Additional Questions for the Record

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Questions from The Honorable Richard Hudson:

1. **How do you think North Carolina can better leverage innovative energy technology, like microgrids, in the face of grid failures? Could this improve the time it takes to get a substation back online?**

In the event of grid failures – which, like all complex systems, do fail at certain rates for various related magnitudes – the most important consequence is typically the loss of electric energy to the customers whose service was interrupted. There are several approaches that can be used to reduce the magnitude and duration of these overall consequences.

One common resilience technique is the installation of an emergency backup power sources at the most important buildings or small campuses. For decades hospitals, 911 centers, and other facilities with community importance have chosen to install emergency generators, usually diesel-fueled, to allow them to continue providing at least baseline levels of their critical functions for as long as fuel is available. With the growing commercial availability of scalable distributed energy resources (DERs) coupled with battery storage, there are more options to diversify backup power capabilities and reduce backup power's dependence on liquid fuels and their necessary supply chain.

Taking the idea of backup generation a step further, where there are electrically and geographically close clusters of customers, microgrids can be designed and established to support those groups of customers. THis requires having sufficient dependable energy resources – generally from the same choices as backup generation – within the borders of the microgrid, a digital controller for the portfolio of resources, and additional metering and communications between the customer loads and the controller and the resources. Larger microgrids may require additional protective relaying and automated coordination with the surrounding utility. Properly designed and maintained microgrids can be a valuable resilience addition to areas where the importance of the loads within them are worth the increased cost in dollars and in complexity. It should go without saying that if a cluster of loads is important enough to warrant implementing a microgrid, that it requires cybersecurity designed into it from the earliest concept stages.

While innovation and investment on the customer side of the meter is an important part of overall resilience, there will always be the need to restore and recover the grid itself quickly and efficiently following failures. Continued support and expansion of mutual assistance programs to share replacement equipment, such as Edison Electric Institute's Spare Transformer Equipment Program (STEP) and SpareConnect[1], the North American Transmission Forum's Regional Equipment Sharing for Transmission Outage Restoration[2] (RESTORE), and the Grid Assurance company[3] is helpful. The spirit and practice of mutual assistance has long been a strength for the electricity industry, and as the threats evolve so must our mitigations.

Increasing interoperability and replaceability of major components – transformers, circuit breakers, and line structures in particular – will magnify the value of equipment-sharing mutual assistance programs and shorten average outage durations over time. This sort of inventory standardization is already starting, as the number of distinct suppliers of this equipment shrinks through mergers and acquisitions. However, there is a point where too much of a good thing is no longer a good thing, if the electric sector industrial base were to contract to the point where product availability suffers, and single points of success and failure emerge. Thankfully we are not there yet in my view, and as utilities evolve their equipment acquisition standards over time, we have an opportunity to smoothly transition to a good balance between helpful standardization and beneficial equipment diversity.

With increased interoperability and exchangeability of equipment, there will be a need and an opportunity for utilities to enhance their standard designs for facilities and subsystems to facilitate easier repair and replacement of major components. Acquiring, and modifying facilities to easily install, temporary and portable equipment, ranging from smaller power transformers to circuit breakers to entire

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[1] https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Reliability-and-Emergency-Response/Spare-Equipment-and-Grid-Resilience-Programs.pdf

[2] https://www.natf.net/docs/natf/documents/resources/resiliency/natf-restore-program-faq.pdf

[3] https://gridassurance.com/about-us/

functional substations on large trailers can also be part of this design. Often this includes elements of modularity, but there is also some simple thinking through possible operation, maintenance, and repair scenarios during the design phase. Some of us have had the unpleasant experience of having to remove a wheel and fender from an automobile just to replace the battery, instead of having that component (which requires occasional maintenance and sometimes replacement) easily removable from the top of the engine bay; substation design and construction is no different in philosophy.

Moving up from facility design, there are longer-term opportunities to redesign parts of the utility's complete system, their part of the grid. Where geography and generation resources allow, installing switching equipment and upgraded conductors to reconfigure distribution circuits to supply blocks of customers from an alternate source is possible. This can be automated and integrated with Fault Location, Isolation, and Service Restoration (FLISR) systems, or it can be manual restoration procedures carried out by control center operators and field crews as the situation requires. As with backup generation and microgrids, these system design modifications require investment so their cost needs to be weighed against the value of the improved service to the customers they can restore in different scenarios. As these are implemented on local distribution systems, state utility commissions will have a role in approval and cost recovery for these sorts of resilience enhancements.

Finally, we would be remiss to neglect the human element. Tabletop discussions, drills, and practice for all the involved stakeholders – organizationally and individually – will serve to create and reinforce accurate expectations and mental models through broader communities, which will pay off when significant grid failures and their resultant societal consequences do come to pass.

