Beyond Capacity Markets: Delivering Capabilities
A High Renewable Energy Grid Needs

Presented by Richard Sedano

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Introducing RAP and Rich

• RAP is a non-profit organization providing technical and educational assistance to government officials on energy and environmental issues. RAP staff have extensive utility regulatory experience. RAP technical assistance to states is supported by US DOE, US EPA and foundations.
  – Richard Sedano directs RAP’s US Program. He was commissioner of the Vermont Department of Public Service from 1991-2001 and is an engineer.
Introduction: What is the question?

Low-carbon transition: Reliability is essential; ensuring reliability at least cost will be a pivotal issue.

The “EOM vs. CRM” debate is fascinating but typically ignores a more fundamental question…

Is the market driving the right investments to ensure a reliable low-carbon transition at least cost?
Messages

- Carbon+reliability
- Operate to net demand
- Flexibility, how to motivate?
- Value: reveal, align wholesale and retail

- Improved energy market
- Ancillary service requirements
- Capacity only with differentiation
- Demand side ++
- Risk
The “baseload” delusion

“Flexibility” takes on a whole new meaning

Gross Demand

Net Demand

Germany, December 2013

Load DE

Net demand DE

Energy solutions
for a changing world
Challenges

Gross & net demand in UK_South in 2030…
Beyond Capacity and Energy toward Valuing Capabilities

• Identify needed capabilities and compensate resources fairly
  – Make system needs transparent
  – Qualify all resources (and verify)
  – Reform markets/RTOs AND procurement
Fixing one problem can create others

Capacity markets can work at cross purposes with a market that needs system flexibility

- All capacity is not the same
- Least cost capacity may be least flexible

Energy only markets can also undervalue flexibility – is waiting for a crisis a biz model?

Inflexibility can lead to higher operating costs, investment in avoidable back up and threaten reliability
The 3 pillars of an effective, equitable energy market

- Raise/eliminate price caps
- Enable demand response/aggregators
- Better shortage pricing
RE Futures, Fig 2.7 (Vol. 1, pg 2-18): “…an increasing fraction of the existing conventional fossil fleet may evolve from an energy-providing role to a reserve-providing role as renewable energy supply increases, thereby reducing the need to install new generation capacity solely to meet operating reserve requirements.”
“How much?” depends on “what kind?”
“How much?” depends on “what kind?”

Reliable, but costly & unstable, with investment based on:
- Single-product capacity mechanisms
- Inflated targets for generation adequacy
- No significant role for demand-side participation
- Flawed energy market implementation
“How much?” depends on “what kind?”

Reliable, low-cost & stable, with investment based on:
- Improved functioning of energy & balancing markets
- Transparent/objective/independent/regional RA assessment
- If desired, a simple multi-product CRM as a safety net
- Full demand-side participation in all markets
Flexible generation is just one piece of the puzzle

Source: IEA Energy Technology Perspectives 2014
What Capabilities on the Demand Side?

<table>
<thead>
<tr>
<th>Service</th>
<th>Service Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency Regulation</strong></td>
<td>Online resources, on automatic generation control, that can respond rapidly to changes in frequency.</td>
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<tr>
<td></td>
<td><strong>Price Range</strong></td>
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<tr>
<td></td>
<td>(*Average, Max) $/MW-hr</td>
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<tr>
<td></td>
<td><strong>Response Speed</strong></td>
</tr>
<tr>
<td></td>
<td>&lt;30 seconds</td>
</tr>
<tr>
<td></td>
<td><strong>Duration</strong></td>
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<tr>
<td></td>
<td>Seconds to Minutes</td>
</tr>
<tr>
<td></td>
<td><strong>Cycle Time</strong></td>
</tr>
<tr>
<td></td>
<td>Seconds to Minutes</td>
</tr>
<tr>
<td><strong>Regulating Reserve</strong></td>
<td>Online resources, on automatic generation control, that can respond rapidly to system-operator requests for up and down movements; used to track the minute-to-minute fluctuations in system load and to correct for unintended fluctuations in generator output.</td>
</tr>
<tr>
<td></td>
<td><strong>Response Speed</strong></td>
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<tr>
<td></td>
<td>4 Seconds to 5 minutes</td>
</tr>
<tr>
<td></td>
<td><strong>Duration</strong></td>
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<tr>
<td></td>
<td>Minutes</td>
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<tr>
<td></td>
<td><strong>Cycle Time</strong></td>
</tr>
<tr>
<td></td>
<td>Minutes</td>
</tr>
<tr>
<td><strong>Load Following</strong></td>
<td>Similar to regulation but slower. Bridges between regulation service and hourly energy markets. This service is performed by the real-time energy market in regions where such a market exists.</td>
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<tr>
<td></td>
<td><strong>Response Speed</strong></td>
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<tr>
<td></td>
<td>~10 minutes</td>
</tr>
<tr>
<td></td>
<td><strong>Duration</strong></td>
</tr>
<tr>
<td></td>
<td>10 min to hours</td>
</tr>
<tr>
<td></td>
<td><strong>Cycle Time</strong></td>
</tr>
<tr>
<td></td>
<td>10 min to hours</td>
</tr>
</tbody>
</table>
## Under Contingency Conditions

