generally, it is appropriate for Congress to establish the broad public policy and allow for the related agencies to implement the logistics as they see fit.¹⁸² However, with smart grids it might be wise to establish more specific goals. Congress therefore should set a firm deadline, by which a smart grid system will be substantially in place throughout the United States by the year 2030.¹⁸³ This would reaffirm Congress's commitment to this program and firmly establish a timeline for implementation, especially since Congress has done this several times before.¹⁸⁴ In EISA, it was required that incandescent light bulbs begin to be phased out starting in 2012;¹⁸⁵ the law also dictated that vehicle fuel economy for automakers in the United States to achieve fleet-wide average of 35.5 miles per gallon highway before 2016.¹⁸⁶ While this might be perceived as a mere paper victory, stating a goal would serve as a resounding statement that Congress thinks our energy sector is a priority and will help to ensure a platform for its remedy.

¹⁸² OFF. OF THE FED. REG., A GUIDE TO THE RULEMAKING PROCESS 2 (2011), https://www.federalregister.gov/uploads/2011/01/the_rulemaking_process.pdf.

Agencies get their authority to issue regulations from laws (statutes) enacted by Congress. In some cases, the President may delegate existing Presidential authority to an agency. Typically, when Congress passes a law to create an agency, it grants that agency general authority to regulate certain activities within our society. Congress may also pass a law that more specifically directs an agency to solve a particular problem or accomplish a certain goal.

Id.

¹⁸³ The term "substantially in place" is admittedly vague. This Comment hesitates to strictly define what level actually meets this threshold. Nevertheless, once a threshold is established, there are several ways this could be measures or evaluated: percentage of total population on smart grid technologies, percentage of overall miles of power lines, or ratio of new equipment installed and in use compared to remaining legacy equipment. It should be feasible to modernize at least 80% of the system over a 15-year period with aggressive, prioritized funding.

¹⁸⁴ See generally Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism Act of 2001, Pub. L. No. 107-56, 115 Stat. 272 (2001); see also generally Energy Independence and Security Act of 2007, 49 U.S.C. §§ 17001 et. seq.

¹⁸⁵ Patrick J. Kiger, *U.S. Phase-Out of Incandescent Light bulbs continues in 2014 with 40-, 60-Watt Varieties*, NAT'L GEO. (Dec. 31, 2013), <http://energyblog.nationalgeographic.com/2013/12/31/u-s-phase-out-of-incandescent-light-bulbs-continues-in-2014-with-40-60-watt-varieties>.

¹⁸⁶ See JOSEPH DOOLEY, PEW CHARITABLE TRUSTS, DRIVING TO 54.5 MPG: A HISTORY OF FUEL EFFICIENCY IN THE UNITED STATES 3 (2012), <http://www.pewtrusts.org/~media/Assets/2014/06/02/FactSheet-Graphic-Fuel-Efficiency-Timeline-FINALSept-2012.pdf>.

C. Command & Supervision by the U.S. Department of Energy

The original congressional intent of EISA alluded that DOE ought to be in command of the several tasks related to this project.¹⁸⁷ With DOE as the point agency, it would be in charge of overseeing and coordinating tasks for developing a better electrical grid, while still delegating various tasks and efforts out to specialty agencies.¹⁸⁸ Such a simple restructuring could provide a clearer organizational layout, while offering a better command-and-control management to encourage evolvement towards a resilient smart grid system.¹⁸⁹

Since DOE is a large government agency, it should specifically assign and refocus its OD to handle all federal smart grid efforts and projects. OD should house the two collaborative taskforces created by EISA, “The Smart Grid Advisory Committee” and “The Smart Grid Task Force.” These restructured organizations within OD would ensure that DOE has effective management over the various other agencies involved, such as NIST, DHS, FERC, and other collaborative entities apart of either group. In this role, DOE, through OD, should have the authority to override any other agency in the event of conflicts related to smart grid issues. Similarly, the DOE needs to also have the capacity to make judgments when handling potentially conflicting recommendations. With this reestablished hierarchy, the DOE will be able to prioritize and manage smart grid modernization projects, while still seeking the expertise of other collaborative agencies.

