Testimony of Thomas Popik, Chairman of the Foundation for Resilient Societies, before the Joint Standing Committee on Energy, Utilities and Technology of the Maine State Legislature Regarding LD 1363 on May 20, 2015

Good afternoon members of the committee, my name is Thomas Popik and I am chairman of the Foundation for Resilient Societies, a nonprofit group dedicated to protection of critical infrastructure from both natural and man-made disasters. Every day, the citizens of Maine and the citizens of all of the United States are exposed to existential threats caused by inadequate protection of critical infrastructure, especially the electric grid; these threats include physical attack, cyber-attack, severe geomagnetic solar storms, and high-altitude electromagnetic pulse. Fortunately, existing state and federal law allows the Maine State Legislature to protect its electric grid and, by extension, the safety of its citizens.

Background on Resilient Societies

Resilient Societies regularly participates in standard-setting for electric reliability at the North American Electric Reliability Corporation (NERC) and federal rulemaking at the Federal Energy Regulatory Commission (FERC). In fact, for some important standard-settings and rulemakings, we are the only public interest group participating. As a 501 (c) 3 organization under the IRS Code, Resilient Societies does not lobby for or against any specific legislation.

For the past four years, Resilient Societies has attended numerous meetings at both NERC and FERC and made dozens of standard-setting comments and docket filings. The work of our group is well-known to the senior executives of both organizations.

Since winter of 2013, this is my sixth trip to Maine to testify before your committee or participate in the electromagnetic pulse/geomagnetic disturbance working group at Central Maine Power (CMP). Our group is well familiar with the special threats that the Maine electric grid faces.

The FERC/NERC System Is Broken and Does Not Assure Reliability of the Maine Electric Grid

I appear before you today to report, based on direct and personal experience, that the current FERC/NERC system of electric grid reliability standard-setting and enforcement will not effectively prevent wide-area, long-term electric grid outages for Maine and their catastrophic social and economic consequences. The present dysfunctional system provides liability protection for electric utilities but does not protect the public interest. Utilities minimize costs, but the risk of blackout is placed upon the public.

A Near-Miss in California Shows How Special Interests Game the FERC/NERC System

On April 16, 2013 unknown parties attacked the Metcalf substation in San Jose, California, a critical electric grid facility providing power to Silicon Valley and the city of San Francisco. These attackers shot out 17 of 21 extra high-voltage transformers, nearly causing a catastrophic blackout for the region. While insiders in the electric utility industry quickly understood the

gravity and implications of this attack, media attention at the time was scant, partially because of the distraction of the Boston Marathon bombing which had occurred just 13 hours before.

On May 8th and 9th, 2013, just three weeks after the Metcalf substation attack, Resilient Societies representatives attended a public meeting of the North American Electric Reliability Corporation. During a public comment opportunity, I proposed a national database of extra high-voltage transformers and their design characteristics that would allow faster repair and replacement during emergencies. The meeting chair abruptly cut me off before I could finish making my statement.

The next day our attorney and I attended a meeting of a key NERC committee. During this meeting, notably attended by senior officials of FERC, the NERC committee members voted unanimously to terminate a project to develop physical security standards for grid substations and other critical facilities. This action was later ratified by the NERC Board of Trustees.

On May 5, 2013, just days before the termination of the physical security project at NERC, the Chairman of FERC, Jon Wellinghoff, had announced his resignation to President Obama. The reasons for Mr. Wellinghoff's unexpected resignation have not been publicly disclosed.

In February and March 2014, front page stories in the *Wall Street Journal* disclosed the national importance of the Metcalf substation attack. Truly, this attack was a wake-up call. One of the key sources for these stories was none other than the prior FERC Chairman, Mr. Wellinghoff. According to an engineering analysis performed by FERC and leaked to the *Wall Street Journal*, a coordinated attack on just nine grid substations could bring down the U.S. electric grid for over a year.

Only after public scrutiny and intervention by the U.S. Congress did FERC order NERC to reinitiate a physical security standard in March 2014. NERC set a physical security standard in April 2014 and this action was ratified by the NERC Board of Trustees in May. On November 12, 2014 the FERC Commissioners approved the NERC physical security standard as being "in the public interest."[1]

The NERC standard for physical security places no requirements on so-called Reliability Coordinators, the highest level of electric grid operational supervisors. According to a joint U.S. Canada task force formed in the aftermath of the 2003 Northeast Blackout affecting 50 million people, lack of reliability coordination was a prime cause of this blackout. Under the NERC system of standards, Reliability Coordinators have sole responsibility for system restoration coordination after a wide-area blackout. Therefore, if an attack were to cause a cascading outage and also disable control centers for Reliability Coordinators, system restoration would be difficult or perhaps impossible.

