

CPET 581 Smart Grid & Energy Management
2013/10/4
6:00-8:45PM Friday
Lecture 8

Topics of Discussion

- Policy Drivers Behind Smart Grid
- Smart Grid Definitions
- Smart Grid :
 - Objectives
 - The Opportunities and Challenges
- IEEE Smart Grid Webinars
- Smart Grid System Reports

Policy Drivers behind Smart Grid

- The Energy Independence and Security Act of 2007 (EISA), Section XIII,
<http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf>
 - Founding document for smart grid implementation
- American Recovery and Reinvestment Act of 2009 (ARRA),
http://www.recovery.gov/About/Pages/The_Act.aspx
 - Economic stimulus bill that provides funding (\$4 billion) for smart grid
- FERC/NARUC Smart Grid Collaborative, <http://www.ferc.gov/industries/electric/industry-act/smart-grid/ferc-naruc-collaborative.pdf>
 - FERC (Federal Energy Regulatory Commission), <https://www.ferc.gov/>
 - NARUC (National Association of Regulatory Utility Commissioners) founded 1889,
<http://www.naruc.org/index.cfm>
- FERC Policy on Smart Grid
- State policies on Advanced Metering Infrastructure, new technologies, renewable resources, etc

Smart Grid Definition, (The Energy Independence and Security Act of 2007 – EISA)

- The EISA 2007 describes smart grid as “a modernization of the Nation’s electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth

Smart Grid Definition (USA)

- A developing network of new technologies, equipment, and controls working together to respond immediately to our 21st century demand for electricity,
http://www.smartgrid.gov/the_smart_grid

Smart Grid (USA DOE)

- A Smart Grid is the electricity delivery system (from point of generation to point of consumption) integrated with communications and information technology for enhancing grid operations, customer services, and environmental benefits.
- Smart Grid Primer (Smart Grid Books), DOE Office of Electricity Delivery & Energy Reliability,
<http://energy.gov/oe/technology-development/smart-grid/smart-grid-primer-smart-grid-books>

Smart Grid Definitions (The European Union Commission)

- An electricity network that can cost-effectively integrate the behavior and actions of all users connected to it in a manner which ensures an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.

SMARTGRID.GOV, <http://www.smartgrid.gov/>

- What is the Smart Grid?
- Recovery Act Smart Grid Programs
- Federal Smart Grid Initiatives
- Smart Grid Resource Center

A Vision for the Smart Grid, The Modern Grid Strategy, 2009,

http://www.netl.doe.gov/smartgrid/referenceshelf/whitepapers/Whitepaper_The%20Modern%20Grid%20Vision_APPROVED_2009_06_18.pdf

- **Modernization of 21st century electric grid with the following 6 values**
 1. The grid must be more reliable
 2. The grid must be more secure
 3. The grid must be more economical
 4. The grid must be more efficient
 5. The grid must be more environmental friendly
 6. The grid must be safer
- **The Smart Grid vision** (the 7 characteristics, features)
 1. Enables Consumer Participation
 - Give consumers information (day-to-day), control and options that allow them to engage in new “electricity markets.”
 - Have ability to modify consumption based on balancing their demands and resources with the electric system’s capability to meet those demands
 - Demand-response (DR) programs
 - Consumers: will satisfy a basic consumer need- greater choice in energy purchases
 - Utilities: the ability to reduce or shift peak demand allows utilities to minimize capital expenditures and operating expenses while also providing substantial environmental benefits by reducing “Line Losses” and minimizing the “operation of inefficient peaking power plants.”
 2. Accommodates All Generation & Storage Option
 3. Enables new products, services, and markets
 4. Meets power quality (PQ) needs for the digital economy
 5. Optimizes asset utilization and operates efficiently
 6. Self Heals (anticipate and respond to system disturbances)
 7. Resists Attack (operate resiliently against attack and natural disaster)
- **The Milestones**
 1. Consumer enablement
 - Information & Education
 - Solutions to empower and utilize new options
 - Advanced metering infrastructure

- Home area networks with in-home displays
 - Distributed energy resources
 - Demand response programs
 - Upgrades to utility information technology architectures and applications that will support “plug-and-play” integration with future Smart Grid technologies
2. Advanced distribution operations
 - Improve reliability and enable “self-healing”
 - Includes solutions
 - Smart sensors and control devices
 - Advanced outage management
 - Distribution management and distribution automation systems
 - Geographical information, and
 - other technologies to support two-way power flow and micro-grid operation
 3. Advanced transmission operations
 - Integrate the distribution system both the consumer enablement and advanced distribution operations milestones, with Regional Transmission Organization (RTO) applications to improve overall grid operations and reduced transmission congestion
 - Includes
 - Substation automation
 - Integrated wide area measurement applications
 - Power electronics
 - Advanced system monitoring and protection schemes, as well as
 - Modeling, simulation, and visualization tools to increase situational awareness and provide a better understanding of real time and future operating risks
 4. Advanced Asset Management (AAM)
 - Integrate the grid intelligence acquired in achieving the other milestones with new and existing asset management applications.
 - This integration will enable utilities to reduce operations, maintenance, and capital costs and better utilizes assets during day-to-day operations.
 - Additionally, advanced asset management will significantly improve the performance of capacity planning, maintenance, engineering and facility design, customer service processes, and work and resource management
- Smart Grid’s mode of operation
 1. Emergency response
 2. Restoration
 3. Routine operation
 4. Optimization
 5. System planning

