Harnessing Electricity Demand Flexibility

PSERC Summer School
Professor Khorsand Hedman
Professor

Dr. Mojdeh Khorsand Hedman
School of Electrical, Computer, and Energy Engineering
PO Box 875706
Arizona State University
Tempe, AZ 85287-5706

E-Mail: mkhorsand@asu.edu
Smart Grid
“Smart grid” generally refers to a class of technologies that people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way digital communications technologies and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers – mostly seen in big improvements in energy efficiency and reliability on the electricity grid and in energy users’ homes and offices.
Smart Grid Overview

- Markets
- Operations
- Service Provider
- Bulk Generation
- Transmission
- Distribution
- Customer

Cybersecurity (everywhere)
- Wide Area Situational Awareness (WASA)
- Networks
- Intelligent sensors
- Electromagnetic compatibility (everywhere)
- Building Automation
- Industrial Control Systems
- Electric Power Metering

Power Electronics
The Grid has always been smart. It’s getting smarter:

- Significant change in the way power supply system is designed and operated
- Improved operational efficiency
- Reduced environmental impact
- More customer choices
- Through application of new technologies
Traditionally

• Passive distribution systems
• Limited sensors, monitoring, and operator visualization
• Poor situational awareness
• Numerous resources to monitor
• Limited information for asset maintenance and replacement
• Time consuming and less targeted crew dispatch
• Lengthy process for fault locating and restoration
• Time-based maintenance

Smart Grid

• Customer owned generation and storage
• Utility owned distributed generation and storage
• Active customer involvement
• Modeling major events and identify the weaknesses and strengths
• Automated plans
• Shorter restoration time
• Reduce emergency response time
• Faster resolution of outages and customer power quality problems
• Improved facility data for crews
• Timely information for customers
• More automated services
• Enhanced situational awareness
• Ability to customize services
Customer Energy Management

- Rooftop solar PV
- Battery energy storage
- Automated Metering Infrastructure (AMI, aka: Smart Meters)
- Home area networks (HAN)
- Demand response (automated; normal or emergency)
- Electric Vehicles
- Programmable Communication Thermostat
- Smart appliances
- Mobile apps
Customer plays a more participative role in energy consumption and generation:

- Customer owned generation
- Customer owned energy storage
- Dynamic rates
- Direct Display of consumption and costs
- Automated appliances

CAISO’s duck curve: Aggregated net load

Change in Load Behavior

More variability and uncertainty in net load
Traditionally: The desire of individual electric customers to pay for reliability were not clear.

How much a customer is willing to pay to have NO interruption in his/her electric services?

Is this the same for all customers?

How about industrial loads?

Can the new advancements help to address this?