CPET 581 Smart Grid & Energy Management 2013/10/8 & 10/10 Tuesday 4:30-5:45PM & Thursday 4:30-5:45PM Lecture 9/10

Topics of Discussion

- Smart Grid Technology Roadmap
- Smart Grid Technology Areas: Generation, Transmission, Distribution, Industrial, Service, Residential
- Smart Grid Deployment
 - Demonstration & Deployment Efforts
- Smart Grid Interoperability Standards

WSJ, 10/5/2013

Investors Bet Big on Hydroelectric Plants, 2013/10/5, http://online.wsj.com/article/SB10001424052702303643304579107590118304648.html

- Burton Creek, Sam Perry's restored hydroelectric plant near Mount Rainier National Park, with 550 ft fall (Sollos Energy LLC of Mancos, Colo)
- 5,000 gallons of water per minute, falls 550 ft into a turbine at the base of the falls
- Generate electricity \$12,000 per month
- Generating capacity: 480 kWh, at 3 to 4 cents per kWh, which would produce electricity worth around \$400 per day, \$12,000 monthly during peak periods (from November to late June)
- Mr. Perry would expect to break even on his his investment within 5 years
- 1978 Public Utility Regulatory Policies Act (PURPA)
- Licenses issued by Hydropower dams, by size, 9/30/2013, Federal Energy Resources Commission
- Video, <u>http://stream.wsj.com/story/world-stream/SS-2-44156/SS-2-346688/?mod=wsj_streaming_world-stream</u>

Ohio Smelter Faces Shutdown Without Utility Rate Relief, 10/5/2013, WSJ, http://online.wsj.com/article/SB10001424052702303492504579113341291138108.html

Smart Grid Technology Area [1, pages 17-21] {NTEL, 2010 and NIST 2010}; V – completely covered, V-slightly overlapped

	Generation	Transmission	Distribution	Industrial	Service	Residential
Wide Area	v	v	V-			
Monitoring &						
Control						
Information &	v	v	v	v	v	v
Communication						
Technology						
Integration						
Renewable &	v	v	v	v	V	v

Distributed						
Generation						
Integration						
Transmission	V-	v	V-			
Enhancement						
Applications						
Distribution &		V-	v	V-		
Management						
Advanced			v	v	v	v
Metering						
Infrastructure						
(AMI)						
EV Charging			v	v	v	v
Infrastructure						
Customer-side				v	v	v
Systems						

Smart Grid Technologies [1, page 21]

Technology	Hardware	Systems and Software		
Areas				
Wide Area	Phase measurement units (PMU) &	SCADA (Supervisory Control and Data		
Monitoring &	other sensor equipment	Acquisition), WAMS (Wide Area Monitoring		
Control		Systems), WAAPCA (Wide-Area Adaptive		
		Protection, Control & Automation), WASA		
		(Wide-Area Situation Awareness)		
Information &	Communication equipment (Power line	Enterprise Resource Planning (ERP)		
Communication	carrier, WIMAX, LTE, RF mesh network,	software, Customer Information System		
Technology	cellular), routers, relays, switches,	(CIS)		
Integration	gateway, computers (servers)			
Renewable &	Power conditioning equipment	Energy management system (EMS),		
Distributed	for bulk power and grid support,	distribution management system (DMS),		
Generation	communication and control hardware	SCADA, geographic Information		
Integration	for generation and enabling storage	system (GIS)		
	technology			
Transmission	Superconductors, FACTS, HVDC	Network stability analysis, automatic		
Enhancement		recovery systems		
Applications				
Distribution &	Automated re-closers, switches	Geographic information system (GIS),		
Management	and capacitors, remote controlled	distribution management system (DMS),		
	distributed generation and storage,	outage management system (OMS),		
	transformer sensors, wire and cable	workforce management system (WMS)		
	sensors			
Advanced	Smart meter, in-home displays, servers,	Meter data management system (MDMS)		
Metering	relays			
Infrastructure				
(AMI)				
EV Charging	Charging infrastructure, batteries,	Energy billing, smart-grid to-vehicle		

Infrastructure	inverters	charging (G2V) and discharging vehicle-to- grid (V2G) methodologies
Customer-side Systems	Smart appliances, routers, in-home display, building automation systems,	Energy dashboards, energy management systems, energy applications for smart
	thermal accumulators, smart thermostat	phones and tablets

