Demand Response Providing Ancillary Services:
A Comparison of Opportunities and Challenges in US Wholesale Markets

Presentation by Jason MacDonald
Grid Integration Group,
Lawrence Berkeley National Laboratory

Authors: Jason MacDonald, Peter Cappers, Duncan Callaway, Sila Kiliccote

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Ancillary Services in US ISO/RTOs

- ISO/RTOs are balancing authorities that run open wholesale markets for both energy and Ancillary Services (AS)

- AS maintain reliable functioning of the bulk power system

- AS in ISO/RTO markets include:
  - Frequency Regulation
  - Spinning Reserve
  - Non-Spinning Reserve
  - Supplemental Reserve

- AS traded in markets are capacity reserve products

- Expressed in units of MW-h, one MW held in reserve for one hour

Source: FERC.gov
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Why DR for AS?

• Qualities of DR resources may provide some benefits to the system:
  – Very fast (extremely high ramp rates)
  – Cheap to operate (likely price takers)
  – Statistical reliability (property of large aggregations of small resources)
  – Fast to market (very few siting/permitting issues)
  – Controllable, distributed resource near load served
What is the Market Clearing Price?

- Resource Cost = sum of its lost opportunity cost and availability bid
- The Market Clearing Price (MCP) is paid to every resource that is economic
Average Annual MCPs

Examining monthly average MCP’s illustrates that sometimes seasonal trends may dominate annual trends.
Daily Trends in MCP

- Daily Trends in MCP show more seasonal effects.
- Additionally, daily trends indicate additional opportunity for loads that can provide AS during hours of higher price.

Southern California Data (Winter and Summer Prices)

Source: California Commercial End Use Survey (CEC)
• Two procurement mechanisms:
  • In markets
  • self-scheduled

• Absolute market procurement is in the hundreds of MW.

### Market Size

#### Annual Market Size

<table>
<thead>
<tr>
<th></th>
<th>CAISO-S</th>
<th>CAISO-N</th>
<th>ERCOT</th>
<th>MISO</th>
<th>PJM</th>
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<tbody>
<tr>
<td><strong>Regulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>-</td>
<td>-</td>
<td>105</td>
<td>-</td>
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<tr>
<td>2010</td>
<td>12</td>
<td>12</td>
<td>118</td>
<td>43</td>
<td>126</td>
</tr>
<tr>
<td>2011</td>
<td>18</td>
<td>12</td>
<td>152</td>
<td>38</td>
<td>123</td>
</tr>
<tr>
<td><strong>Spinning Reserve</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>-</td>
<td>-</td>
<td>119</td>
<td>-</td>
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<tr>
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<td>11</td>
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<td>122</td>
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<tr>
<td>2011</td>
<td>19</td>
<td>18</td>
<td>462</td>
<td>23</td>
<td>51</td>
</tr>
</tbody>
</table>

• Market Size = \( \sum \text{Procurement}(t) \times \text{MCP}(t) \)

• PJM spinning reserve market size based on Mid-Atlantic Reserve Zone
Market Rules: Resource Size

- DR resources are smaller than traditional grid resources
- DR resources are not symmetric in their ability to shed and take load
- Some DR Resources are limited in the length of response at full power

### Regulation Rules

<table>
<thead>
<tr>
<th></th>
<th>Min. Size (MW)</th>
<th>Aggregation Allowed</th>
<th>Symmetric Bid Req’d</th>
<th>Continuous Energy Period</th>
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</thead>
<tbody>
<tr>
<td>CAISO**</td>
<td>0.5</td>
<td>No</td>
<td>No</td>
<td>60 min</td>
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<tr>
<td>ERCOT</td>
<td>0.1</td>
<td>No***</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>MISO</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>60 min</td>
</tr>
<tr>
<td>PJM</td>
<td>0.1</td>
<td>Yes*</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>NYISO</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>ISO-NE</td>
<td>NA***</td>
<td>NA***</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Requires approval.
** Forthcoming, WECC does not currently allow demand side resources to provide this product.
*** Pilots are underway to examine the ability to change this rule.

### Spinning Reserve Rules

<table>
<thead>
<tr>
<th></th>
<th>Min. Size (MW)</th>
<th>Aggregation Allowed</th>
<th>Continuous Energy Period</th>
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</thead>
<tbody>
<tr>
<td>CAISO**</td>
<td>0.5</td>
<td>No</td>
<td>30 min</td>
</tr>
<tr>
<td>ERCOT</td>
<td>0.1</td>
<td>No***</td>
<td>NA</td>
</tr>
<tr>
<td>MISO</td>
<td>1</td>
<td>Yes</td>
<td>60 min</td>
</tr>
<tr>
<td>PJM</td>
<td>0.1</td>
<td>Yes*</td>
<td>NA</td>
</tr>
<tr>
<td>NYISO</td>
<td>1</td>
<td>No</td>
<td>60 min</td>
</tr>
<tr>
<td>ISO-NE</td>
<td>1</td>
<td>Yes</td>
<td>NA</td>
</tr>
</tbody>
</table>
Market Rules: M&V

- DR is more cost effective with less stringent M&V requirements
  - Accuracy requirements are different for revenue metering and telemetry, but cost may dictate that the same device perform both functions
  - Telemetry is necessary for regulation, but in some cases, also required for Spinning Reserve
  - Maintaining data for every DR resource in an aggregation is resource intensive

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Telemetry Rate</th>
<th>Revenue Metering Accuracy</th>
<th>Telemetry for Spin Res</th>
<th>Data Source Level</th>
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</thead>
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<tr>
<td>CAISO</td>
<td>4 sec</td>
<td>+/- 0.25%</td>
<td>Yes</td>
<td>Resource</td>
</tr>
<tr>
<td>ERCOT</td>
<td>3-5 sec</td>
<td>+/- 2%</td>
<td>No</td>
<td>Aggregate</td>
</tr>
<tr>
<td>MISO</td>
<td>4 sec</td>
<td>State Spec</td>
<td>Yes</td>
<td>Resource</td>
</tr>
<tr>
<td>PJM</td>
<td>2 sec*</td>
<td>+/- 2%</td>
<td>No</td>
<td>Aggregate</td>
</tr>
<tr>
<td>NYISO</td>
<td>6 sec</td>
<td>+/- 2%</td>
<td>Yes</td>
<td>Resource</td>
</tr>
<tr>
<td>ISO-NE</td>
<td>10 sec</td>
<td>+/- 0.5%</td>
<td>Yes</td>
<td>Resource</td>
</tr>
</tbody>
</table>

*Can be batch sent once every minute
Concluding Remarks

• Wide range in AS value between ISO/RTOs, although relatively thin.
• Currently, the most favorable wholesale AS market conditions for DR exist at PJM and ERCOT.
• Reducing the minimum resource size and allowing aggregation may be the most important rules for promoting DR participation in AS.
• Ancillary services will be one of a portfolio of applications of fast demand response.
Questions?

Contact:
Jason MacDonald
jsmacdonald@lbl.gov

Reference paper (presented at Grid Interop 2012):

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