Industrial Innovation and The Smart Grid

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GE Digital Energy
“I find out what the world needs, then I proceed to invent it.”

-Thomas Edison
GE and Industrial Innovation
GE Today

GE Energy Infrastructure
- Energy Management
- Oil & Gas
- Power & Water

Healthcare

Aviation

Transportation

GE Capital
- Home & Business Solutions

~$150B Annual Revenue ... aligned for growth
GE Global Research
Market-focused R&D

Global Research Center
Niskayuna, NY

India Technology Center
Bangalore, India

China Technology Center
Shanghai, China

Global Research Europe
Munich, Germany

Advanced Manufacturing & Software Technology Center
Ann Arbor, MI

Global Software Center
Silicon Valley, CA

Brazil Technology Center
Rio de Janeiro, Brazil

• ~2000 scientists/engineers, nearly two-thirds PhDs.
• 3,615 US patents filed by GE in 2011
• One of the world's most diversified industrial research organizations, providing innovative technology for all of GE’s businesses

Cornerstone of innovation for GE
Global Research at GE

- Deliver core technologies for New Product Introductions
- Invent new technology and new businesses
- Harness advanced technologies
- Spread technology across GE
- Develop world-class talent
- Form technology partnerships and foster collaboration

Clear mission … core to GE
Business-driven Model for Innovation

**Inputs**

- GE businesses
- Customers
- VC’s
- M&A
- Government agencies
- National Labs
- Universities
- Global Scouts
- CEO

**Process**

- Session Ts/quarterly reviews/benchmarking
- Engagement & collaboration
- Energy ventures/healthymagination Fund
- Extensive technical due diligence
- Strengthening connection … materials, renewables, HPC, energy management
- 300+ engagements … IP progress
- Russia, Japan, Israel
- Monthly reviews

**Outputs**
Innovation and Transition to Product

- Common language between Global Research & the businesses
- Plan, manage projects vs. Technology Readiness Level (TRL) & Manufacturing Readiness Level (MRL) progression
- Evaluate readiness for business transition
GE’s Sustainable Energy Programs

More Efficient
- Large GTs … 65% efficiency
- Distributed generation … 70% efficiency

More Natural Gas, & Oil
- Subsea production and exploration
- Applications … Locos and Aircraft
- CO2 capture

More Renewables
- Wind
- Solar
- Energy storage

Smarter Energy Management
- Smarter grid … maximize grid utilization
- Smarter products … intelligent operations
Smart Grid: Technology Development
Distributed Generation

Industry Challenge

A wide array of DG is creating unique challenges in the grid: two-way power flow, voltage regulation concerns.

Distribution controls and protection traditionally take advantage of and are designed only for uni-directional power flow.
Distributed Generation

Industry Challenge

Open circuit over-voltage due to unintentional islanding

Protection ratings not matched to fault currents

Varying Fault Currents due to DG

Stress on Voltage Regulation equipment
Distribution Automation

Industry Challenge

US distribution outage duration prolonged by lack of automation

- Fault Occurs
- Customer Reports Outage
- Travel Time: 5 – 10 minutes
- Fault Investigation & Patrol Time: 15 – 30 minutes
- Fault Located
- Time to Perform Manual Switching: 15 – 20 minutes
- Power Restored to Customers on Healthy Sections of Feeder: 10 – 15 minutes
- Repair Time: 1 – 4 Hours
- Feeder Back to Normal

- Power Restored to Customers on Healthy Sections of Feeder: 45 – 75 minutes
- Customer Reports Outage
- Travel Time: 5 – 10 minutes
- Field Crews On-Scene
- Patrol Time: 15 – 30 minutes
- Repair Time: 5 – 10 minutes
- Feeder Back to Normal

1 to 5 minutes
Distributed Generation Integration

Technology Solution: Wireless solutions can provide fast control of DG that becomes isolated by a fault.
Distributed Generation Integration

Technology Solution

Optimal dispatch of complex energy resources

U90 Microgrid Controller

Smart control system to optimize and manage generators, energy storage and loads featuring:

• Optimal Dispatch
• Supervisory Controls
• Islanding/Tie-Line Controls
Distributed Generation Integration

Technology Solutions

Optimize conventional generation dispatch
- Leverage production forecasting in optimal dispatch
- Intelligent unit commitment and use of reserves

Compensate for variability when needed
- Use of fast-start thermal generation
- *Bridging* storage (if needed)
- Demand response

Leverage full capabilities of the renewables
- Fault ride-through
- Volt/VAr regulation
- Ramp-rate controls
- Curtailment
- Inertial response
Distribution Automation

Technology Solution: Optimizing voltage and reactive power with software, controllers, and communications

Model-Based Control

Substation

Control commands

Distribution system measurements

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

Technology Solution  Multi-faceted energy resources management

Software application to optimize the use of load resources for peak load management and grid operation support while enabling consumers to better manage consumption and cost.
Smart Grid:
Standards Development
Smart Grid Interoperability Panel

Milestones:
- Nov. 2009 – Formation of SGIP
- Jun. 2010 – Formation of SG Federal Advisory Committee
- Dec. 2011 – SGFAC Report to NIST
- Apr. 2012 – Draft of SGIP 2.0 Business Sustainment Plan
- Jul. 2012 – Business Sustainment Plan Finalized, SGIP 2.0 incorporated

Today:  [www.sgip.org](http://www.sgip.org)

Nearly 100 companies and organizations are paying SGIP members

Catalog of Standards:
- Hundreds of standards considered
- 42 Included in the catalog
- 14 currently being voted on
- 82 in the review/evaluation queue

International letters of intent have been signed with countries in Europe, Asia, and the Americas with many more to come
Smart Grid: Policy Development
Regulation and Innovation

Industry Challenge

Deregulation has not occurred consistently in all areas; this has led to limited competition and hindered innovation.

Where utility territories cross jurisdictions, they must often gain approvals from multiple commissions and regulatory bodies.

These factors can slow, delay, or even prevent projects from getting started.

Excerpted from "Smart Grid 101: The Barriers to a Smart Grid", SmartGridNews.com
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imagination at work