Some Smart Grid Applications

- Advanced transmission technologies
- Demand response and advanced metering interfaces
- Energy efficiency and ancillary services provided by loads

- Renewable resources, especially wind and solar
- Distributed generation and storage

Smart Grid

- Smart Grid Primer (Smart Grid Books), DOE Office of Electricity Delivery & Energy Reliability, <http://energy.gov/oe/technology-development/smart-grid/smart-grid-primer-smart-grid-books>
- NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 2.0, 227 pages, http://www.nist.gov/smartgrid/upload/NIST_Framework_Release_2-0_corr.pdf
- Smart Grid Roadmap and Architecture, EPRI, December 2010, http://www.smartgrid.epri.com/doc/cal%20iso%20roadmap_public.pdf
- IEEE Smart Grid, <http://smartgrid.ieee.org/ieee-smart-grid/smart-grid-conceptual-model>
- Global Smart Grid Federation 2012 Report, Canada, http://www.smartgrid.gov/sites/default/files/doc/files/Global_Smart_Grid_Federation_Report.pdf
- Smart Grid System Reports
 - 20 Metrics for the Smart Grid System Report, <http://energy.gov/oe/downloads/smart-grid-system-report>
 - Metric #1: The Fraction of Customers and Total Load Served by Real-Time Pricing, Critical Peak Pricing, and Time-of-Use Pricing
 - Metric #2: Real-Time System Operations Data Sharing
 - Metric #3: Standard Distributed Resource Connection Policies
 - Metric #4: Regulatory Recovery for Smart Grid Investments
 - Metric #5: Load Participation
 - Metric #6: Load Served by MicroGrids
 - Metric #7: Grid-Connected Distributed Generation and Storage
 - Metric #8: Market Penetration of Electric Vehicles and Plug-In Hybrid Electric Vehicles
 - Metric #9: Grid-Responsive, Non-Generating Demand-Side Equipment
 - Metric #10: Transmission and Distribution Reliability
 - Metric #11: Transmission and Distribution Automation
 - Metric #12: Advanced Meters
 - Metric #13: Advanced Measurement Systems
 - Metric #14: Capacity Factors
 - Metric #15: Generation, Transmission, and Distribution Efficiency
 - Metric #16: Dynamic Line Ratings
 - Metric #17: Customer Complaints regarding Power Quality Issues
 - Metric #18: Cyber Security
 - Metric #19: Open Architecture/Standards
 - Metric #20: Venture Capital Investment in Smart Grid Startup Companies

- 2009 Report (July 2009), <http://energy.gov/oe/downloads/2009-smart-grid-system-report-july-2009>
- 2010 Report (Feb. 2012), <http://energy.gov/oe/downloads/2010-smart-grid-system-report-february-2012>

Smart Grid System Report, Pacific Northwest National Laboratory,
<https://spcollab.pnnl.gov/sites/SGSRWeb/Pages/Home.aspx>

EAC (Electricity Advisory Committee) Recommendations for DOE Action Regarding Consumer Acceptance of Smart Grid – June 6, 2013 (20 pages), <http://energy.gov/oe/downloads/eac-recommendations-doe-action-regarding-consumer-acceptance-smart-grid-june-6-2013>

IEEE Smart Grid Webinars, <http://smartgrid.ieee.org/resources/ieee-smart-grid-webinars/past-ieee-smart-grid-webinars> (assigned webinar 9/24 through 9/27)

- **The Evolution of the Smart Grid – Part I with Steven Collier (2013/6/6, 1 hr 3 min):** Historical factors leading to and sustaining today's grid; changed in circumstances that are eroding or even reversing them
- **The Evolution of the Smart Grid – Part II with Steven Collier (2013/6/27, 1 hr 1 min):** Developments that require a new kind of grid for the 21st century: Technology, Market, and Global Economy.
- **The Evolution of the Smart Grid – Part III with Steven Collier (2013/7/18, 59 min):** The technology revolution enables an intelligent grid for the 21st Century: Electronics, Telecommunications, Information, Energy
- **The Evolution of the Smart Grid – Part IV with Steven Collier (2013/8/22, 1 hr):** The Smart Grid is inseparable from the Internet: The Enernet, The Internet of Things, Peer to Peer Energy
- **IT Innovations, Cyber-Physical Security and Cyber-Infrastructure Security with Massoud Amin (2013/6/20, 1hr 8 min)**