[1] See FERC Order No. 802. On April 23, 2015, FERC denied a Petition by Resilient Societies seeking FERC rehearing of Order 802. Our petition asked FERC to apply physical security standards to Reliability Coordinators, Balancing Authorities, and large generation facilities over 2 gigawatts nameplate capacity. Also see FERC Order Denying Rehearing, issued April 23, 2015, Docket RM14-15-001.

In testimony to the U.S. Senate Energy Committee, FERC Chair Cheryl LaFleur admitted that attack on a single electric generation facility could cause cascading outage. Nonetheless, the NERC standard for physical security places no requirements on any generation facility.

For any category of electric grid facility, the NERC standard contains no specific requirements for physical security. Instead, the standard allows electric utilities to develop their own paper plans for security. These paper plans can be reviewed and approved by peer utilities, but need not be approved by governmental authorities.

The Nuclear Regulatory Commission requires so-called "force on force" exercises to test security procedures. Far more people would die during a widespread and long-term electric grid blackout than would die from the most severe nuclear accident. Nonetheless, there are no provisions for force-on-force exercises in the NERC/FERC physical security standard.

Our group, Resilient Societies, participated through public comments in standard-setting for physical security and in the subsequent rulemaking at FERC. We also met with individual FERC Commissioners to express our concerns. In December 2014, we filed an administrative appeal of the defective NERC physical security standard. I'm sorry to tell you that on April 23rd, the FERC Commissioners denied our appeal in its entirety.[2]

Unfortunately, the NERC physical security standard is only one of several defective standards that could result in catastrophic blackout and widespread loss of life. Aspects of NERC standard-setting for so-called "high impact, low frequency events" include exemption of whole categories of grid facilities, reliance on self-devised paper plans rather than concrete requirements, use of engineering models that have not been validated using real-world data, and withholding of operational data from public scrutiny. I will now give other examples from our experience in the FERC/NERC standard-setting process.

FERC Declines to Implement the Federal Law for Cybersecurity Protection of the Electric Grid

In November 2014, Admiral Michael Rogers, director of the National Security Agency, disclosed that China and other foreign nations could take down our electric grid through cyber-attack. Back in 2005, the U.S. Congress recognized this vulnerability with great foresight and passed specific legislation requiring that "communications networks" for the electric grid be protected against cyber-attack. Five separate sets of cybersecurity standards have been passed by NERC and approved by FERC without ever implementing this specific and essential requirement of law. As a result, malware implanted by both China and Russia within the U.S. electric grid in the period 2011 through 2014 provides foreign governments and their proxies opportunities to cause grid blackouts. An effective cyber-attack could cause long-term blackout because of permanent damage to grid and customer equipment with long replacement lead times. For example, the so-

[2] FERC's April 23, 2015 Order denied the Petition by Resilient Societies to apply physical security standards to Reliability Coordinators, and Balancing Authorities, and to 50 generation facilities with over 2 gigawatt nameplate capacity. See FERC Order Denying Rehearing, issued April 23, 2015, Docket RM14-15-001.

called “Aurora Vulnerability,” as disclosed on the TV news show “Sixty Minutes,” shows how cyber-attack could damage electric generators.[3]

NERC and FERC Play Russian Roulette with the Sun—And the Public Is at Risk

On June 19, 2014, FERC approved an operational standard to protect against geomagnetic solar storms.[4] These storms can cause electric grid collapse and permanent damage to hard-to-replace high-voltage transformers. While this standard requires electric utilities to take real-time actions during solar storms, there is no requirement to gauge the intensity of the storms impact on transmission lines as the storm is occurring. Nor is there a requirement to share vital indicators of transformer risk in time for the President or the Nuclear Regulatory Commission (for nuclear plants) to order protective shutdowns before transformers are damaged beyond repair.

A good analogy would be an FAA emergency procedure for airport control towers to direct landing of airliners during thunderstorms without the benefit of wind speed indicators. Common sense would say that this would be an extremely imprudent approach, both for airplanes and the electric grid.

