Utility of the Future: 
*Smart Grid, Smart Consumers*

Metering East Coast, October 25, 2008
Raleigh NC

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Utility of the Future

Drivers

- Government policies
- Market liberalization & competition
- Climate change & environmental sustainability
  - CO₂ emissions & policies
- Energy independence & security
  - Demand growth
  - Fuel / wholesale costs
  - Renewables & alternatives
  - Demand response
- Consumer demands
  - Cost, Choice, Comfort
  - Social responsibility
- Infrastructure
  - Aging assets
  - Technical obsolescence
  - Investment priorities (Gen, Tx, Dist)

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Climate Change

- Target reduction of GHG emissions
  - EU 20% by 2020
- e.g. EPRI estimates the US Electric sector can by 2030 achieve a reduction to below 1990 levels through:
  - Energy efficiency
  - Renewables
  - Nuclear & advanced coal generation
  - CO$_2$ capture & storage
  - Distributed energy resources
  - Plug-in hybrid electric vehicles
- How do you engage consumers?

**Alliance for Climate Protection:**
- 9% Activists
- 35% Engaged
- 38% State of Fear
- 18% Ignorant of Issues
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Energy Efficiency

• Why Energy Efficiency?
  • Large untapped resource
  • Can help reduce GHG emissions
  • Utilities are well positioned to deliver efficiency programs
    • 11 states have energy efficiency goals

• How?
  • Recognize efficiency as a high-priority resource
  • Make long term commitment to implement cost-effective efficiency programs as a resource
  • Align utility incentives & ratemaking
  • Educate & engage consumers

• Via Feedback
  Source: “Direct Energy Feedback Technology Assessment for SCE”, by Lynn Fryer & Nadav Enbar, EPRI Solutions, March 2006
  • Numerous studies have found a savings of 4 to 15% of overall consumption where consumers were given real-time feedback

<table>
<thead>
<tr>
<th>Segment</th>
<th>Efficiency Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Median 26%</td>
</tr>
<tr>
<td>Commercial</td>
<td>Median 22%</td>
</tr>
<tr>
<td>Industrial</td>
<td>Median 14%</td>
</tr>
</tbody>
</table>

Steven Nadel, Anna Shipley & R. Neal Elliott (ACEEE) 2004
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Demand Response

- Studies/pilots have shown there exist mass market elasticity's of response
  - Customers are more interested in programs if they can realize a significant bill savings (10% or more)
    - The higher the CPP or greater the PTR the better

- Demand response can be used for:
  - Economic dispatch
  - Socioeconomic dispatch
  - Reliability dispatch
  - Environmental sustainability dispatch (intermittency)

<table>
<thead>
<tr>
<th>Elasticity Estimates by Customer Type</th>
<th>Avg</th>
<th>CAC</th>
<th>No CAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Elasticity (peak to off-peak) CPP</td>
<td>-0.11762</td>
<td>-0.13853</td>
<td>-0.05489</td>
</tr>
<tr>
<td>Daily Price Elasticity CPP</td>
<td>-0.03003</td>
<td>-0.03993</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Substitution Elasticity (peak to off-peak) non CPP</td>
<td>-0.11048</td>
<td>-0.13139</td>
<td>-0.04775</td>
</tr>
<tr>
<td>Daily Price Elasticity non CPP</td>
<td>-0.04660</td>
<td>-0.05650</td>
<td>-0.01690</td>
</tr>
</tbody>
</table>

Source: “EEI Quantifying the Benefits of Dynamic Pricing In the Mass Market”, Jan 2008
Ahmad Faruqui & Lisa Wood, The Brattle Group
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Renewables & Alternatives

- Renewable energy roadmap
  - Renewable portfolio standards exist in 26 states
- Major sources
  - Wind: 100 GW capacity in 2007
  - Solar: 2.8 GW capacity in 2007
- Grid parity estimates between 2010-2015 based on
  - Decreasing cost of PV & Wind technologies
    - PV: Thin film, Building integrated PV (BIPV)
    - Wind: Superconducting turbines
  - Increasing costs of current generation
- Issues:
  - Distributed source of supply
  - Intermittent source of supply

Source: WWEA
Source: IEA
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Distributed Energy Resources

- Micro-generation
  - Recuperative micro-turbines
  - Combined heat & power
  - Fuel cells
- Energy storage
  - Ice energy storage for AC
- Rechargeable batteries
- PHEV’s
  - As a distributed energy resource
    - e.g. “better place” battery exchanges & charge spots powered via renewable energy
  - Vehicle-to-grid = source for on-peak supply & ancillary services
- Goal of all distributed energy resources is peak shaving, contingency, & other ancillary services
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Grid Modernization

- Existing
  - Substation protection
  - Feeder automation
  - Distribution automation
  - Volt-VAR optimization

- New
  - Home area networking
  - Distributed monitoring & control
  - Distributed energy resources
  - Micro-grids

- Goal
  - Integrate existing grid monitoring & control to new distributed & consumer focused resources
  - Requires new generation of distribution management systems
    - Pervasive communications
    - Advanced analytics
    - Dynamic control
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Linking it all Together: “The Smart Grid”

Smart Grid is an evolution, AMI is today’s building block

Source: EPRI
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Near Term Smart Grid Impacts (AMI)

- Time Differentiated Rates
- Customer Feedback
- Load Control
- Demand Response
- Awareness & Resource Efficiency
- Climate Change

Load Reduction

- 2-12%
- 4-15%
- 12-40%
- 20-30%
- 15-35%
- 15-35%
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Long Term Smart Grid Impacts

1. Reduce Customers’ Peak Loads
   - Utility-controlled circuit-level management

2. Discharge Stored Power During Peak
   - Clean, reliable, efficient
   - Targeted deployments

3. Offer Value-Added Services
   - Online energy management
   - Renewables integration

4. Optimize Generation and T&D Assets
   - Charge energy storage and PHEVs off-peak

Source: GridPoint
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Networks of Communicating Smart Devices

- LAN
- edge connection
- peer-to-peer controlled comms
- battery-powered comms

**Applications**

- Enterprise Connection

**Public and Private WAN Networks**

- WAN-to-LAN
- LAN-to-LAN (Bridge)
- Home router

- Meter (E,G,W)
- In-premise device
- Distribution sense & control device

- AMI concentrator
- Smart Grid controller
- Distributed application node
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Platform for the Smart Grid

- 2-way mesh with distributed intelligence
- Built for measurement & control (deterministic comms)
- Energy efficiency & demand response implementations today
- 1st generation smart grid in the field today
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Benefits

**Utility**
- Ability to address growing demand incrementally and economically
- Proactive integration of clean/green technology without impact to reliability, stability, and safety
- Improved grid reliability
- Consumer retention
- Reduced financial risk and volatility

**Consumer**
- Awareness & participation in energy efficiency and energy management
- Reduction of carbon footprint
- Intelligent clean/green utilization
- Cost management

**Society**
- Environmental and economic sustainability
- Energy independence & security
- Platform for technology evolution
Thank-you

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