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

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.

Intelligent Electronic Device (IED)
• Any device incorporating one or more processors with the capability to receive or send data/control from or to an external source (e.g., electronic multifunction meters, digital relays, controllers)
### Substation Integration and Automation Levels

<table>
<thead>
<tr>
<th>Utility Enterprise</th>
</tr>
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<tbody>
<tr>
<td>Substation Automation Applications</td>
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<tr>
<td>IED Integration</td>
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<tr>
<td>Intelligent Electronic Device (IED) Implementation</td>
</tr>
<tr>
<td>Power System Equipment (Transformers, Breakers)</td>
</tr>
</tbody>
</table>

### Integration

- Integration of protection, control and data acquisition functions into a minimal number of platforms to reduce capital and operating costs, reduce panel and control room space, and eliminate redundant equipment and databases.
Automation

- Deployment of substation and feeder operating functions and applications ranging from SCADA and alarm processing to integrated volt/Var control in order to optimize the management of capital assets and enhance operation and maintenance (O&M) efficiencies with minimal human intervention.

Communication Paths From Substation

- Two second data to SCADA system (operational data – extracted using industry standard protocol such as DNP3)
- On demand data to utility information server or data warehouse (non-operational data – extracted using IED vendor’s proprietary ASCII commands)
- Remote access from remote site to isolate a particular IED (also called “pass through” or “loop through”)
Communication Paths From Substation (continued)

<table>
<thead>
<tr>
<th>Utility Enterprise Connection</th>
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</thead>
<tbody>
<tr>
<td>SCADA Data to MCC</td>
</tr>
<tr>
<td>Historical Data to Data</td>
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<tr>
<td>Warehouse</td>
</tr>
<tr>
<td>Remote Dial-In to IED</td>
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</tbody>
</table>

<table>
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<th>Substation Automation Applications</th>
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<td>IED Integration Via Data Concentrator/Substation Host Processor</td>
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<td>IED Implementation</td>
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</tbody>
</table>

Operational and Non-Operational Data Paths
Data Concepts

Logic Overview
Local vs. Enterprise Data Marts

- Local historian at substation level is a component of the Substation Automation System (e.g., PC with local substation HMI and historical data archiving) and is designed for Data Mart integration
  - Ability to push data from substation to enterprise Data Mart based on time, demand or event triggered
  - Enterprise Data Mart can pull data from local Data Mart in substation

Enterprise Interoperability

- T & D Planning
- Forecasting
- Scheduling
- Control Center EMS, DMS
- Generation
- Monitoring & Controls
- Substation / Feeder Automation
- Executive Dashboard
- Engineering & Maintenance
- GIS
- EMS
- DMS
- MWM
- AMR
- CIS
- Billing
- Settlements
- Operational Data
- Non-Oper Data
Communications Vision

Data Mart Vision

The Virtual Data Mart Links Users and Applications to Data from Multiple Sources of Record
Vision - Proof of Concept Architecture

(IEC 61850, phasor measurements, PDCs, local historian, local state estimator, visualization and GPS time sync with IEEE 1588 v2, IEEE C37.238)

Distribution Automation

Industry Challenge

US distribution outage duration prolonged by lack of automation
**Distribution Automation Technology Solution**  
Optimizing voltage and reactive power with software, controllers, and communications

**Control commands**

- Model-Based Control
- Substation
- Secondary
- Primary (main breaker)
- OLTC
- SC
- SVR

Distribution system measurements

CVVC and IVVC controls for better regulation of line voltages, loss management, and demand response

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**Distribution Automation Technology Solution**  
Fault Detection, Isolation, Restoration

Replace visual identification of faults

Network analysis, and recloser automation

Outage times can be reduced significantly through improved distribution automation

