Smart Grid

Concepts, Solutions, Standards, Recent Deployments and Lessons Learned

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Smart Grid Concepts
Smart Grid View

The integration of electrical and information infrastructures, and the incorporation of automation and information technologies with our existing electrical network.

Comprehensive solutions that:

- Improve the utility’s power reliability, operational performance and overall productivity
- Deliver increases in energy efficiencies and decreases in carbon emissions
- Empower consumers to manage their energy usage and save money without compromising their lifestyle
- Optimize renewable energy integration and enabling broader penetration

That deliver meaningful, measurable and sustainable benefits to the utility, the consumer, the economy and the Environment.

More Focus on the Distribution System
A “Smarter” Grid

Management
“Applications”

Control
“How Power Flows”

Heavy Metal
“Generate & Deliver Power”

‘New Applications enabled by Additional Infrastructure’

Old Grid
- You call when the power goes out.
- Utility pays whatever it takes to meet peak demand.
- Difficult to manage high Wind and Solar penetration.
- Cannot manage distributed generation safely.
- ~10% power loss in T&D

Smart Grid
- Utility knows power is out and usually restores it automatically.
- Utility suppresses demand at peak. Lowers cost. Reduces CAPEX.
- No problem with higher wind and solar penetration.
- Can manage distributed generation safely.
- Power Loss reduced by 2+%, lowers emissions & customer bills.

Enabled Utility Managers
Enabled Consumers
Old Grid
Smart Grid Adds
Smart Grid Solutions
Smart Grid Holistic Solutions

Transitioning from products/systems to holistic solutions
Smart Grid Standards
Development and Interoperability
Example: Standards Framework
National Institute of Standards and Technology (NIST)

... Smart Grid Conceptual Reference Model
... Smart Grid Interoperability Panel Organizational Structure
Following the April 28-29 Smart Grid Interoperability workshop, NIST deemed that sufficient consensus has been achieved on 16 initial standards.

On May 8, NIST announced intention to recognize these standards following 30 day comment period.

NIST’s announcement recognized that some of these standards will require further development and many additional standards will be needed.

**NIST will recognize additional standards as consensus is achieved.**

<table>
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<th>Standard</th>
<th>Application</th>
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<tr>
<td>AMI-SEC System Security Requirements</td>
<td>Advanced metering infrastructure (AMI) and Smart Grid end-to-end security</td>
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<tr>
<td>ANSI C12.19/MC1219</td>
<td>Revenue metering information model</td>
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<td>BACnet ANSI ASHRAE 135-2008/ISO 16484-5</td>
<td>Building automation</td>
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<td>DNP3</td>
<td>Substation and feeder device automation</td>
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<tr>
<td>IEC 60870-6 / TASE.2</td>
<td>Inter-control center communications</td>
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<td>IEC 61968/61970</td>
<td>Application level energy management system interfaces</td>
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<tr>
<td>IEC 62351 Parts 1-8</td>
<td>Information security for power system control operations</td>
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<tr>
<td>IEEE C37.118</td>
<td>Phasor measurement unit (PMU) communications</td>
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<tr>
<td>IEEE 1547</td>
<td>Physical and electrical interconnections between utility and distributed generation (DG)</td>
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<tr>
<td>IEEE 1686-2007</td>
<td>Security for intelligent electronic devices (IEDs)</td>
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<tr>
<td>NERC CIP 002-009</td>
<td>Cyber security standards for the bulk power system</td>
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<tr>
<td>NIST Special Publication (SP) 800-53, NIST SP 800-82</td>
<td>Cyber security standards and guidelines for federal information systems, including those for the bulk power system</td>
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<tr>
<td>Open Automated Demand Response (Open ADR)</td>
<td>Price responsive and direct load control</td>
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<tr>
<td>OpenHAN</td>
<td>Home Area Network device communication, measurement, and control</td>
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<tr>
<td>ZigBee/HomePlug Smart Energy Profile</td>
<td>Home Area Network (HAN) Device Communications and Information Model</td>
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Global Standards Collaboration
Global Standards Collaboration - Ecuador
Smart Grid Standards Vision
The Next Generation
www.SGIP.org
Smart Grid Recent Deployments and Lessons Learned
AEP Smart Grid Project

Summary

• American Electric Power is one of the largest electric utilities in the United States, delivering electricity to more than 5 million customers in 11 states

• 36,000 MW of generating capacity; 39K miles of transmission lines, 208K miles of distribution lines

Drivers

• Enhanced Customer Experience (Customer control, tools to understand usage)

• Operational Efficiencies (Reduce operational costs of the network)

• Energy Efficiency
  • Utilize AMI infrastructure for Automation

Status

• Partnership developed to work together toward developing, demonstrating, & deploying Smart Grid solutions.

