NIST Smart Grid Program



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NIST Framework 3.0— Digging Deeper into Vision and Next Steps

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Three Panelists

 Dr. David Wollman— NIST

Deputy Director, Smart Grid and Cyber-Physical Systems Program Office

Smart grid interoperability standards and coordination; Green Button Initiative

- Dr. Allen Hefner-
 - NIST

Senior Scientist, Semiconductor and Dimensional Metrology Division

Power conditioning interconnection standards; microgrids; storage

- Dr. Gerald Fitzpatrick—
 - NIST

Leader, Applied Electrical Metrology Group, Quantum Measurement Div

Standards for synchrophasor metrology; precision measurements of electric power





Vision and Next Steps

- In this session, we are particularly interested in identifying what might be missing from the draft Framework 3.0 regarding visions and next steps
- Draft Framework is posted to the NIST Smart Grid site, with a link on the SGIP twiki
- The NIST Framework smart grid vision (Chapter 2) refers to a modern cyber-physical power grid that affords improved implementability, safety, reliability, and resiliency
- The smart grid will include distributed sensors and remote metering for enhanced provider awareness, on-line control and communication capabilities to enhance convenience and economy for users, and large-scale storage and two-way power flow to accommodate wide-spread deployment of renewables and electric vehicles





Smart Grid Standards to Enhance Resiliency in the NIST Framework and Roadmap (Release 3 Draft)

Al Hefner NIST



NIST smart grid program

engineering laboratory

ECONOMIC BENEFITS OF INCREASING ELECTRIC GRID RESILIENCE TO WEATHER OUTAGES

Executive Office of the President August 2013

"Priority 3: Increase System Flexibility and Robustness"

"Additional transmission lines increase power flow capacity and provide greater control over energy flows. This can increase system flexibility by providing greater ability to bypass damaged lines and reduce the risk of cascading failures. **Power electronic-based controllers can provide the flexibility and speed in controlling the flow of power over transmission and distribution lines**.

Energy storage can also help level loads and improve system stability. Electricity storage devices can reduce the amount of generating capacity required to supply customers at times of high energy demand – known as peak load periods. **Another application of energy storage is the ability to balance microgrids to achieve a good match between generation and load.** Storage devices can provide frequency regulation to maintain the balance between the network's load and power generated. Power electronics and energy storage technologies also support the utilization of renewable energy, whose power output cannot be controlled by grid operators.

A key feature of a microgrid is its ability during a utility grid disturbance to separate and isolate itself from the utility seamlessly with little or no disruption to the loads within the microgrid. Then, when the utility grid returns to normal, the microgrid automatically resynchronizes and reconnects itself to the grid in an equally seamless fashion.

Technologies include advanced communication and controls, building controls, and distributed generation, including combined heat and power which demonstrated its potential by keeping on light and heat at several institutions following Superstorm Sandy."

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ECONOMIC BENEFITS OF INCREASING ELECTRIC GRID RESILIENCE TO WEATHER OUTAGES Executive Office of the President August 2013

"Priority 4: Increase Visualization and Situational Awareness"

"Until recently, most utilities became aware that customers had lost power when the customers called to report the outage. Thus utilities have had incomplete information about outage locations, resulting in delayed and inefficient responses. Smart meters have outage notification capabilities which make it possible for utilities to know when customers lose power and to pinpoint outage locations more precisely. Smart meters also indicate when power has been restored. When the outage notification capability enabled by smart meters is coupled with automated feeder switching, the result is a significant improvement in field restoration efforts since field crews can be deployed more efficiently, saving time and money. The Recovery Act investment has added greater visibility and intelligence across the electric system through advanced outage management systems, distribution management tools as well as transmission visibility.

Another example, synchrophasor technology, derived from phasor measurement units (PMUs), is used within the transmission system to provide high-fidelity, time-synchronized visibility of the grid. PMUs enable operators to identify reliability concerns, mitigate disturbances, enhance the efficiency/capacity of transmission system, and help manage islanding during emergency situations."



"1.3.1. Definitions

Resiliency: The attribute that allows a grid to better sustain and more quickly recover from adverse events such as attacks or natural disasters. Grid resiliency includes hardening, advanced capabilities, and recovery/reconstitution. Although most attention is placed on best practices for hardening, resiliency strategies must also consider options to improve grid flexibility and control. Resiliency also includes reconstitution and general readiness, outage management, use of mobile transformers and substations, and participation in mutual assistance groups."

