GRIDWISE ALLIANCE Advocating for a Smarter Grid

# WHAT IS MISSING IN OUR FUNDAMENTAL KNOWLEDGE OF SMART GRID IMPLEMENTATION?

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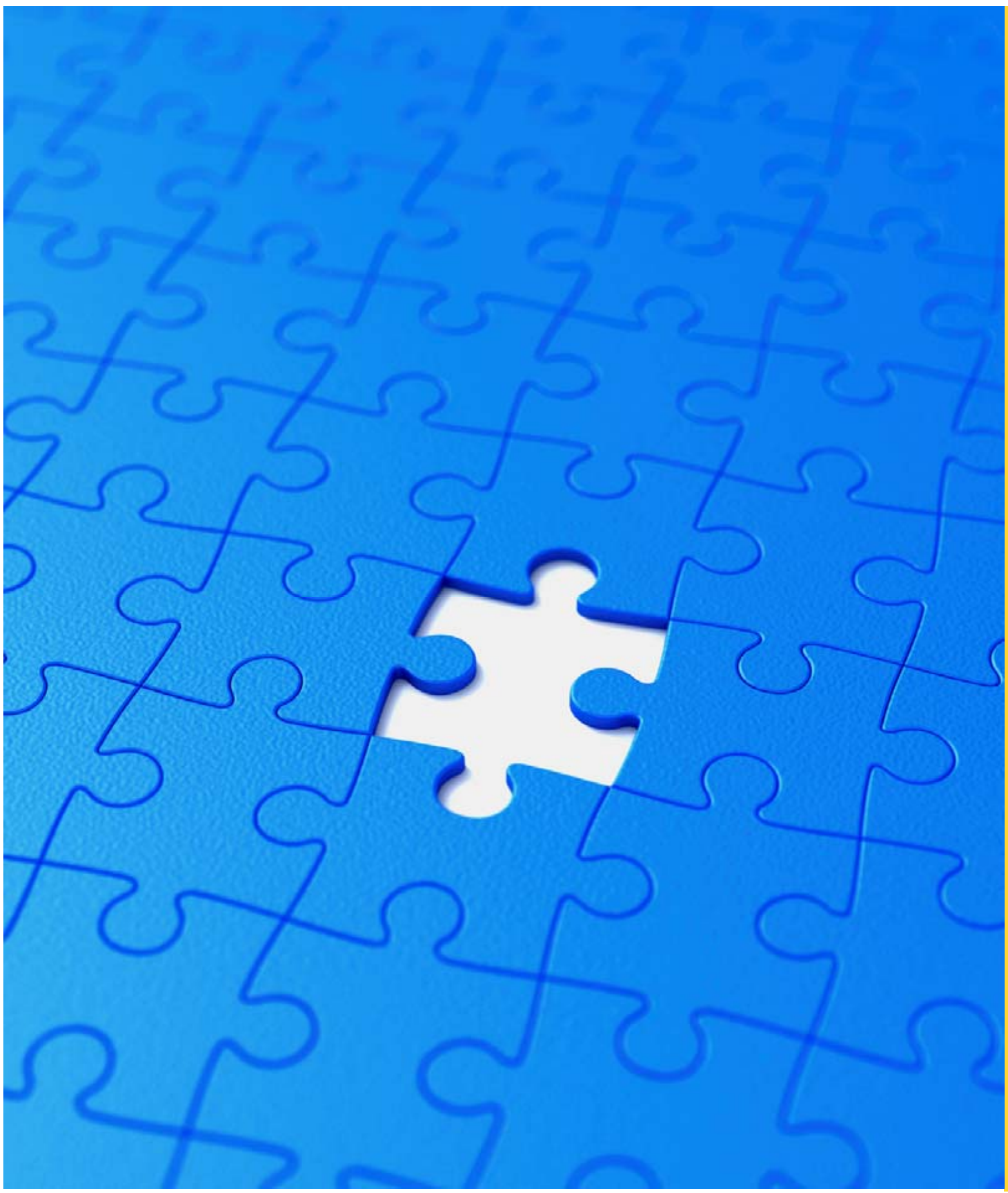

**This document was prepared in cooperation with the GridWise Alliance Implementation Work Group and Carl Imhoff, Battelle/PNNL.**

**The GridWise® Alliance – Advocating for a Smarter Grid**

The GridWise Alliance, founded in 2003, is a consortium of public and private stakeholders which include utilities, IT companies, equipment vendors, new technology providers and academic institutions. The Alliance members are aligned around a shared vision of a smarter electric system that integrates the infrastructure, processes, devices, information, and market structure. This integration will ensure that energy can be generated, distributed, and consumed more efficiently and cost effectively resulting in a more resilient, secure and reliable energy system.

