Industry Trends and the Future of Demand Response

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Director, Business Development
Market Forces

What if...

... demand grew 50% in 20 years?
... 50% of skilled workers retired in 10 years?
... carbon constraints became severe?
... fuel costs kept going up?
... power quality demands got much higher?
... renewables were mandated all over the country?
... reliability rules became more stringent?

Would you...

... build 50% more power plants... hire 50% more workers... build 50% more power lines... raise rates over and over again?

What if they all came true... all at once
Factors Driving the Smart Grid Evolution

1. Distributed Communications
2. Supply and Demand Tech
3. Architectural Standards
4. Demographic/Economic Shifts
5. Government Policies
Intelligence to the Edges

Centralized
Mainframe
Intelligence in middle

Distributed
Client-server
Intelligence migrates out

True network
Internet
Intelligence everywhere

The move from control-based interactions toward **transaction-oriented interactions** will significantly improve information exchange between the electric system devices and the end-use consumers.
DR & AMR / AMI / SmartGrid

Smart Grid

Distribution Control
Transformer Monitoring
Intelligent Appliances

DR
Peak Reduction
15 min LP

AMI
Integrated Demand Response

Renewables
Outage
Service Disconnect

AMR
Automated reads

TOU & CPP
Transactive Demand Response
Smart Grid Transition

Then Comes PHEV storage…
… and Solar/Wind Microgrids

Common Platforms

Clean Technology

Educated & Motivated Consumers

Robust Signalling

Timely Decision Data

Automated Response

Clean Technology Educated & Motivated Consumers
Consumer Driven Approach

Source: pjm
Innovative Uses of DR for Clean Energy

Open Market Development

Emissions Credits

DR as a Reliability and Economic Resource

TOU / CPP / RTP Programs

Combination of DR + EE Programs

Continued Product Innovation
Clean Capacity Through Demand Response

Energy Efficiency (Blue) reduces load all the time
Demand Response (Red) reduces just when we need it
Integrated DR Product Suite

Demand Response Automation Platform

Large Appliance Automation

In Home Energy Display

Home HVAC Automation

Integrated Customer Experience

Comprehensive Suite

ZigBee Integrated & Tested

Open Standards

Experience

DR Leader & Roadmap
Evolving Business Models

Traditional Utility
- Grid Generation
- Retail Electric Supply
- Capacity Markets
- Utility-Scale Renewables
- Reliability

Traditional Customer
- Meter Data Analysis
- Facilities Management
- Performance-based Contracting
- Distributed Generation
- Energy Procurement
- Power Quality

Transaction Utility
- Grid Generation
- Utility-Scale Renewables
- Reliability

Services
- Smart Meter
- DR+/-, EE
- Renewables
- Capacity Mkt

Transaction Customer
- Service
- HVAC
- Maintenance
EMERGENCY

Designed to provide a method by which end-use customers may be compensated by PJM for reducing load during an emergency event.

ECONOMIC

Designed to provide an incentive to customers or curtailment service providers to reduce consumption when PJM LMP prices are high.

Load Response = Demand Side Response (DSR)
## Comparison of Revenue Opportunities for Demand Response Current vs. Revised

<table>
<thead>
<tr>
<th>Revenue Opportunity</th>
<th>PJM (as of 12/31/05)</th>
<th>PJM with new initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-Time/Spot Energy Sales</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Day-Ahead Energy Sales</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Forward Energy Sales</td>
<td>No</td>
<td>Yes; Forward Energy Reserve Market (under development)</td>
</tr>
<tr>
<td>Forward Capacity Sales</td>
<td>Yes, but limited</td>
<td>Yes; RPM auction provides options for participants</td>
</tr>
<tr>
<td>Energy &amp; Capacity payment for emergencies</td>
<td>Not in all cases</td>
<td>Yes; Emergency program changes ensure payment</td>
</tr>
<tr>
<td>Ancillary Services</td>
<td>No</td>
<td>Yes; Synchronous Reserves &amp; Regulation (mandatory training for CSP's @ pjm.com)</td>
</tr>
</tbody>
</table>
Definition & Purpose of RPM

- Reliability Pricing Model (RPM) is PJM’s new resource adequacy construct
- The purpose of RPM is to develop a long term pricing signal for capacity resources and LSE obligations that is consistent with the PJM Regional Transmission Expansion Planning Process (RTEPP)
- RPM adds stability and a locational nature to the pricing signal
- RPM replaced PJM’s capacity construct effective June 1, 2007

Source:
Load Response in PJM

<table>
<thead>
<tr>
<th>Energy</th>
<th>Capacity</th>
<th>Ancillary Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Economic</td>
<td>• Emergency – Capacity Only</td>
<td>• Synchronous Reserves</td>
</tr>
<tr>
<td>• Emergency – Energy Only</td>
<td>• Emergency – Full (also gets an energy payment)</td>
<td>• Regulation</td>
</tr>
<tr>
<td>Voluntary load reductions for energy, even during a PJM emergency event</td>
<td><strong>Mandatory</strong> reduction for PJM Load Management emergency event</td>
<td>Load bids into these markets and responds to an event exactly like a generator</td>
</tr>
<tr>
<td></td>
<td><strong>Mandatory</strong> response to a Synchronous Reserve event if cleared in market</td>
<td></td>
</tr>
</tbody>
</table>

Source: comverge

Diagram:
- **Load Management**
  - DLC, FSL, GLD
  - DR
  - ILR
Other Options for Participation

- **PJM Ancillary Service Markets**
  - **PJM Regulation Market**
    - Automatic adjustment of load in response to PJM regulation control signal
  - **PJM Synchronized Reserve Market**
    - Ability to achieve required reduction of load in a 10 minute period when notified by PJM

- Details of these markets are covered in “Load Response for Ancillary Services” training presentation
- Mandatory online training for participation

Source:
What is Frequency Regulation?

Regulation is the continuous adjustment of AC electricity frequency (60 Hz)
What Does Regulation Cost?

- Contract for expected need (+ margin)
- Cost (fossil fuels) is opportunity cost of not generating during that period
- Cost of energy provided to Ancillary Service is far above wholesale or retail rates
- Contract is for capacity, not energy
Regulation Contract
## Regulation - Market Value

<table>
<thead>
<tr>
<th></th>
<th>Average Market Clearing Price ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
</tr>
<tr>
<td>PJM</td>
<td>$42.75</td>
</tr>
<tr>
<td>ISO-NE</td>
<td>$28.92</td>
</tr>
<tr>
<td>NY ISO</td>
<td>$22.59</td>
</tr>
<tr>
<td>ERCOT</td>
<td>$22.66</td>
</tr>
<tr>
<td>CA ISO</td>
<td>$29.00</td>
</tr>
</tbody>
</table>
10-Year Present Value V2G Revenue Potential

Assumptions: 80% availability; Reg. $40/MW-h; Spin. $10/MW-h, 7% discount rate, example calculations

Basic per Vehicle Values

Green Mountain College
Providing Regulation from an EV

- Red line shows power (kW) to the battery (left axis)
- Green line shows the state of charge steadily rising (right axis)
- Blue line shows the regulation signal. Notice how closely the commanded power follows the power delivered by the vehicle
Consumer Driven Approach

- Intuitive Web Controls
- Current kW-hr Pricing Info
- Access to education
- Access to account data
- Streamlined bus. process
Thank You!

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