"1.3.2. Applications and Requirements: Nine Priority Areas

... Distributed Energy Resources (DER): Covers generation and/or electric storage systems that are interconnected with distribution systems, including devices that reside on a customer premise, "behind the meter." DER systems utilize a wide range of generation and storage technologies such as renewable energy, combined heat and power generators (CHP), fixed battery storage, and electric vehicles with bi-directional chargers. DER systems can be used for local generation/storage, can participate in capacity and ancillary service markets, and/or can be aggregated as virtual power plants. Advanced grid-interactive DER functionalities, enabled by smart inverter interconnection equipment, are becoming increasingly available (and required in some jurisdictions) to ensure power quality and grid stability while simultaneously meeting the safety requirements of the distribution system. Advanced DER functionalities also enable new grid architectures incorporating "microgrids" that can separate from the grid when power is disrupted and can interact in cooperation with grid operations to form a more adaptive resilient power system."



"8.1.2 Definitions of Reliability and Resiliency of the Grid

The U.S. Department of Energy (DOE) has used definitions for reliability and resiliency in some of its publications. One publication defines reliability as the ability of power system components to deliver electricity to all points of consumption, in the quantity and with the quality demanded by the customer.169 Another DOE publication defines resiliency as the ability of an energy facility to recover quickly from damage to any of its components or to any of the external systems on which it depends.170 Resiliency measures do not prevent damage; rather they enable energy systems to continue operating despite damage and/or promote a rapid return to normal operations when damage/outages do occur. Other definitions are also available. The North American Electric Reliability Corporation (NERC) defines "operating reliability"171 as the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system components. The National Infrastructure Advisory Council (NIAC) defines "infrastructure resilience"172 as the ability to reduce the magnitude or duration of disruptive events.



"8.1.3 Implementability, Safety, Reliability, Resiliency, and Impact of Framework Standards

... [cons due to improper standards and technology implantation]

During the evolution of the legacy grid to the smart grid, the introduction of new standards and technologies may pose implementation and transition challenges as well as possibly affect the reliability, resiliency, and safety of the grid.

... [pros due to improved technologies and polices]

Recent events such as Hurricane Sandy in 2012 and the Southwest Blackout of September 2011 have raised the public visibility and concern about reliability and resiliency. A DOE report, "U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather (July 2013)"₁₇₆ found that "the pace, scale, and scope of combined public and private efforts to improve the climate preparedness and resilience of the energy sector will need to increase, given the challenges identified. Greater resilience will require improved technologies, polices, information, and stakeholder engagement."



"8.1.3 Implementability, Safety, Reliability, Resiliency, and Impact of Framework Standards

A White House report, "Economic Benefits Of Increasing Electric Grid Resilience To Weather Outages (August 2013),"177 found that weather-related outages in the period from 2003 to 2012 are estimated to have cost the U.S. economy an inflation-adjusted annual average of \$18 billion to \$33 billion. The report concluded, "Continued investment in grid modernization and resilience will mitigate these costs over time—saving the economy billions of dollars and reducing the hardship experienced by millions of Americans when extreme weather strikes."



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"8.1.3 Implementability, Safety, Reliability, Resiliency, and Impact of Framework Standards

There is an increased awareness of the impact of power grid disruptions from weather related events as a consequence of Hurricane Sandy. Reliability and resilience of the power deliver system has become a top priority for utilities, regulators, and the DOE. Potential threats to the gird from cyber- and/or physical-attacks compound the importance of considering solutions to strengthen the power system in light of these threats and low probability, high impact events (e.g. geo-magnetic storms). Smart grid technologies in different configurations in the distribution system offer answers to these threats and the disruption that they bring to the normal functioning of the social and economic environment.



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"8.1.3 Implementability, Safety, Reliability, Resiliency, and Impact of Framework Standards

Microgrids offer an ideal solution for such disruptions by bringing smart grid technologies and communications together to maintain the supply of power to critical loads and non-critical loads alike to assure continuity of power delivery to critical systems and facilities, while also providing a more adaptive and reliable power system during normal operating conditions. The SGIP has recently added a new group focused on information exchange and standards for microgrids, and the NIST smart grid laboratory programs include a focus on advanced technologies and interoperability for microgrid scenarios."



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Cyber-Physical Architecture Reference for Resilient/Transactive Power Systems



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PROGRESS THROUGH

NOVEMBER 5-7, 2013

Level 3g: Microgrid Architecture