D. Hierarchy of Command

Other than making the DOE the point agency, the remaining roles of subordinate agencies should largely remain the same. NIST would be in charge of

¹⁸⁷ See 42 U.S.C. §§ 17382-17386 (stating the Secretary and Advisory committees’ responsibilities and mission in implementing the program).

¹⁸⁸ See *Mission*, U.S. DEP’T OF ENERGY, <http://energy.gov/mission> (last visited Apr. 10, 2015) (quoting the DOE’s mission, which presents an informal goal as to “[e]stablish an operational and adaptable framework that combines the best wisdom of all Department stakeholders to maximize mission success.”).

¹⁸⁹ See IAN BUCHANAN ET AL., BOOZ ALLEN HAMILTON, MANAGEMENT SPANS AND LAYERS: STREAMLINING THE OUT-OF-SHAPE ORGANIZATION 3 (2003), <http://www.boozallen.com/media/file/missiondna-management-spans-and-layers.pdf>.

In an environment of ever-escalating efficiency, effectiveness, and performance requirements, public sector organizations need to be fit and flexible to prosper. Too many, however, are burdened with a cumbersome organizational structure. Developing a flattering and more streamlined profile is not only a key to driving greater efficiency in the short term but also an invitation to enhancing mission effectiveness over the longer haul.

Id.

establishing related measurements and standardizations needed for effective operation of a smart grid. NIST ought to prioritize working on interoperability standards, as it would establish a uniform language to allow various parts of the grid to effectively communicate to each other.¹⁹⁰ FERC would work with the several states as well as energy and utility companies in implementing effective, binding regulations.¹⁹¹ Meanwhile, DHS should remain tasked with the duty to ensure physical security as well as the cybersecurity of the grid.¹⁹² Outsourcing highly specialized and technical jobs to agencies that have expertise is proper and helps to ensure more effective outcomes and ought to yield much better results.

VI. OUTLOOK

A. The Economics of Smart Grid Technology & Energy Redevelopment

The economics of implementing smart grid technology are extremely impressive, all around. Most infrastructure development is marked by high up-front capital costs.¹⁹³ Electrical power components, power plants, substations, and power lines are no exception.¹⁹⁴ Legislation like the Recovery Act has helped to make some initial strides in electricity reinvestment and development efforts, but much more is still needed.¹⁹⁵ Recent total spending levels by inves-

¹⁹⁰ See generally Bosch, *supra* note 83, at 1377 (“While all interoperability standards remain voluntary, utilities will continue to pick and choose what standards to abide by, often opting for minimum security to save money.”).

¹⁹¹ See *id.* at 1378-79.

¹⁹² See Critical Infrastructure Security and Resilience, *supra* note 91.

¹⁹³ See generally Tracy Gordon & David Schleicher, *High Costs May Explain Crumbling Support for U.S. Infrastructure*, REAL CLEAR POL’Y (Mar. 31, 2015), http://www.realclearpolicy.com/blog/2015/03/31/high_costs_may_explain_crumbling_support_for_us_infrastructure_1249.html (“Put bluntly: the costs of U.S. infrastructure are too damn high.”).

¹⁹⁴ See *Electricity Transmission*, INST. FOR ENERGY RES. (Sept. 2, 2014), <http://instituteforenergyresearch.org/electricity-transmission>.

Although transmission represents a small portion of the overall cost of electricity, building and expanding the electricity transmission infrastructure is expensive. The transmission system’s size and complexity are significant barriers to entry for new companies, owing to the massive initial capital investment needed to transmit power. Transmission projects cost hundreds of millions of dollars and require long lead times and many right-of-way easements.

Id.

¹⁹⁵ See ASCE, 2013 REPORT CARD, *supra* note 7, at 62-63.