<table>
<thead>
<tr>
<th>Contingency Conditions</th>
<th>Online generation, synchronized to the grid, that can increase output immediately in response to a major generator or transmission outage and can reach full output within 10 min.</th>
<th>Seconds to &lt;10 min</th>
<th>10 to 120 min</th>
<th>Hours to Days</th>
<th>$7-$7</th>
<th>$100-$300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinning Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Non-Spinning Reserve</td>
<td>Same as spinning reserve, but need not respond immediately. Resources can be</td>
<td>&lt;10 min</td>
<td>10 to 120 min</td>
<td>Hours to Days</td>
<td>$3-$6</td>
<td>$100-$400</td>
</tr>
<tr>
<td>Replacement or Supplemental Reserve</td>
<td>Same as supplemental reserve, but with a 30-60 min response time; used to restore spinning and non-spinning reserves to their pre-contingency status.</td>
<td>&lt;30 min</td>
<td>2 hours</td>
<td>Hours to days</td>
<td>$0.4-$2</td>
<td>$2-$36</td>
</tr>
</tbody>
</table>
Achieving Value Alignment

1. Does demand reflect load modification?
2. Is demand net of must take transparent?
3. Are resource capabilities qualified fairly?
4. Is M&V there to certify qualified resources?
5. Are regulation, markets, and operations aligned to deliver value in the near term?
6. Are regulation, markets, operations and planning aligned to support the right infrastructure?
Coordination will be key to unlocking critical flexibility

Source: Gunnar Lorenz, Eurelectric
The four corners of effective demand participation

- Aggregation
- Automation/Control Technology
- Integrated energy & balancing scarcity pricing
- Dynamic retail prices
The four corners of effective demand participation

- Aggregation
- Integrated energy & balancing scarcity pricing
- Dynamic retail prices
- Automation/Control Technology
Implications for demand side

• “Hope is not a strategy”: Assume 745 is gone – states need to get to work, *fast*
• “It’s the energy market, stupid”: focus on ways to make the daily load curve dynamic
• PJM has gone too far, but the sooner DR outgrows capacity market crutch the better
• Value of DR will evolve & grow; venues for DR participation must do the same
Cost per Unit of Performance for Various Energy Storage Options

Capital cost per unit energy - $/kWh output

Capital cost per unit power - $/kW

Sources: Electricity Storage Association, EPRI, Sandia National Laboratories, Ecofys
Ways to Evaluate Market Designs

- Balance value of market intervention compared with degree of intervention
- Clarity of pricing and payment mechanism signals
  - Through scarcity conditions
- Planning, adapting markets for renewable energy targets
  - Reflect market/system value distinctions among resources
- Accommodate a range of risk/reward appetites
- Address identified risk factors
ISO-NE’s Strategic Planning risk matrix (ca. 2011)

NOTES
1. Assessment regarding impact and likelihood reflects the collective assessment of ISO-NE senior staff, and are described in the pages that follow.
2. Color coding on category markers: BLUE: Risk is already evident or likely to materialize over the near-term (0-3 years); PURPLE: Risk is likely to materialize over the mid-term (3-6 years); YELLOW: Risk is likely to materialize over the long term (6-7 years)
About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

rsedano@raponline.org
Markets: where are we headed?

• Wholesale markets: renewables integration
  – DR as flexible resource: capacity markets, services markets, dispatchability, scarcity pricing in energy and services markets
  – DR as daily resource: DR + end-use energy storage + “technology”
  – “Due discrimination”: FERC Order 1000, tiered auctions, capabilities, public policy
Markets: where are we headed?

• Retail markets: multiple challenges, multiple opportunities
  – Integration of distributed generation on distribution system
  – Facilitation of “DR + end-use energy storage” as a wholesale system resource: wires charges, distribution system impacts
  – Customer value proposition: dynamic pricing vs. payment for services, automation, equity
Markets: where are we headed?

• Wholesale vs. retail markets:
  – Competition between TSOs and DSOs for DR services
  – Who is willing to pay, how much, and in what form? Market access for 3rd party providers
  – Cooperation across the largest feasible geographic footprint – argues for giving the lead to TSOs, establishing a protocol with member DSOs
Resources

• What Lies Beyond Capacity Markets? (Hogan, Gottstein, et al (RAP))
  http://raponline.org/document/download/id/6041
  http://raponline.org/document/download/id/4854

• Demand Response as a Power System Resource (Hurley, et al. (Synapse for RAP))
  www.raponline.org/document/download/id/6597

• CAISO DR/EE Roadmap: Maximizing Preferred Resources (CAISO)
More Resources

- Teaching the Duck to Fly (Lazar (RAP))
  http://www.raponline.org/document/download/id/6977
- Integrating Renewables at Least Cost in the West
  http://www.raponline.org/document/download/id/5041
- Aligning Power Markets to Deliver Value (Hogan (RAP) for APP)
  http://www.raponline.org/document/download/id/6932
- Capacity Mechanisms for Power System Supply (Keay-Bright (RAP))
  http://www.raponline.org/document/download/id/6805