Leveraging Power Markets to Achieve a Reliable, Least-Cost Transition to a Low-Carbon Power System

Webinar
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Questions?

Please send questions through the Questions pane
Introduction: What is the question?

Low-carbon transition: Reliability is essential; ensuring reliability at least cost will be the 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?
Resource adequacy at least cost: generation
Experience with various “capacity mechanisms”

<table>
<thead>
<tr>
<th>Extent of capacity intervention</th>
<th>avg annual new-build as % of 2014 peak</th>
<th>ratio of actual to target reserve margins (2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT</td>
<td></td>
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<tr>
<td>NYISO</td>
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<tr>
<td>PJM</td>
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<td>ISO-NE</td>
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<td>NEM</td>
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<td>SWIS</td>
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Source: RAP, from published system operator data
“How much?” depends on “what kind?”

Source: Adapted from *The Power of Transformation* (IEA, 2014)
PJM: a decade of lessons learned

Source: Brattle Group
PJM Capacity Market 2007

Capacity – single product
PJM Capacity Market 2011

Capacity – single product
PJM Capacity Market 2014 (proposed)

- Qualified generation
- Annual DR
- Non-qual. generation
- Extended Summer
- Limited DR
- Non-CP capacity

“Capacity Performance” capacity
PJM Capacity Market 2016

Capacity Performance (Supply and Demand)

Capacity – single product

...we need to get out of the “capacity market” box
Cheap (and effective) alternatives to generator flexibility
Generation: just one piece of the puzzle

Source: IEA Energy Technology Perspectives 2014
Complementary sources of flexibility

Generation

Grids

Interconnectors
Complementary sources of flexibility

- Grids
- Interconnectors
- Market geography
- Market operations
- Generation
Complementary sources of flexibility

- Grids
- Inter-connectors
- Market geography
- Market operations
- Energy & services markets
- Capability-driven FCMs

Generator flexibility
Complementary sources of flexibility

- Grids
- Interconnectors
- Generator flexibility
- Energy & services markets
- Market geography
- Market operations
- Demand participation
- Electricity storage
- Capability-driven FCMs
Market operations, market geography, and grids
“Bigger,” “faster” markets

Source: National Renewable Energy Laboratory (U.S.), 2013
Regional independent market governance

Markets that reduce grid congestion

Record demand: ERCOT, August 2011

Record demand: ERCOT, August 2016

Source: ERCOT data via SNL Energy
Questions?

Please send questions through the Questions pane.
Tapping the untapped flexibility of demand
3 pillars of an effective energy market

- Competition/market monitoring
- Enable demand response/aggregation
- Better shortage pricing
Demand-side flexibility

Demand-side flexibility

Source: G. Strbac, Imperial College London
Demand-side flexibility

Cost per Unit of Performance
for Various System Flexibility Options

Source: Sandia National Laboratory, Energy Storage Association & Ecofys
4 keys to effective demand participation

- Aggregation
- Automation/Control Technology
- Integrated energy & reserves pricing
- Dynamic retail prices
Energy pricing that exposes the value of investment in flexibility
Full range of marginal costs

<table>
<thead>
<tr>
<th>System Resource</th>
<th>Full marginal cost (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation capacity (&quot;firm&quot; or &quot;de-rated&quot;)</td>
<td>20-250</td>
</tr>
<tr>
<td>Imports</td>
<td>20-1000</td>
</tr>
<tr>
<td>Secondary (operating) reserves</td>
<td>250-5000</td>
</tr>
<tr>
<td>Emergency generation</td>
<td>500</td>
</tr>
<tr>
<td>Primary (regulation) reserves</td>
<td>500-9000</td>
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<tr>
<td>30-minute responsive back-up</td>
<td>1400</td>
</tr>
<tr>
<td>30-minute controllable demand response</td>
<td>2400</td>
</tr>
<tr>
<td>10-minute controllable demand response</td>
<td>2600</td>
</tr>
<tr>
<td>10-minute responsive back-up</td>
<td>3700</td>
</tr>
<tr>
<td>Emergency load-shedding</td>
<td>9000</td>
</tr>
</tbody>
</table>

Source: Adapted from Brattle Group & Astrape Consulting (2014 report to Public Utilities Commission of Texas & 2013 report to the Federal Energy Regulatory Commission)
Energy price formation: legacy

Energy price formation: corrected

Energy price formation: evolved

Better locational price formation

Administrative shortage pricing

Example: ERCOT Operating Reserve Demand Curve

Source: ERCOT
Administrative shortage pricing

Source: ERCOT
Sharper prices ≠ higher prices

Source: Ventyx (via Brattle Group) & Northbridge
Evolution away from binary model

- Market driven, time varying
  - Rudimentary ‘EOM’
  - Ancillary svcs market reforms
  - Energy market improvements
  - Reserve shortage pricing intervention
  - Growing consumer empowerment
  - Phase out capacity market

- Administrative, fixed
  - Fixed single-product CMs
  - Ltd. segmentation (e.g., DR)
  - Single-product with major ‘scarcity event’ risk/reward
  - Evolving definitions of adequacy

- Time
Continued deployment of renewables
What’s the end-game for RES support? How do we get there?

**Time**

- **RES**
- **Conventional generation**
- **Demand-side resources**

**Conventional gen** (incl RES) + **DSR (incl RES)**

**Innovation & better regulation** handle this

But how’s this going to work?
Saturation, new investment & retirement
Saturation, new investment & retirement

EU28 (assumes zero capacity for PV, 20% for wind)

EU28 (full nameplate capacity for PV and wind)
Support for deployment of “commercial” RES

203?: Full RES convergence w/market? What market?

Auctions + [2030 targets] +

“System-friendly” production support
- but needs “RES-friendly” system
“Capacity”-based revenue support
- varied based on performance?
Economic curtailment of RES
Beginnings of x-border harmonization

Binding targets + deployment support
Discussion / Q&A
Key take-aways

Delivering clean, reliable electricity at the lowest reasonable cost through organized markets:

• “How much?” depends on “what kind?”

• Critical energy market design choices can make all the difference

• Net growth in zero-carbon investment will not be market-driven for the foreseeable future
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 sector. 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

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