We filed an administrative appeal of the defective NERC standard for operational control during solar storms. The FERC Commissioners denied our appeal.[5]

On December 17, 2014, the NERC Board of Trustees adopted another standard to protect against geomagnetic solar storms, this time to require analysis of whether hardware-based surge blockers should be installed on vulnerable transformers. The history of this standard’s development was illustrative of the industry bias inherent in NERC standard-setting. The magnitude of the largest postulated solar storm was based on data not from the United States, but from a few observatories in Finland and a small patch of Northern Europe. According to John Kappenman, one of our nation’s foremost experts on solar storm impact on electric grids, the threat level proposed in this standard is lower than several smaller storms that have occurred; hence, the standard’s threat level is much lower than the 1-In-100 year event that a NERC whitepaper claims. When the already weak standard failed to pass a ballot, the standard drafting committee arbitrarily weakened the “withstand limit” of transformers by a factor of five, from 15 amps to 75 amps; the standard then easily passed.

Data about grid impacts during solar storms is held by the electric utility industry, but has not been comprehensively released for NERC standard-setting. For example, data on induced currents during storms in the electric grid is available, but has been held as “proprietary” by the Electric Power Research Institute, an industry research organization. Data on transformer failures during and after solar storms is held by NERC in two databases, but has not been made available to independent researchers.

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[3] Multiple public reports by U.S. CERT, an entity funded by the U.S. Department of Homeland Security, document these cybersecurity hazards.

[4] See FERC Order No. 797, Reliability Standard for Geomagnetic Disturbance Operations, issued June 19, 2014.

[5] See FERC Order No. 797-A, Reliability Standard for Geomagnetic Disturbance Operations, issued October 16, 2014.

If electric utilities were to protect against the moderate level solar storms postulated in the benchmark event for this standard, they would gain protection against liability claims, even for storms much greater than those expected by NERC. We currently have an appeal pending at NERC against this imprudent standard for hardware-based protection against solar storms.[6]

NASA scientists have estimated the chance each decade of a catastrophic solar storm is 12%. Over your lifetime, or the lifetime of your children, these odds are equivalent to playing the game of Russian Roulette approximately five times. No responsible person or corporation would force Russian Roulette upon the public for even one decade, much less the several decades that have passed since the risk of severe solar storms was demonstrated by the Hydro-Quebec blackout of March 1989.

FERC Declines to Require Cost-Effective Protection Against Electromagnetic Pulse Attack

In 2001 the U.S. Congress established the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack or "EMP Commission." This commission released public reports in 2004 and 2008 that concluded the U.S. is vulnerable to attack from a high-altitude nuclear detonation that would collapse much of the North American electric grid. The EMP Commission specifically noted that about two thousand high voltage transformers are vulnerable to high altitude EMP attack.

Due to the efforts of an entrepreneur in Minnesota, cost-effective EMP protective equipment is now available for only $350,000 per transformer site. This protective equipment successfully passed testing in an operational grid at Idaho National Laboratory.

FERC has not initiated any rulemaking to protect against EMP attack. NERC has lobbied against EMP protection legislation, stating in testimony that private companies should not be obligated to protect critical infrastructure against foreign attack.

Resilient Societies and others have urged FERC to include man-made EMP hazards in a proposed reliability standard. But in May 2013 FERC specifically excluded man-made electromagnetic pulse from the scope of mitigation demanded of NERC.[7] Ironically, the same hardware that would protect against solar storms would also protect high-voltage transformers from an important component of EMP.

Consequently, if FERC approves a benchmark model for solar storms that requires virtually no hardware deployments to protect high voltage transformers, the country will also lose protection against high-altitude nuclear EMP attack. Protection of high voltage transformers against both solar storms and EMP attack would cost about 50 cents per person per year, according to a cost-estimate we prepared and presented to NERC.

NERC Resists Appropriate Regulation To Ensure Public Safety

[6] See the Resilient Societies Stage 1 Appeal on NERC Standard TPL-007-001, filed January 4, 2015.
[7] See FERC Order No. 779, Reliability Standards for Geomagnetic Disturbances, issued May 16, 2013,

Deficiencies in the FERC/NERC system should be no surprise to anyone who understands the governance process of NERC, the weak regulatory authority of FERC under Section 215 of the Federal Power Act, and the political influence of the electric utility industry. NERC is governed by vote of its members and approximately 70% of NERC members are representatives of electric utilities.

FERC cannot write or directly enforce electric reliability standards; instead, it depends upon a designated Electric Reliability Organization. FERC has repeatedly selected NERC as the Electric Reliability Organization, despite a record of NERC favoring industry positions over public safety.

Can you imagine the automotive industry setting its own standards for safety and crashworthiness? Or airlines holding back data from blackbox recorders recovered from crash sites? Or the pharmaceutical companies holding data as proprietary when patients die after taking drugs? Or consumers having no recourse when they are harmed by the negligence of these profit-making enterprises?