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# I. Introduction

The Energy Security and Independence Act of 2007 (EISA) formalized the emerging interest and investment in “smart grid” in the U.S. It defined the general boundaries of smart grid concepts and framed the strategic interests that the nation had in the successful development and deployment of smart grid concepts. EISA, via Title XIII – Smart Grid, authorized a substantial increase in federal research and development (R&D) funding and called for public/private co-investment in major regional demonstrations of smart grid technology.

Pockets of smart grid implementations exist today; multiple demonstrations that span utility footprints, community footprints, and even regional footprints are in various stages of development. These efforts have arisen from local interests and needs and, at best, provide an ad hoc base of learning and results for consideration by the community at large.

Policy and regulatory dimensions of smart grid received attention in EISA with the call for federal coordination across agencies via a Smart Grid Task Force as well as a coordinated effort by state and federal regulators to examine regulatory innovation necessary to support successful implementation of smart grid concepts. In response, the Department of Energy’s (DOE) Office of Electricity Delivery and Energy Reliability convened the Federal Smart Grid Task Force (March 2008). In addition, the Federal Energy Regulatory Commission (FERC) and the National Association of Regulatory Utility Commissioners (NARUC) launched a joint collaborative on smart grid implementation in May 2008.

The GridWise Alliance recognizes the growing interest in smart grid and the substantial increase in planned demonstrations. The Alliance’s Implementation Work Group was established to improve and accelerate the progress of smart grid demonstrations and learn from these efforts for the benefit of nation-wide smart grid implementation. The Implementation Work Group sought to provide a regular summary of key research objectives that could maximize benefits extracted from investment in demonstrations. The Work Group also called for a common high standard of program evaluation and transparency, particularly for demonstrations receiving federal funding to insure that all stakeholders had access to credible and consistent information about these projects.

This document identifies gaps in knowledge about the implementation of smart grid technologies and recommends critical areas where information should be tracked and presented to understand the level of success of smart grid projects.

# II. Smart Grid Knowledge Gaps

### *1. How do consumers respond to continuous requests to curtail demand?*

**Consumer participation over time in the face of repeated requests from utilities during peak demand days should be studied to better understand consumer reaction to demand response programs.**

Preliminary demonstrations have shown strong consumer response to financial incentives for demand response, or utilities cycling off certain equipment (like air conditioning) during peak demand periods. It will be important to track these levels of participation and better understand customer response to calls for demand response since this tool is becoming more sophisticated and prevalent in the smart grid system.

### *2. How will transmission and distribution markets establish a common basis for regulatory innovation to support smart grid deployment?*

**Market interfaces for smart grid implementation at the distribution and transmission levels (ancillary services, bulk power markets, etc.) need to be evaluated and compared to establish a common basis for regulatory innovation to support smart grid implementation.**

Elements of this issue include (but are not limited to) the following items:

a. Incorporation of environmental incentives into smart grid business models at the distribution and transmission levels.
b. Evaluation of consumer response and utility impacts of alternate rate structures, and evaluate the impact of the use of multiple rate structures versus single rate structures. Those structures may include real-time rates, critical peak pricing, peak rebate programs, simple two-tier rates, and traditional flat rates as part of a blend of rates in a given area.
c. Establishment of benchmarks for quantifying added values to support self-sustaining rollouts versus externally funded demonstrations.

### *3. How can the benefits of smart grid be quantified to demonstrate a host of claims?*

**It will be critical to test the impact of smart grid concepts on real-time distribution system optimization for economic benefits, energy efficiency and operational flexibility as well as customer service, outage management and enhanced emergency operations.**

Most Advanced Metering Initiatives (AMI) and demand response demonstrations have focused on a narrow set of value propositions - typically peak demand management, billing efficiencies, and enhanced connect/disconnect services. The nation's energy policy agenda seeks higher energy efficiency from grid assets; demonstrations need to evaluate the real impacts on distribution balancing efficiency and improved asset management. Elements of this system include, but are not limited to, phase balancing, control of load power factor and harmonics, optimal voltage management, reduced peaks, automatic network reconfiguration, and substation asset sharing (which can defer substation upgrades and extend the life of transformers).

### ***4. What will the framework be for system interoperability between new smart grid communications and markets and existing systems?***

**It will be important to understand the value delivered to all parts of the grid as new technologies are installed and data flows across legacy boundaries.**

Our transmission system currently uses SCADA technologies which will be impacted when newer smart grid devices like synchrophasers are added to the grid. On the demand side, Energy Management Systems (EMS) will be affected by new smart meters and Home Area Network (HAN) systems. Demonstrations to date have had limited transfer of near real-time smart grid data across the traditional boundaries between the transmission, distribution, and customer interface systems. With more focus on integrated systems, we will begin to see more interaction along all parts of the grid. As newer technologies are installed, it will be important to test data flow across these traditional boundaries and the new paradigm of delivering value in both directions on the grid.