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Collaboration is critical

Customers/Vendors

Academic Institutions

Trade Associations

Technical Standards

Collaboration is critical
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>
<thead>
<tr>
<th>Standard</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI C12.19/IEEE 1696</td>
<td>Revenue metering and information model</td>
</tr>
<tr>
<td>ANSI C12.19-2001</td>
<td>Revenue metering and information model</td>
</tr>
<tr>
<td>BACnet ANSI ASHRAE 135-2006/ISO 16484-5</td>
<td>Building automation</td>
</tr>
<tr>
<td>DNP3</td>
<td>Substation and feeder device automation</td>
</tr>
<tr>
<td>IEC 61850-5</td>
<td>Inter-control center communications</td>
</tr>
<tr>
<td>IEC 61850-9-2</td>
<td>Substation automation and protection</td>
</tr>
<tr>
<td>IEC 61850-9-21</td>
<td>Application level energy management system interfaces</td>
</tr>
<tr>
<td>IEC 62351-8</td>
<td>Information security for power system control operations</td>
</tr>
<tr>
<td>IEEE C37.118</td>
<td>Phasor measurement units (PMUs) communications</td>
</tr>
<tr>
<td>IEEE 1547</td>
<td>Meter to meter communications between utility and distributed generation (DG)</td>
</tr>
<tr>
<td>IEEE 1588-2008</td>
<td>Security for intelligent electronic devices (IEDs)</td>
</tr>
<tr>
<td>NERC CIP-002-009</td>
<td>Cyber security standards for the bulk power system</td>
</tr>
<tr>
<td>NIST Special Publication (SP) 800-53</td>
<td>Cyber security standards and guidelines for federal information systems, including those for the bulk power system</td>
</tr>
<tr>
<td>Open Automated Demand Response (OpenADR)</td>
<td>Price responsive and direct load control</td>
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</table>

Global Standards Collaboration

[Images of various standards organizations logos]
Leadership makes the difference

Continental Automated Buildings Association
GE role: Board Member
Mission: To advance intelligent home and intelligent building technologies.

DRSG
GE role: Board Member
Mission: To educate and provide information to policymakers, utilities, the media, the general public, and industry stakeholders about demand response and smart grid technologies such as smart meters that can help modernize the electricity system and provide customers with new information and options for managing their electricity use.

Utilities Telecom Council
GE role: Committee Member
Mission: To create a favorable business, regulatory, and technological environment for companies that own, manage, or provide critical telecommunications systems in support of their core business.

Smart Meter Manuf Assoc of America
GE role: Board Member
Mission: To educate legislators, regulators, media, and other stakeholders about the benefits of smart meters and to advocate for policies and regulations that support the widespread deployment within an overall utility smart grid vision.

Smart Grid Consumer Collaborative
GE role: Board Member; Committee Chair; Founding Member
Mission: To gather all stakeholders to listen, educate, and collaborate toward modernized electric systems in the United States.

Smart Grid Canada
GE role: Founding Member
Mission: To drive innovation and development of Canada’s Smart Grid infrastructure by engaging stakeholders from multiple industries.

Smart Grid Ireland
GE role: Chair
Mission: To help develop and leverage opportunities emerging from the global smart grid movement.

Transatlantic Business Dialogue
GE role: Exec. Board Member
Mission: To serve as the official dialogue mechanism between American and European business leaders and U.S. cabinet secretaries and EU commissioners.

Friends of the Super Grid
GE role: Board Member
Mission: To promote and influence the regulatory framework requirements needed for large-scale interconnection in Europe.

Japan Smart Community Alliance
GE role: Member
Mission: To strengthen collaboration among a wide range of concerned organizations; conduct activities of mutual interest, such as dissemination of information and presentation of roadmaps to achieve Smart Communities.

Smart Grid Demand
Mission: To promote the active participation of the demand side in European electricity markets – enhance consumer benefits; increase security of supply and system reliability.

Japan Smart Community Alliance
GE role: Member
Mission: To strengthen collaboration among a wide range of concerned organizations; conduct activities of mutual interest, such as dissemination of information and presentation of roadmaps to achieve Smart Communities.

Smart Energy Demand
Mission: To promote the active participation of the demand side in European electricity markets – enhance consumer benefits; increase security of supply and system reliability.

Smart Grid Australia
GE role: Committee Member
Mission: To educate, inform and lead the debate to ensure consumers, government and policy makers understand the solutions, benefits and possibilities of smart grids.

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