2. What concerns do you have with expanding the electrification of various sectors, like transportation, industry, space heating, and agriculture, while the federal government, states, and utilities lack an understanding of the potential for impacts on emergency management and infrastructure development?

Electrification is a main component of decarbonization strategies for many sectors, as part of the fight to survive climate change. With this, electric system peak and base loads are going to increase significantly over the next several decades in almost every realistic scenario. Like the airline safety briefings that tell us to “put on our own oxygen mask before helping others,” the electric industry will need to lead the transition with its own generation decarbonization and power delivery reinforcement to realize the benefits for other sectors that will in turn become more dependent on electricity. This increased dependency for other sectors’ critical function assurance – in many cases even greater than the foundationally critical role of electricity today – needs to be thoroughly understood and deliberately factored into other sectors’ resilience and critical function assurance plans and actions.

We will need significantly more generation, and a commensurate amount of essential reliability services[4] that have traditionally been supplied by conventional generation. Siting, permitting, and building new generation resources today takes an exorbitant amount of time due to environmental considerations and public opposition; without some process reforms to expedite these processes we will likely be unable to add enough generation fast enough to meet electric sector goals, much less support other sectors’ electrification. Nuclear generation, especially in the form of small modular reactors, will be a key solution to rapidly grow available capacity; here again we need enhancements to the permitting and approval processes to be able to build at the rate required. And increasing amounts of inverter-based and distributed energy resources will add to the complexity of the system. To be sure we need more of all types of generation, but they need to be carefully integrated into the system with deliberate interregional coordination.

Generation is only part of the equation though, as the increased energy demand will require increased transmission and especially distribution capacity to deliver the energy to the newly electrified loads. I see this as fundamentally a construction exercise, with all the permitting and material supply and skilled labor availability constraints that transmission and distribution construction understand already, but at a scale and scope beyond anything the industry has undertaken before.

With essentially all utilities pursing these plans at once, we will need to apply the principles and techniques of urban planning on a national scale. We must balance the sense of focused urgency with the need to minimize unintended consequences in the cross-sector and interdependency space, since

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[4] https://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/ERSWG_Sufficiency_Guideline_Report.pdf

electrification will change several of the foundational practices, assumptions, and mental models for entire industries.

Last, as electrification picks up speed there will be some hard conversations about who pays the bills for the transformation. Certain benefits will accrue directly to newly electrified customers (e.g., trucking fleets) but will also have societal benefits through decreased carbon intensity and improved climate management posture. The old truism in the electricity industry of “the load always pays” is the presumptive oversimplified answer, but determining a just and reasonable implementation is a complex and opaque problem entangling grid operations, macroeconomics, and regulatory policy.

3. Congressional mandates on physical security measures aren’t a cost-effective or permanent solution. What physical security measures have been successful in the past? What is currently recommended for substations now?

Recognizing that it’s not economically possible nor efficient to protect everything in a system as distributed as the grid we must, in the wise words of one of my mentors in the world of physical security, “protect pencils like pencils, and gold like gold.” This gets to one of the foundational truths underlying Idaho National Laboratory’s security activities, that analysis must start with identification and prioritization of potential consequences.

Historically, “guards, gates, and guns” have been the mainstay of facility security, but for geographically dispersed and unstaffed facilities like those that comprise most of the power delivery part of the grid perimeter fences and door alarms have been the main physical security measures deployed at scale. In the last 10-20 years, video surveillance systems and various intrusion detection and gunshot detection capabilities have become more common at larger and more important facilities.

Current recommended practice for substation security start with identifying high consequence events and applying a variety of protections and mitigations to ensure that the as-built protection level is commensurate with the design basis threat level. The Electricity ISAC’s Vulnerability of Integrated Security Assessment (VISA) process and 2023 Electric Sector Design Basis Threat report provide proven guidance for owners and operators to apply integrated approaches that aid in earlier detection of suspicious activity, extend the time required for an adversary to create effects at the facility, and speed the arrival of the response force (often this is local law enforcement). Both these resources are available to all electric sector owners and operators via E-ISAC.

Last, deterrence is part of a comprehensive portfolio of physical security measures. The enforcement of laws that consistently and visibly impose significant penalties for damaging critical infrastructure or disrupting the critical functions that the infrastructure delivers can reduce the number of incidents by dissuading would-be attackers that consider the consequences of their actions. The province of Alberta in Canada has had success in reducing the number and severity of intrusions and copper thefts from electric power facilities through their Critical Infrastructure Defence Act[5] that imposes significant penalties for unauthorized entry, damage, or destruction of "essential infrastructure" including electric utilities.

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[5] https://www.alberta.ca/protecting-critical-infrastructure