Maturity Levels & Development Trends of Smart Grid Technologies [1, page 22]

Technology Areas	Maturity Level	Development Trend
Wide Area Monitoring & Control	Developing	Fast
Information & Communication	Mature	Fast
Technology Integration		
Renewable & Distributed	Developing	Fast
Generation Integration		
Transmission Enhancement	Mature	Moderate
Applications		
Distribution & Management	Developing	Moderate
Advanced Metering Infrastructure	Mature	Fast
(AMI)		
EV Charging Infrastructure	Developing	Fast
Customer-side Systems	Developing	Fast

California ISO/EPRI Smart Grid Roadmap & Architecture [3]

- Key Smart Grid Drivers:
 - Energy supply from renewables
 - CO2 emission level rolled back to 1990 level by 2020
 - One million roof-top solar panels
 - Large investment in energy conservation & delivery
 - New Once-Through Cooling regulation affecting coastal plants 2012-2024
 - Large investments in smart grid (smart meters, storage, etc)
- Smart Grid Objectives (research, pilot, implement, integrate smart grid technologies)
 - Increase grid visibility, efficiency, and reliability
 - Enable diverse generation including utility-scale renewable resources, demand response, storage and smaller-scale solar PV technologies to fully participate in the wholesale market
 - Provide enhanced physical and cyber security
- The Expected Benefits
 - Ability to recognize grid problems sooner and resolve them
 - Efficiently use the transmission system to defer or displace costly transmission investments
 - Enable customers to react to grid conditions making them active participants in their energy use
 - Leverage conventional generation and emerging technologies when possible including distributed energy resources, demand response and energy storage, to address the challenges introduced by variable renewable resources

References

[1] Smart Grid Road Map, 2011, IEA Free Publication,

http://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf

- [2] Free Publications, International Energy Agency, <u>http://www.iea.org/publications/</u>
- [3]Smart Grid Roadmap and Architecture, California ISO/EPRI, December 2010, http://www.smartgrid.epri.com/doc/cal%20iso%20roadmap_public.pdf
- [4]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
- [5]NIST Smart Grid Interoperability Standards Update, July 25, 2011, <u>http://www.smartgrid.gov/sites/default/files/doc/files/National_Institute_Standards_Technology_N_IST_Smart_Grid_Inte_201103.pdf</u>
- [6]NIST Smart Grid Advisory Committee (SGAC) Report, 2011, 70 pages, <u>http://www.smartgrid.gov/sites/default/files/doc/files/NIST_Smart_Grid_Advisory_Committee_SGA_C_Report.pdf</u>

Smart Grid Demos

- [1]EPRI (Electric Power Research Institute) Smart Grid Demo Projects (Youtube), http://www.youtube.com/playlist?list=PLphKrnecF69X0MxPf4aHDu1UJHNn8wGuq
 - a. EDF Smart Grid Demo, 2012
 - b. PNM/EPRI Smart Grid Demo
 - c. KCP&L/EPRI Smart Grid Demo
 - d. Smart Grid Application Southern Company's Approach
- [2]Smart Grid Demos Integration of Distributed Energy Resources, EPRI Smart Grid Resource Center, http://smartgrid.epri.com/Demo.aspx
 - a. Smart Grid Demonstration Five-Year Update, 28 pages, 08/10/2013
 - b. Smart Grid Demonstration Four-Year Update, 07/26/2012
 - c. Smart Grid Demonstration Three-Year Update, 07/21/2011
 - d. Smart Grid Demonstration Two-Year Update, 08/20/2010
- [3]Pacific Northwest Smart Grid Demo Project, <u>http://www.pnwsmartgrid.org/</u>
 - a. Transactive Control
 - b. Integrating Renewable Energy
 - c. Improving Reliability
 - d. Keeping the Cost Down
 - e. Empowering Consumers
- [4] The Pecan Street Project, Texas, <u>http://www.pecanstreet.org/projects/smart-grid-demonstration/</u>
- [5]Lower Valley Energy, <u>http://www.lvenergy.com/smart-grid-demo-project-moves-forward/</u>
- [6]Residential Smart Grid Solutions Lutron, <u>http://www.lutron.com/en-US/Residential-Commercial-Solutions/Pages/Residential-Solutions/ResidentialSmartGridSolutions.aspx</u>