



U.S. Energy Infrastructure Investment

**Large-Scale Integrated Smart Grid
Solutions with High Penetration of
Renewable Resources, Dispersed
Generation, and Customer Participation**

**Mladen Kezunovic
Coordinator**

Smart Grid Advisory Meeting
June 24, 2009



Outline

- PSerc Smart Grid Task Force
 - PSerc Smart Grid Efforts
 - PSerc Smart Grid White Paper
 - Project ideas proposed by PSerc researchers
 - Next steps

Smart Grid Task Force



- M. Kezunovic, Coordinator
- N. Bhatt, AEP
- A. Bose, WSU
- C. DeMarco, Wisconsin
- J. Giri, AREVA
- G. Heydt, ASU,
- W. Jewell, Wichita State

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Smart Grid Efforts



- Executive Forum “Smart Grid Deployment Strategies and Business Opportunities”, March 6, 2009
- Panel “Research Frontiers for the Smart grid: University-Industry Partnership” IEEE PSCE in Seattle, March 16, 2009
- IEEE P&E Magazine paper “Is Teamwork the Smart Solution “, March/April 2009
- NAPS paper “Professional Resources to Implement the Smart grid”, October 2009
- Team for support of NIST/EPRI Interoperability activities

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Smart Grid White Paper Team



- Lisa Beard, TVA
- Navin Bhatt, AEP
- Anjan Bose, Washington State University
- Ian Dobson, University of Wisconsin - Madison
- Floyd Galvan, Entergy
- Jay Giri, AREVA T&D
- Gerald T. Heydt, Arizona State University
- Ward Jewell, Wichita State University
- Mladen Kezunovic, Texas A&M University
- Jim McCalley, Iowa State University
- Sakis Meliopoulos, Georgia Tech University
- James Momoh, Howard University
- Dennis Ray, PSERC
- Peter Sauer, University of Illinois at Urbana/Champaign
- Vijay Vittal, Arizona State University

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Smart Grid White Paper Focus



1. Enabling informed participation by customers
2. Accommodating all generation and storage options
3. Enabling new products, services, and markets
4. Providing the power quality for the range of needs in the 21st century economy
5. Optimizing asset utilization and operating efficiently
6. Addressing disturbances through automated prevention, containment, and restoration
7. Operating resiliently against all hazards.

Smart Grid White Paper: The Three principal aspects



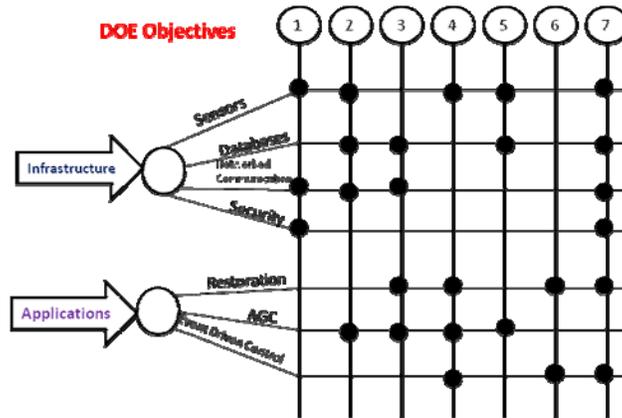
- ***Expansion of the electricity grid infrastructure.***
- ***Introduction of information technology, communications infrastructure, and modern sensors at large - scales for both on - line and back - office services to facilitate the operation and management of assets.***
- ***Incorporation of new monitoring, control, and protection applications that are integrated and operate seamlessly.***

The Four Crucial Steps

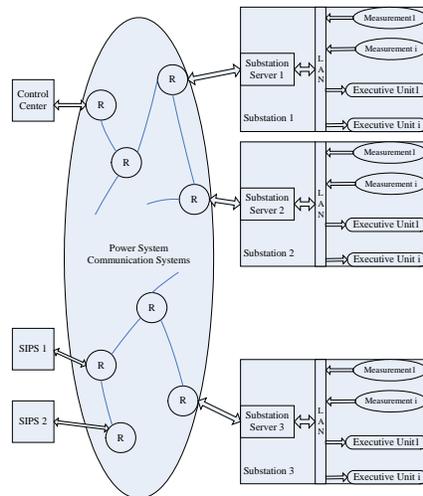


- ☑ Define a vision of an integrated solution
- Conceptualize the overall smart grid architecture
- Conduct research and development to create an integrated solution
- Move forward with stakeholder collaboration and large - scale demonstrations.