Electric utilities set their own reliability standards and can legally conceal data that could allow independent researchers and the public to find that the standards are imprudent. In addition, utility tariffs and state laws often grant electric utilities wide exemption from liability even when outages are foreseeable and can be cost-effectively prevented. Among all major industries, the electric utility industry is unique in its potential adverse impact on public safety, concealment of safety-related data, and broad exemption from liability.

The unique FERC/NERC regulatory apparatus is the result of lobbying by the electric utility industry. When some in Congress have attempted to strengthen regulation of electric grid reliability, NERC has actively opposed remedial legislation. Ironically, the American public indirectly pays for NERC lobbying through our electric utility bills.

Special Factors for the State of Maine

Among the 50 states, Maine is significantly exposed to solar storm threats because of its high latitude and igneous rock formations. In fact, Maine has narrowly avoided catastrophic impacts during previous solar storms due to equipment malfunctions. Examples include tripping of the Chester SVC and Phase II High Voltage Direct Current (HVDC) link from Quebec, a transformer explosion and fire at the now-decommissioned Maine Yankee nuclear plant, and premature failure of another transformer at the Seabrook nuclear plant just across the border in New Hampshire.

Maine utilities have known about these solar storm threats for 25 years. Just as you don't have to be a weatherman to know which way the wind is blowing, one need not be an electrical engineer to know that Maine is exposed to blackout, especially since the Hydro-Quebec blackout in March 1989 demonstrated the threat. After twenty-five years of inaction by Maine's utilities, it's time for the citizens of Maine to require both action and accountability.

Estimated Costs to Protect the Maine Grid from Nuclear EMP and Solar Storms

LD 131, passed on June 10, 2013, directed the Maine Public Utilities Commission "To Examine Measures To Mitigate the Effects of Geomagnetic Disturbances and Electromagnetic Pulse on the State's Transmission System," including estimating "the costs of potential mitigation measures and develop options for low cost, mid-cost and high-cost measures."

In preparation for this testimony, Resilient Societies developed low cost, mid-cost and high-cost estimates for EMP and solar storm (GMD) protection of the Maine electric grid:

Cost Element	Low-Cost	Mid-Cost	High-Cost
Electric Grid Control Rooms (EMP)	$0.0M	$17.6M	$17.6M
Solar Storm Protection (GMD)	$6.6M	$6.6M	$6.6M
Transmission Substations (EMP)	$12.1M	$32.0M	$51.9M
Telecommunications (EMP)	$0.0M	$12.9M	$25.8M
Totals	**$18.7M**	**$69.2M**	**$102.0M**
Cost per Ratepayer per Year	$4.68	$17.30	$25.50

A graphic display of these cost estimates is appended to this testimony.

In preparing these cost estimates, we made the following assumptions:

1. Low-Cost measures assume protection of only Extra High Voltage (EHV) transformer substations (345kV and Up).
2. Mid-Cost measures assume protection of CMP and Bangor Hydro control rooms, all EVH transformer substations, half of other transmission substations, and half of telecom nodes and Remote Terminal Units (RTUs).
3. High-Cost measures assume protection of CMP and Bangor Hydro control rooms, all transmission substations, and half of telecom nodes and RTUs.
4. We assume legacy hydroelectric plants have EMP-resilient analog controls and we assume no protection of other electric generation facilities.

The Low-Cost estimate includes all protections listed in LD1363, namely "geomagnetically induced current monitoring sites, neutral current blocking devices, supervisory control and data acquisition system protectors and the holding of sufficient spare transformers" for the most critical element of the grid, extra high voltage transformer substations. The Mid-Cost and High-Cost estimates include protection of control rooms, lower voltage substations, and telecom for electric grid operations. The principal difference between the Mid-Cost and High-Cost estimates is the proportion of grid facilities protected.

No doubt some will disagree with details of our cost estimates. Nonetheless, we believe our methodology is robust. We estimate costs from the bottom up, listing the components to be protected and their approximate units, and then multiplying by per-unit costs. We do not always assume 100% protection. Cost drivers are clearly delineated. For those who wish to run

alternative scenarios, our model enables users to substitute assumptions about the protection components that are essential, or not, the percentages of equipment types to be protected, and variants in per-unit protection costs.

We have provided our cost model in Excel spreadsheet format to the Committee Analyst.

States Retain Parallel Authority to Protect the Reliability of Their Electric Grids

Despite this bleak accounting of special risks for the Maine electric grid and the failures of the FERC/NERC regulatory system, our system of federalism provides opportunities for remedial action at the state and regional level. As we have shown with our cost estimates, EMP and solar storm (GMD) protection costs are affordable, both on an aggregate and per ratepayer basis.