For example, as part of the American Reinvestment and Recovery Act, the United States invested more than \$4.5 billion for electricity delivery and energy reliability modernization. These funds were matched by more than \$5.5 billion from local agencies and the private sector to fund smart grid and energy storage technologies across the country, with additional funding going toward workforce training.

tor-owned entities on the electrical power grid averaged about \$25.5 billion per year, excluding the cost of building power generation facilities;¹⁹⁶ transmission lines alone cost, on average, between \$10 and \$17 billion annually.¹⁹⁷ Furthermore, cybersecurity for smart grid technology in North America between 2010 and 2015 was projected to cost approximately \$1.5 billion, a number that is projected to increase much higher in the years ahead.¹⁹⁸

Transition to a smart grid would be able to better adapt and meet the needs of a modern America. The Electric Power Research Institute (“EPRI”) estimates an additional \$17 and \$24 billion will be needed annually over the next two decades to bring a smart grid system to flourishing.¹⁹⁹ The total net investment is projected to run somewhere between \$338 billion and \$476 billion.²⁰⁰ The transmission lines segment of the electrical power grid is forecasted to cost approximately \$56 billion to \$64 billion alone, according to EPRI.²⁰¹ Cybersecurity costs are projected to cost approximately 15% of total costs of upgrading the system.²⁰² While these numbers are considerably high, the likely return on investment is even more awe-inspiring.

Some have called this endeavor as the program that “cost billions, but saves trillions.”²⁰³ While monumental costs as high as \$476 billion are nothing to

Id.

¹⁹⁶ USDOE, 2014 SMART GRID REPORT, *supra* note 37, at 2-3 (“[T]otal capital investments by investor-owned utilities (in 2012 dollars) in electricity delivery systems averaged \$8.5 billion annually for transmission system upgrades and \$17 billion annually for distribution system upgrades from 2003–2012.”).

¹⁹⁷ See generally U.S. DEP’T OF ENERGY, LARGE POWER TRANSFORMERS AND THE U.S. ELECTRIC GRID 18-19 FIG.10 (2012), http://energy.gov/sites/prod/files/Large%20Power%20Transformer%20Study%20-%20June%202012_0.pdf (noting that historical costs have varied across years, between \$10 and \$14 billion, and costs are forecast to increase in the near future); see also USDOE, 2014 SMART GRID REPORT, *supra* note 37, at 2-3 (estimating an average of \$17 billion per year).

¹⁹⁸ CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 16.

¹⁹⁹ EPRI, ESTIMATING COSTS, *supra* note 70, at 1-4.

Over and above the investment to meet electric load growth, Table 1-1 shows that the estimated net investment needed to realize the envisioned power delivery system (PDS) of the future is between \$338 and \$476 billion... This indicates an investment level of between \$17 and \$24 billion per year will be required over the next 20 years.

Id.

²⁰⁰ *Id.*

²⁰¹ *Id.* at 5-1 (“The cost includes several categories of technology whose functionality overlaps significantly between the transmission system and substations as well as some elements of the distribution system described later, as well as enterprise level functions, such as cyber security and back office systems.”).

²⁰² CAMPBELL, SMART GRID & CYBERSECURITY, *supra* note 14, at 16.

²⁰³ See, e.g., Scott DiSavino & Alden Bentley, *U.S. Smart Grid to Cost Billions, Save Trillions*, REUTERS, (May 24, 2011, 4:54 PM), <http://www.reuters.com/article/2011/05/24/us-utilities-smartgrid-epri-idUSTRE74N7O420110524>; EPRI, ESTIMATING COSTS, *supra* note 70, at 1-4; Peter Behr,

scoff at, the estimated return on investment is much greater—up to nearly five-times greater, overall. EPRI estimates that America could reasonably expect to see a “consumer benefit” of \$1.294 trillion upwards to \$2.028 trillion, over a 20-year period with additional benefit and value for decades to follow.²⁰⁴ Even if the conservative estimates ring true, that is still more than a \$2 return in value for each and every dollar spent, which would have an excellent impact nationwide.