• Implement Smart Grid solutions to over 5MM customers by 2015

• First Smart Grid pilot complete in South Bend, IN. Next city-scale project in planning phase.

• GE and AEP working as partners to develop most effective Smart Grid
AEP Project – Solutions Delivered

Demand Optimization
- Smart meters with AMI
  - Time of use pricing
- Home Area Network
- Smart Appliances

Delivery Optimization
- Integrated Volt/Var Control
  - Analysis of theoretical and measured results
  - Analysis of financial benefits (MW, MWH, MVAR, and MVARH savings)
- Smart meters linked to Outage Management System (OMS)
- GENe DMS
- Poweron OMS
- Integration of DMS and OMS
- Leverage AMI for Distribution Automation

Asset Optimization
- Remote transformer monitoring of “at-risk” transformers.
Collaborations & alliances are critical

- $200M smart grid initiative
- ~800-1,000 “green collar” jobs
- Public/private alliance
  - GE
  - City of Miami
  - FPL
  - Cisco
  - Silver Spring Networks
- ~1MM customers involved
  - Smart Meters
  - Demand Management
  - Distribution Automation
  - Substation Intelligence
  - Distributed Generation
  - Enterprise Systems

“It’s time for action. With projects like Energy Smart Miami, we can stimulate the economy today and build a brighter, cleaner tomorrow. It’s truly a win-win.”

Carol Browner
Assistant to the President for Energy and Climate Change
Smart Grid Lessons Learned

Technology:

• **Challenge: “Hype” versus “Reality”**
  • Utility expectations were that basic SG solutions were “shovel-ready”
  • Reality - Component technology was not as mature as advertised when combined to create a Smart Grid Solution
  • In many cases components were field re-engineered or upgraded to meet objectives and expectations

• **Challenge: Integration / Interoperability**
  • Integrating multiple supplier products to create a SG solution
  • Lesson Learned: adopt and insist on standards and open architecture methodology – drive for plug and play solutions

• **Test, Test, Test**
  • Lesson Learned: Extensive lab testing for “SG Solutions” is mandatory prior to implementation – understand the capabilities
  • Re-do’s are expensive and time consuming!
Smart Grid Lessons Learned

Implementation & Deployment:

• Challenge: Coordinating multiple suppliers
  • Managing equipment, shipments & delivery – pieces and parts along with assembly required for implementation (e.g., radio, controller, AMI network, substation equipment with software)
  • Coordinating software functionality with multi-supplier hardware and AMI
  • Lesson Learned: Minimize niche suppliers – prefer alliance suppliers with strong engineering and solution teams

• Challenge: Coordinating multiple internal departments
  • Managing Substation and Distribution Engineering, Protection and Control, Communications and Construction
  • Lesson Learned: Engage 1 Project Manager for each Smart Grid solution with multi-discipline authority

• Prefer packaged solutions from fewer suppliers – minimize the finger-pointing
Smart Grid Lessons Learned

Project Management:

• Establish Program Management Office
  • Multiple Project Managers reporting to the Program Manager
  • Adhere to PM guidelines such as Communication, Status Reporting, Risk Management, etc.
  • Build an “A” team with project and technical members – there will be challenges to collectively solve

• Establish Corporate Steering Committee
  • Key status meetings with Utility Executives and Alliance Suppliers
  • Escalation and Risk Mitigation in timely manner is critical

• Build Strategic Alliances with Key Suppliers
  • Define, Engineer and Build the Smart Grid solutions collectively
  • Alliance Supplier provides “On-site” management and technical support
Smart Grid Lessons Learned

Change Management:

• Smart Grid solutions involve multiple stakeholders (actors)
  • Residential / Commercial customers are now a “Major Stakeholder”
  • For example: PCT’s, In-home devices, utility incentivized customer programs, 2-way communication with the Utility

• Define and develop “Use-Cases” for each component of Smart Grid
  • Use-Cases provide – a scenario description, defines the benefits, actors, functional requirements, and business rules and assumptions
  • Lesson Learned: Use-cases form the basis for the benefits achieved, functional requirements, development, and training
  • Smart Grid actors require “Significant Training” on the operation and maintenance of the deployed system (i.e., Operations Center, Communications, Customer Call Center, Engineering, Field Crews, etc.)
Thank You!