### ***5. What measurements are necessary to understand how demand side controls impact the supply side during outages?***

**System operators need to be able to quantify demand side measures and their direct impact on the supply side of the grid.**

Transmission operators need verification that the control resource represented by demand response is real, durable, and available needed to respond to a reliability event. Tools for representing available control resource and delivering it with high reliability need to be tested and the results shared with reliability councils and the North American Electric Reliability Corporation (NERC) committees to engage the operations stakeholders.

### ***6. What types of regulatory support are necessary to provide meaningful demand response as renewable generation increases?***

**Validate the potential of aggregated demand response to provide meaningful fast regulation resources to support increased renewable generation.**

Preliminary demonstrations have shown that real-time pricing extracts rapid and durable demand response that appears to offer value as "fast regulation" that would support integration of renewable generation resources and energy storage techniques. Emerging demonstrations need to validate that a meaningful amount of regulation resource could support a balancing area's ability to firm renewable generation.

***7. What is needed to protect customer privacy in a two-way communications system?***

**Demonstrate models to provide customer privacy while still providing real-time response to low and high voltage operations.**

Two-way communications will provide substantial knowledge of end-use activities. Methods need to be developed to demonstrate how to manage privacy issues to assure consumers and regulators that customer information is protected.

***8. How can new digital transmission monitoring systems evolve into control systems?***

**Demonstrate the value of time synchronized data to support real-time control, an important step towards the goal of adaptive, self-healing grids.**

The emerging Synchrophasor network being led by the DOE and NERC is nearing the point of sufficient coverage to enable wide-area monitoring and situational awareness. The next step for industry and government is to demonstrate the ability of time synchronized real-time smart grid data monitoring systems to achieve real-time control and advanced islanding and arming of fast grid transmission and distribution controls.

***9. How can smart grid monitoring systems deliver lower reliability risks at the interconnection level?***

**Demonstrate the ability of smart grid monitoring systems to provide real time transmission and distribution system situational awareness and real-time alarming of impending reliability risks at the interconnection level.**

High resolution, time synchronized data at the transmission and distribution levels have been, for the most part, implemented independently. An important next step for demonstrations is to link synchronized data with detailed system model and distributed computation, such as substation state estimators, into a coordinated monitoring and prediction system in order to enhance regional and local reliability operations.

***10. How will the concept of distributed agents figure into the implementation of smart grid technologies?***

**Evaluate performance of "distributed agent" concepts and test interoperability as these systems evolve.**

Distributed devices – or agents – have local intelligence and make decisions individually along the grid. These devices are being tested and considered for implementation in demand response demonstrations while key issues such as performance and compatibility with consumer preferences remain to be evaluated. Additionally, issues of interoperability need to be tested as these concepts are implemented at different levels of the power system and as systems evolve over time adding functions and changing communication platforms. These individual ultimately need to integrate seamlessly back to the operating utility.

***11. What additional data is needed to demonstrate the benefits of smart grid?***

**Demonstrate the value of non-operational data collected from the smart grid to improve planning, asset management, and decision support for the power delivery system.**

Smart grid communications and sensor technology enable the capture of specific equipment performance characteristics, equipment load profiles, system disturbances and events, and condition monitoring data. This information can be coupled with AMI data from the meters for detailed analysis of asset performance and system requirements. Decision support processes can be improved for system planning; asset utilization; operations and contingency response; asset life cycle management including transparent decisions for equipment upgrades retrofits, or replacements; and asset maintenance based on condition monitoring and assessment. Requirements for asset monitoring continue to evolve and grow.

# III. Common Requirements for Qualifying Smart Grid Demonstration Projects

The national investment in major regional smart grid demonstrations can deliver the most value to the nation's smart grid agenda if they meet common standards for evaluation and if a broad population of regulatory models is covered in the demonstrations. Basic guidelines are suggested below.

### A. Seek substantial demand response demonstrations (20,000+ premises) in four main regulatory footprints.

The intent is to capture a rich set of results depicting consumer behavior, performance of various rate structures, improvements in utility performance at low and high voltage levels, and the ability to leverage smart grid communications to support ancillary services markets where applicable. The primary regulatory footprints of interest include the following:

1. Investor-owned utilities (IOU) in a traditional vertically integrated utility environment (no market structures);
2. IOU in a market environment run by an Independent System Operator (ISO);
3. Tax Exempt public utility with municipal utilities and Public Utility Commissions serving as the Load Serving Entities; and
4. Electric Cooperatives/Rural Electrification Administration (REA) structure with Generation and Transmissions (G&T's) providing high voltage delivery and base load power.

### B. A common standard for program evaluation needs to be set for projects attracting federal investment per the EISA Title XIII guidance to ensure that results are available and useful for review by stakeholders from regulatory to utility to policy to the vendor community.

The nation has a sense of urgency to address a range of energy issues including costs, constrained infrastructure, increased domestic content, and reduced carbon emissions. Regulators and policy groups need a substantial base of program results and data upon which to frame the next generation of regulatory concepts to encourage prudent implementation of the smart grid at a pace that serves the national energy imperatives.