The smart grid transition will be a major stimulus program, both building the value of the nation as well as the associated economic spending. The Recovery Act included provisions to infuse stimulus money to modernize various grid projects.²⁰⁵ As an element of the stimulus funding, the U.S. Government spent approximately \$4.5 billion in “electricity delivery and energy reliability modernization,” which was matched by \$5.5 billion which was contributed from local agencies and the private sector;²⁰⁶ these matching funds went towards implementing some smart grid and energy storage technologies, with additional funding allocated for workforce training.²⁰⁷

Implementing President Obama’s Policy Directive No. 21, as well as the specifics outlined in EISA, would be felt throughout the nation’s economy and could cause an industry boom. Many companies would be needed for software development, equipment and component manufacturing, delivery, installation, and maintenance of these new technologies.²⁰⁸ Currently, huge multinational companies like General Electric, Microsoft, Google, and Siemens are already beginning to vie to be a part of this revolution.²⁰⁹ Furthermore, new and experienced workers alike will need to be trained on these new technologies;²¹⁰ esti-

Smart Grid Costs Are Massive, but Benefits Will Be Larger, Industry Study Says, N.Y. TIMES (May 25, 2011), <http://www.nytimes.com/cwire/2011/05/25/25climatewire-smart-grid-costs-are-massive-but-benefits-wi-48403.html?pagewanted=all>.

²⁰⁴ See EPRI, ESTIMATING COSTS, *supra* note 70, at 4-1-4-10.

EPRI undertook a study to estimate the cost and value (benefits) of the power delivery system of the future. To do so, it developed a flexible framework...[, which] involved the identification of *attributes* of the power system (e.g., cost of energy, capacity, security, quality, reliability, environment, safety, quality of life, and productivity). EPRI then developed the framework to quantitatively estimate the dollar value of improving each of these attributes by a defined amount (i.e., percentage improvement)...[T]he total benefit of all attributes for the Smart Grid is estimated to be between \$1,294 billion and \$2,028 billion for the period 2010 to 2030. EPRI believes that once all of the attributes and benefits of a Smart Grid are identified and analyzed, estimates of the total benefit will increase even more.

Id.

²⁰⁵ See ASCE, 2013 REPORT CARD, *supra* note 7, at 63.

²⁰⁶ *Id.*

²⁰⁷ *Id.*

²⁰⁸ DiSavino & Bentley, *supra* note 203.

²⁰⁹ *Id.*

²¹⁰ EPRI, ESTIMATING COSTS, *supra* note 70, at 2-10.

mates state smart grid initiatives could create over 210,000 jobs nationwide just for utility worker jobs to run and install power lines.²¹¹

Lastly, there is another secondary mission of smart grid implementation—reassert America’s global economic competitiveness. With renewed electrical systems, America would be able to excel again on a global scale. Modern businesses demand an environment where utilities are advanced and can provide clean, uninterrupted service to commercial and industrial consumers.²¹² With the addition of reliable smart grid technology, America can rise once again in various global economy competitiveness rankings and be used as a selling point as to why a company should establish their businesses here in the United States.²¹³ The American economy can regain lost productivity and grow the nation’s gross domestic product (“GDP”) just by becoming more efficient.

B. Potential Issues & How to Minimize Their Impact

1. *Too Broad and Mission Creep*

Since the start of the 114th Congress, there have already been at least four bills introduced relating to smart grid technology and energy infrastructure redevelopment.²¹⁴ However, these bills in their current form will not be suc-

The utility work force is undergoing a significant challenge. One-half of the [current] 500,000 to 600,000 utility workers will be eligible to retire in the next five years. They need to be replaced with a trained and motivated work force. Introducing Smart Grid technologies requires employees with different skills to support the implementation, maintenance, and operation of the systems with digital components.

Id.

