Customer Side Smart Grid Installations
Preparing for the Future

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1 Continuing Education Hour

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Learning Objectives

• Describe Implications of the Smart Grid on Energy Consumers

• Discuss Customer Side Smart Grid Technologies, including Demand-Side Management, Energy Generation, and Energy Storage

• Evaluate Marketing Strategies for Electrical Contractors, including advantages and risk
Introduction, Background, and Justification

Federal Smart Grid Initiative Vision

“an electrical grid that uses information and communications technology to gather and act on information about the behaviors of suppliers and consumers”

Smart grid is evolving into a network of new technologies, equipment, and controls; which working together, will be able to respond immediately to the demand for electricity in the 21st century.

Goal is to automate and improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

Three main components of the smart grid are:

1. Electric energy generation
2. Distribution
3. Consumption

Smart Grid - Applications

The NIST Smart Grid Collaboration Site (http://www.nist.gov/smartgrid/twiki.cfm) lists a wide range of energy management applications and electrical service provider interactions, including:

1. On-site generation
2. Demand response
3. Electrical storage
4. Peak demand management
5. Forward power usage estimation
6. Load shedding capability estimation
7. End load monitoring (sub metering)
8. Power quality of service monitoring
9. Utilization of historical energy consumption data
10. Responsive energy control
Smart Grid Customer Domain

Traditional Grid versus Smart Grid

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Smart Meter – Market Growth

United States Smart Meter Penetration by 2014

Smart Meter – Metering

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Electric Rate ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM to 11:00 AM</td>
<td>Off-Peak (Morning)</td>
</tr>
<tr>
<td>11:00 AM to 4:00 PM</td>
<td>Peak</td>
</tr>
<tr>
<td>4:00 PM to 10:00 PM</td>
<td>Partial Peak</td>
</tr>
<tr>
<td>10:00 PM to 6:00 AM</td>
<td>Off-Peak (Night)</td>
</tr>
</tbody>
</table>

Time of Use (TOU) Metering Example
Smart Meter – Metering

<table>
<thead>
<tr>
<th>Electric Rate</th>
<th>Tiers</th>
<th>Total Standard electric rates ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Summer</td>
</tr>
<tr>
<td>Baseline</td>
<td>Tier 1</td>
<td>.15</td>
</tr>
<tr>
<td>101% to 130% of Baseline</td>
<td>Tier 2</td>
<td>.17</td>
</tr>
<tr>
<td>131% to 200% of Baseline</td>
<td>Tier 3</td>
<td>.35</td>
</tr>
<tr>
<td>Above 200% of Baseline</td>
<td>Tier 4</td>
<td>.37</td>
</tr>
</tbody>
</table>

Tiered Rate Metering Example

Customer Side Smart Grid Technologies

Customer may choose to manage and control their energy consumption by:

- Implementing a home energy management system to manage energy usage of appliances, equipment, lighting, etc. and to balance TOU metering
- Installing an on-site energy generation systems in order to mitigate increased energy cost due to tiered rate metering
- Scheduling electric vehicle charging to take advantage of off-peak pricing rates
- Implementing smart charging for electric thermal storage systems (i.e., in-ground heating systems, unit heaters, etc.)
- Implementing load shedding
Impact of Smart Grid Technologies

- Dramatic increase in data communication, including dedicated low voltage wired systems, low voltage wired systems impressed upon line voltage carriers, and wireless systems between smart grid appliances/outlets and smart meters, or between devices and home energy management and control systems
- Critical circuits for life-safety systems - including special needs equipment such as patient care equipment (ventilators, diagnosis equipment, etc.), which will need to remain powered during load shedding
- Power and/or control wiring to tie into panel boards/load centers
- Grounding and bonding for all new smart grid components
- Sensors will be needed to connect major electrical loads to a smart meter
- Current and overload protection for smart systems to prevent frequent current inrush from switching of large appliance loads
- Harmonics protection induced from Class 2 wiring

Energy Management and Control Systems (EMCS)

Energy savings may be realized via an EMCS in a number of ways:

- Benchmarking and Base-lining
- Off-hours energy use
- Anomaly detection
- Load shape optimization
- Energy rate analysis
- Retrofits and retro-commissioning
Energy Management and Control Systems (EMCS)

Generic Framework for an Energy Management and Control System (EMCS)

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Energy Management and Control Systems (EMCS)

Graphical comparison of HVAC, Lighting, and MEL's in a Commercial building

Advanced Metering Infrastructure and Submetering

Electrical Distribution tree in a commercial building, showing sub-metering
Advanced Metering Infrastructure and Submetering

Instrumentation deployment and communication in a commercial building

Load Shedding

Critical
- Refrigerator
- Emergency Lighting
- Fire Detection
- Fire Alarm
- Electric Range
- Security
- Critical Outlets

Non-Essential
- Clothes Washer
- Dryer
- Air-Conditioner
- Outlets
- Lighting
- Fountain Pumps

Separation of Critical and Non-Essential Loads
# Energy Generation

- Photovoltaics (PV) and Built-In PV's
- Small Scale Wind Turbines
- Micro-Hydro Generators
- Fuel Cells and Microbial Fuel Cells
- Combined Heat and Power (CHP) and Micro CHP (MicroCHP) Installations

# Energy Storage

- Batteries
- EV Storage
- Integrated Storage
- UPS
Marketing Strategies for Electrical Contractors

Monitoring and identification of Current Energy Needs

**Commercial Office Buildings (EIA, 2009)**
- Heating Systems (28%)
- Cooling/Venting Systems (15%)
- Office Equipment and Other (21%)
- Lighting Systems and Appliances (26%)
- Water Heating (10%)

**Residential Structures (EIA, 2009)**
- Heating Systems (~31%)
- Lighting and Appliances (~31%)
- Water Heating (~27%)
- Air Conditioning (~6%)
- Refrigeration (~5%)

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U.S. Energy Consumption in Office Buildings by End Use

[Diagram showing energy consumption by end use in different regions.]

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Marketing Strategies for Electrical Contractors

- Consumer Advantages
- Reduction of Energy Use
- Strategic Cost Savings from Variable Cost Structures
- Consumer Risk
- Subcontractor Advantages
- Subcontractor Risk
Quiz

• Smart grid technologies have the potential to save energy consumers up to 15 to 30 percent in energy costs.
  – True
  – False
• The Smart Grid has a wide range of energy management applications and electrical service provider interactions, including:
  – On-site generation
  – Demand response
  – Electrical storage
  – All of the above
• The implementation of the smart grid allows for Time of Use (TOU) metering which enables electric utility providers to charge different rates at different times throughout the day.
  – True
  – False

Quiz

• Prerequisite factors needed for the successful implementation of customer side smart grid installations include:
  – Identification and Monitoring of current energy needs
  – Creating and implementing changes for adaptive subsystems
  – Developing centralized adaptive controls for optimization and unification of subsystems
  – All of the above
• An Energy Service Company typically offers the following services:
  – Develop, design, and arrange financing for energy efficiency projects
  – Install and maintain the energy efficient equipment
  – Measure, monitor, and verify the project’s energy savings
  – Assume the technical and performance risk that the project will save the amount of energy guaranteed
  – All of the above
Questions

Thank You!