As members of the Joint Standing Committee on Energy, Utilities and Technology, you have a unique opportunity in the history of your state and the history of America to expose and remedy shortcomings in the current system for electric grid reliability. Fortunately, Maine and other states have the authority to impose their own requirements for electric grid reliability to protect citizens and economies from catastrophic long-term blackout.

I appreciate your time today and look forward to your questions.

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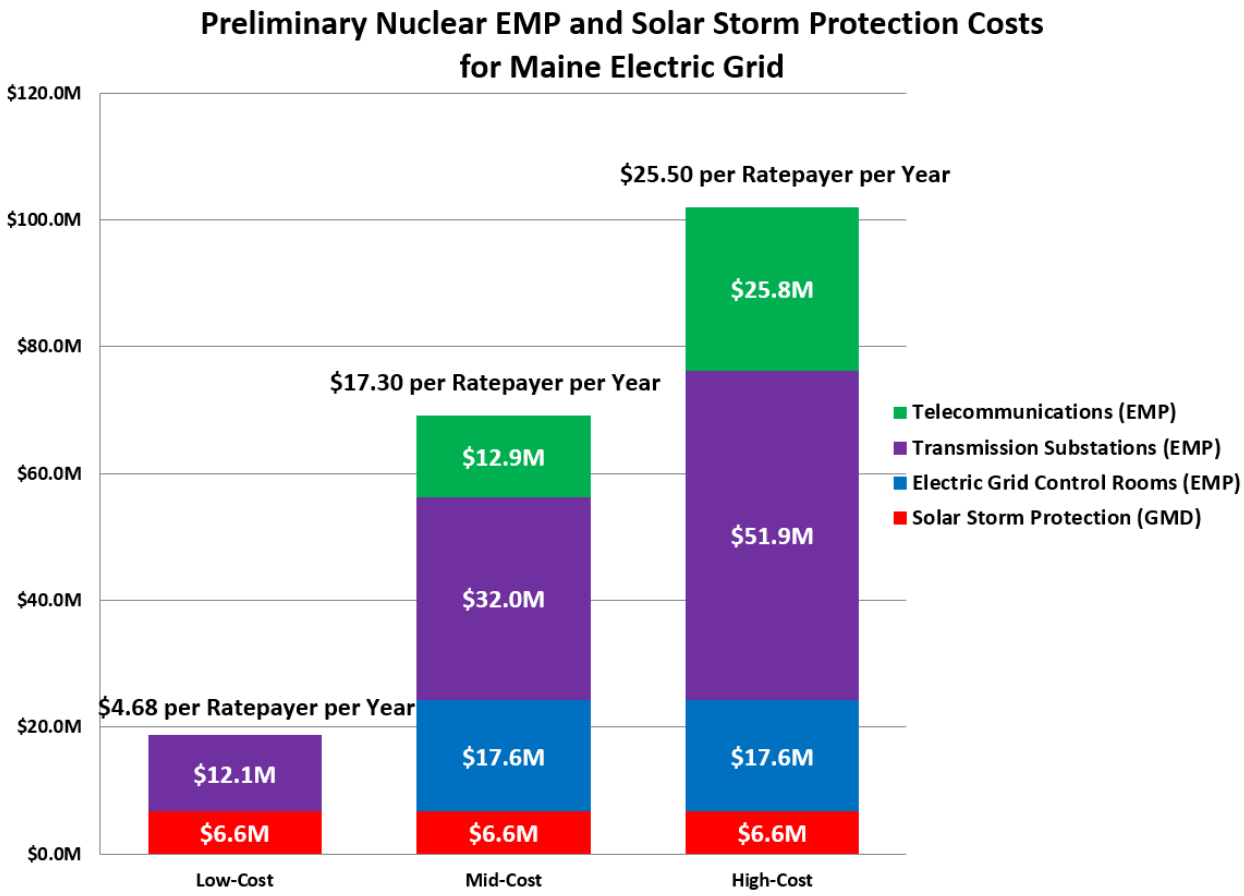

Notes:

1. Low-Cost measures assume protection of only Extra High Voltgage (EHV) transformer substations (345kV and Up).
2. Mid-Cost measures assume protection of CMP and Bangor Hydro control rooms, all EVH transformer substations, half of other transmission, and half of telecom.
3. High-Cost measures assume protection of CMP and Bangor Hydro control rooms, all transmission substations, and half of telecom nodes and RTUs.
4. Assume legacy hydroelectric plants have EMP-resilient analog controls, no protection of other electric generation facilities.

Source: Preliminary Electromagnetic Pulse & Geomagnetic Disturbance Protection Cost Model for Maine Rev 0.6 by Resilient Societies