²¹¹ William Herkewitz, *What It Will Take to Build a Real Smart Grid*, POPULAR MECH. (July 11, 2013), <http://www.popularmechanics.com/technology/infrastructure/a9173/what-it-will-take-to-build-a-real-smart-grid-15683905/>. (statement of Professor Massoud Amin) (“We can create jobs in this area [—] very high-paying jobs. Just to integrate distributed resources such as wind power, we need to add about 42,000 miles of high-voltage line, and that would create over 210,000 jobs.”); *see generally* Marcacci, *supra* note 89 (noting that smart grid initiatives have already created 33,000 jobs).

²¹² EPRI, ESTIMATING COSTS, *supra* note 70, at 2-3; *see also* NAT’L ASS’N OF MFRS., INFRASTRUCTURE: ESSENTIAL TO MANUFACTURING COMPETITIVENESS 3 (2013), <http://www.nam.org/Data-and-Reports/NAM-BAF-Infrastructure-Survey/NAM-BAF-Infrastructure-Survey.pdf>. (“A major investment in infrastructure—specifically, road, rail, seaports and energy—is needed and could help build, rebuild or strengthen American manufacturers’ competitive advantage over foreign competition.”).

²¹³ *Hearing*, *supra* note 18, at 1 (statement of Edward G. Rendell, former Governor of Pennsylvania) (“Together, we represent a diverse and bipartisan coalition of state and local officials working to advance infrastructure investment to promote economic growth, global competitiveness and better quality of life for all Americans.”).

²¹⁴ *See, e.g.*, Terrorism Prevention and Critical Infrastructure Protection Act of 2015, H.R. 85, 114th Cong. (2015); Infrastructure Jobs and Energy Independence Act, H.R. 1663,

successful in achieving the goals advocated by this Comment because they are too broad and open the possibility of mission creep, which occurs when a campaign is not carefully limited and slowly shifts or expands its scope outward.²¹⁵ To achieve effective change, any legislation considered must focus on the narrow issue of smart grid deployment and its funding. It might be advisable to breakdown reinvestment by stage, beginning with transmission and distribution lines and then turn to building new power plants or the rollout of smart meters.

2. Institutional Resistance

Energy companies, utilities, and grid operators might be resistant to the government trying to get involved. These entities likely see the government as intrusive, burdensome, or even the start down a road filled with many new arduous regulations.²¹⁶ However, energy companies ought to be open to this form of government involvement because the smart grid will benefit both the nation as well as the energy companies. Smart grid technology could ultimately mean that providers can charge more money for the energy delivered, but produce less power, reducing overall wasted energy and lowering maintenance costs.²¹⁷ While consumers will not be thrilled to learn that they will have to pay more for electricity—nearly double by 2050—the smart grid is cheaper than the alternative.²¹⁸ If the current system endures without modernization, electricity prices are expected to increase six-fold by 2050.²¹⁹ Ultimately, it becomes a win-win situation with the deployment of smart grid systems for consumers and providers alike.

3. Who Foots the Bill?

Who pays the bill? The answer: the American people will ultimately bankroll this project. The real question is: “How?” The first option is regulating and requiring energy companies to make various changes on their own, while meeting stringent government standards. In pursuing this first option, Americans will face steeply increasing electricity bills from the onset. The second

114th Cong. (2015); Smart Grid Act of 2015, S. 1232, 114th Cong. (2015); Enhanced Grid Security Act of 2015, S. 1241, 114th Cong. (2015).

²¹⁵ See generally Davis & Hodgdon Assoc. CPA, *Nonprofit Mission Creep: How to Avoid it*, VT TAX BLOG, <http://www.dh-cpa.com/nonprofit-mission-creep-how-to-avoid-it.html> (last visited Oct. 12, 2015).

²¹⁶ Davide Savenije, *FirstEnergy CEO: ‘Government Interference’ Disrupting the Electricity Business*, UTIL. DIVE (Apr. 9, 2014), <http://www.utilitydive.com/news/firstenergy-ceo-government-interference-disrupting-the-electricity-busin/249158>.

²¹⁷ DiSavino & Bentley, *supra* note 203.