Define a Vision for Integrated Systems Operations



Communication Capability

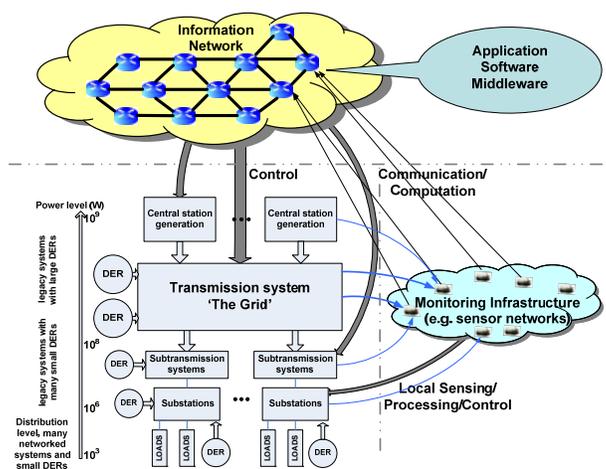


Four Crucial Steps



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Conceptualize the Overall Smart Grid Architecture



Four Crucial Steps



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- ☑ Conduct research and development to create an integrated solution
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Conduct Research and Development to Create an Integrated Smart Grid Solution



- *Develop and establish forward - looking, updated operations criteria including methods, tools, and operational structure of the interconnection*
- *Analyze the likely interactions of renewable resources and storage with the bulk transmission system*
- *Assess the effects of high penetration of low - carbon solutions along with implementation of possible policy scenarios (such as cap and trade) on investment and operations, and on economic profitability and risk under today's market designs to determine whether those designs need to be changed in the future*
- *Develop technologies and tools to facilitate customer participation*

Forward - looking, updated operations criteria including methods, tools, and operational structure



- *Measurements and sensors*
- *Communications*
- *Integration of information technology*
- *Monitoring and supervisory control*
- *Intelligent recovery and restoration*
- *Wide area control and protection*
- *On - line grid control and management tools*

Technologies and Tools



- Demand side management
- Intelligent metering
- Use of plug - in hybrid and all electric vehicles
- Aggregation as a means of collective participation
- Load as a resource
- New designs for information sharing and transacting in an energy exchange system
- Factors that drive customer and business adoption of new technologies and ways of transacting
- Business models in the new energy enterprise.

Four Crucial Steps



- Define a vision of an integrated solution
- Conceptualize the overall smart grid architecture
- Conduct research and development to create an integrated solution
- ☑ Move forward with stakeholder collaboration and large - scale demonstrations.

Move forward with stakeholder collaboration and large - scale demonstrations



- *Engage stakeholders from the beginning in defining the scale, scope, and objectives to the end when results are evaluated and next steps are discussed.*
- *Link the scale, scope and objectives to the information needed to commit resources to building a smart grid.*
- *Define the metrics for evaluating the demonstration's results.*
- *Coordinate the planning of the demonstration with other demonstration projects.*
- *Use scientific study methodologies rather than just technology demonstrations when appropriate.*

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Project ideas: T&D



- Next generation software tools and equipment for validation, standard certification and calibration of advanced substation Intelligent Electronic Devices
- Communication Requirements and Integration Options for Smart Grid Deployment
- Modeling, Analysis, and Design of Highly Reliable Control and Communication Systems for Smart Grid
- New Generation of Substation and Control System Design for the 21st Century
- Next Generation Monitoring Systems for the Smart Grid
- Real-Time Health Assessment of Transmission Lines and Apparatus through High-Fidelity, Intelligent Diagnostics
- Intelligent Monitoring and Diagnostics for Improved Distribution System Reliability and Operations
- Asset optimization of distribution systems to enable grid modernization

Project ideas: Distributed resources and renewable generation



- The optimal size of synchronous AC electrical grids with increased penetration of renewable resources
- Operations with High Penetrations of Solar Photovoltaic (PV) Generation
- Prototyping and demonstration of a smart inverter interfacing PV to the electric grid
- Reliability Roadblocks and Solutions in Integrating Wind Power in Smart Grid
- Control of Energy Storage for Greenhouse Gas Reduction
- PHEVs as Dynamically Configurable Dispersed Energy Storage
- Pricing and Market for Renewable Energy Options

Project ideas: Customer Sites and utility interfaces



- Integration of DC and AC Systems for Delivering Premium Power to Mission-Critical Loads
- Analysis of Power Architecture for DC Microgrid For Utilities, Residential And Commercial Users
- Fast Acting Demand Response
- Large scale System Implementation Demand Side Management
- Real-Time Metering in Texas: Measuring the Impacts



Project ideas: System studies

- Flexible and error tolerant multi-area state estimation using synchrophasors
- Real-time tools for smart grid operation using synchrophasors
- Exploring Approaches to Suppressing Oscillations
- Extreme Event Research
- Injection Points for New Generation Based on Available Transmission Capacity
- Improve grid operation by inserting HVDC links
- Automated Model-Based Wide Area Monitoring System
- Real Time OPF for Grid Control with Stability Constraints
- Power System Visualization for the Smart Grid
- Improving Security Constrained Economic Dispatch through Dynamic Co-Optimization of Grid Topology
- Active N-1 operational reliability analysis



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Next steps



- Define new Smart Grid architecture
- Work with DOE, NETL and others to define ideas for future projects
- Promote Workforce Education Issues
- Develop partnerships for smart grid demonstrations
- Promote PSerc's research capabilities