²¹⁸ *Id.*

²¹⁹ *Id.*

option is that government carries the costs of modernization; however, this would result in higher taxes or increased deficit spending to support this endeavor. A third option would be a hybrid approach, which is largely what has been followed since the enactment of the Recovery Act and its stimulus spending since 2009.

Realistically, a hybrid approach is probably the best scenario for rolling out the smart grid fairly quickly. The DOE and its entities distribute funding through grants and various public works projects.²²⁰ This has been effective in injecting money to cover the costs of upgrading systems, but at current spending levels it would take decades to complete a total overhaul of the current grid system.²²¹ Much too slow and improvement might be outpaced and overwhelmed by forecasted for increased demand over the next decade.²²² Therefore, if America continues to use this hybrid option, they would be advised to both increase government spending on this program, while strongly encouraging the utilities to do the same to meet a 2030 deadline.

C. The Current Sociopolitical Climate: Ripe for Readdressing

America wants infrastructure investment and redevelopment. Energy and grid development is frequently cited as important for continued investment and improvement.²²³ Businesses cite infrastructure reliability as a key consideration in choosing where a business should be established, expanded, and operated in a given locale.²²⁴ Businesses and the United States Chamber of Commerce have petitioned America, Congress, and the White House to move towards a smart grid as well as investment in infrastructure generally.²²⁵ Even labor unions have joined the same side as business owners—in a rare partnership—declaring that infrastructure development would create good jobs and strengthen the job market for workers.²²⁶ Citizens have also become aware of America's weakening

²²⁰ Marcacci, *supra* note 89.

²²¹ EPRI, ESTIMATING COSTS, *supra* note 70, at 1-4.

²²² ASCE, 2013 REPORT CARD, *supra* note 7, at 61.

²²³ Michael J. Sullivan, *How to Estimate the Value of Service Reliability Improvements 1* (Lawrence Berkeley Nat'l Lab., Paper No. LBNL-3529E, 2010), <http://escholarship.org/uc/item/8gz990pz>.

²²⁴ Michael E. Porter, *The Competitive Advantage of Nations*, HARV. BUS. REV., Mar.-Apr. 1990, at 79 ("According to standard economic theory, factors of production—labor, land, natural resources, capital, infrastructure—will determine the flow of trade. A nation will export those goods that make most use of the factors with which it is relatively well endowed.").

²²⁵ *Our Position*, U.S. CHAMBER OF COMMERCE, <https://www.uschamber.com/infrastructure/position> (last visited Oct. 12, 2015).

²²⁶ See Richard Trumka, AFL-CIO President, Remarks at the United Nations Investor Summit on Climate Risk (Jan. 12, 2012), <http://www.aflcio.org/Press->

energy grid, as it has risen among American's top issues of concern.²²⁷ Americans are becoming increasingly frustrated with electrical outages—from both short and intermittent to prolonged outages.²²⁸

Smart grid and energy investment can be a bipartisan political issue and can be presented as a “purple issue,” where Republican and Democrats should be able to find a solid middle ground.²²⁹ Several Democrats²³⁰ have called for various energy grid reforms, as have many Republicans.²³¹ Within the recently installed 114th Congress, many polarizing and contentious issues have been ruled out due to the high tensions and a divided government.²³² Nevertheless,

Room/Speeches/Remarks-by-AFL-CIO-President-Richard-Trumka-UN-Investor-Summit-on-Climate-Risk.

²²⁷ See generally *Smart Grid*, EDISON ELEC. INST., <http://smartgrid.eei.org/Pages/EEI.aspx> (last visited on Aug. 20, 2015) (“80% of Americans surveyed believe it should be a priority for local, state, and federal governments—along with electricity providers—to begin implementing smart grid technology over the next one to five years.”).

²²⁸ *Consumers desire a reliable grid*, SMARTGRID CONSUMER COLLAB. (May 7, 2012, 11:04 AM), <http://smartgridcc.org/news-events/consumers-desire-a-reliable-grid>.

When asked why they considered this benefit important, one consumer said ‘without upgrading to new technology my service is only going to get worse.’ Another stated, ‘outages are going to be much more frequent and longer and I’m already put out and inconvenienced enough.’ These consumers told us stories about the dates and length of time that their power was out. Their recollections conveyed strong emotions — frustration surrounding the uncertainty of service restoration, discomfort with sitting in the dark for hours, if not days and finally, a sense of real relief when the power was restored.

Id.

²²⁹ See generally Deirdre Walsh & Ted Barrett, *GOP agenda for Congress: Challenge Obama, prove they can govern*, CNN (Jan. 6, 2015, 11:05 AM), <http://www.cnn.com/2015/01/05/politics/gop-agenda-for-the-new-congress/> (statement of Senator Mitch McConnell) (“[w]hen the American people elect divided government, they’re not saying they don’t want anything done’ . . . [w]hat they’re saying is they want things done in the political center, things that both sides can agree on.”).

²³⁰ See, e.g., President Barack Obama, State of the Union Address (Jan. 20, 2015), (transcript available at <https://www.whitehouse.gov/the-press-office/2015/01/20/remarks-president-state-union-address-january-20-2015>); *Klobuchar Hosts Meeting on Improving Our Transportation Infrastructure*, S. DEM. STEERING & OUTREACH COMM. (Jan. 28, 2015), <http://www.dsoc.senate.gov/2015/01/28/klobuchar-hosts-meeting-on-improving-our-transportation-infrastructure/> (quoting Senator Amy Klobuchar); Press Release, Representative Peter DeFazio, Rep. DeFazio Elected Top Democrat on House Transp. & Infrastructure Comm. (Nov. 19, 2014), <http://defazio.house.gov/media-center/press-releases/rep-defazio-elected-top-democrat-on-house-transportation-infrastructure>.

²³¹ See, e.g., Infrastructure Jobs and Energy Independence Act, H.R. 1663, 114th Cong. (1st Sess., 2015) (stating that the bill was sponsored by the following Republican Congressmen: Tim Murphy, Mike Kelly, David McKinley, and Gregg Harper); Walsh & Barrett, *supra* note 229.

²³² See generally Walsh & Barrett, *supra* note 229 (statement of Representative Steny Hoyer) (“If we didn’t have the President, we’d be shuttered off to the side—we don’t care what you think.”).

infrastructure redevelopment and related policies can realistically bridge this divide.²³³ Redevelopment would improve the quality of American Life, while stimulating a sputtering economy and creating new jobs.²³⁴ Infrastructure is not a wasted expenditure; rather, it is an investment in America's future.²³⁵ Since elements, *inter alia* distribution power lines, power plants, seaports, and roadways, are used every day and can endure decades into the future, they offer great long-term benefits to their communities and the nation as a whole.²³⁶

D. A Model for the Future

Successful transition and implementation of smart grid technology could become a model for other developmental endeavors. There are several elements of America's infrastructure in need of critical repairs.²³⁷ Many of America's water pipes have frequently seen a century of use.²³⁸ Meanwhile, the nation's seaports and airports are showing their age and capacity issues.²³⁹ Roads, highways, and bridges, too, are in a poor state; many bridges are far-exceeding design capacity and are now "structurally deficient."²⁴⁰ In ASCE's *2013 Report Card for American Infrastructure*, America received an overall grade of "D+."²⁴¹ Nevertheless, if this Comment's recommendations are ultimately

²³³ ASCE, 2013 REPORT CARD, *supra* note 7, at 3 ("Our infrastructure is the foundation of our economy and our quality of life, and repairing and modernizing it has exponential benefits, including: increasing our gross domestic product, growing household income, protecting jobs, and maintaining a strong U.S. position in international markets.").

²³⁴ *Id.*

²³⁵ Sylvain Leduc & Daniel Wilson, *Highway Grants: Roads to Prosperity?*, FRBSF ECON. LETTER, no. 2012-35, Nov. 26, 2012, at 1-4, <http://www.frbsf.org/economic-research/files/el2012-35.pdf>.

²³⁶ *Hearing*, *supra* note 18, at 7 (statement of Edward G. Rendell, former Governor of Pennsylvania) ("Infrastructure is an economic driver and has the added benefit of creating long-term quality jobs. It improves the quality of our lives and it enhances our economic competitiveness.").

²³⁷ See ASCE, 2013 REPORT CARD, *supra* note 7, at 3.

²³⁸ *Id.* at 17-18 ("Even though pipes and mains are frequently more than 100 years old and in need of replacement, outbreaks of disease attributable to drinking water are rare...Some pipes date back to the Civil War and often are not examined until there is a problem or a water main break.").

²³⁹ See *id.* at 7, 32, 41-42 (noting that our ports need to be "maintained, modernized, and expanded," given airport congestion is a growing problem that causes the mishandling and mismanagement of transitioning cargo).

²⁴⁰ See *Structurally Deficient Bridges*, AM. ROAD & TRANSP. BUILDERS ASS'N, <http://www.artba.org/economics/us-deficient-bridges> (last visited Aug. 21, 2015) ("There are over 215 million daily crossings on 61,064 U.S. structurally deficient bridges in need of repair.").

²⁴¹ ASCE, 2013 REPORT CARD, *supra* note 7, at 4.

While the modest progress is encouraging, it is clear that we have a significant back-

adopted, perhaps smart grid and energy investment could serve as a rudimentary model for additional infrastructure revitalization projects.

VII. CONCLUSION

If the United States of America pursues a serious reinvestment plan, then smart grid has the potential to be the largest undertaking in public works initiative since the creation of President Dwight D. Eisenhower's Interstate Highway System,²⁴² and has the potential to improve the economy like President Franklin Delano Roosevelt's Works Progress Administration²⁴³ during the Great Depression. While the costs could be undeniably high, the costs of America doing nothing would be even higher.²⁴⁴ According to estimates from multiple sources, energy grid developments are projected to more than pay for itself.²⁴⁵ Dubbed as the program that "costs billions and saves trillions,"²⁴⁶ the real question is can America afford to forgo this endeavor? America cannot continue to mortgage its future and neglect our nation's energy grid, especially if it hopes to remain a leading world power. A leading, industrial nation cannot have the floundering infrastructure of a developing country.

There is too much at stake, which impacts our economy, convenience, life, and safety. The current grid is susceptible to attack on several fronts, from acts of nature to decades-old equipment failing to malicious computer hackers, both at home and abroad. While blackouts and service disruptions cannot be completely eliminated, such events can be isolated, minimized, and possibly prevented with a reactive smart grid system. This issue is ripe for readdressing in this current sociopolitical climate as an issue, which can easily be presented and adopted as a nonpartisan issue that helps America to help itself. A 21st century America must not rely on a power grid largely unchanged from that of the 19th century. America, let's get smart and work together towards investing in America's infrastructure. We owe it to ourselves and future generations.

log of overdue maintenance across our infrastructure systems, a pressing need for modernization, and an immense opportunity to create reliable, long-term funding sources to avoid wiping out our recent gains. Overall, most grades fell below a C, and our cumulative GPA inched up just slightly to a D+ from a D four years ago.

Id.

²⁴² Al Neuharth, *Traveling Interstates Is Our Sixth Freedom*, USA TODAY (June 22, 2006, 8:58 PM), http://usatoday30.usatoday.com/news/opinion/columnist/neuharth/2006-06-22-interstates_x.htm.

²⁴³ Dave Demerjian, *Note to Next President: Modern-Day WPA Will Save the Economy*, WIRED (Oct. 19, 2008, 3:00 PM), <http://www.wired.com/2008/10/wall-street-bai/>.

²⁴⁴ DiSavino & Bentley, *supra* note 203.

²⁴⁵ *See id.*; Behr, *supra* note 203; *see also generally* EPRI, ESTIMATING COSTS, *supra* note 70, at 1-4, tbl. 1-1 (estimating a benefit-to-cost ratio between 2.8 and 6.0).

²⁴⁶ DiSavino & Bentley, *supra* note 203.