The Flexibility Challenge in Global Power Sector Transformation: Monopoly vs. Liberalized Markets

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Question:
Monopolistic or liberalized market designs as enablers for decarbonization and flexibility?

Answer:
Yes.
Requirements for regulated & liberalized power systems to increase flexibility of power systems & minimize power system costs?
Nominal 25GW system

Gross Demand, 1 Jan to 31 Dec 2030

Energy solutions
for a changing world
35% RES (of which 77% VRES)
The flexible challenge...from a generation perspective

- Life for peaking plants doesn’t change much...
- Flexible everyday resources are in much greater demand...
- But traditional base load is poorly matched to net load.
Many ways to skin this cat...with very different price tags

<table>
<thead>
<tr>
<th>Pathways</th>
<th>DSM</th>
<th>Transmission</th>
<th>Back-up and balancing</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% RES 10% CCS 10% nuclear</td>
<td>0%</td>
<td>0%</td>
<td>127 166 255</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>87</td>
<td>140 150</td>
</tr>
<tr>
<td>60% RES 20% CCS 20% nuclear</td>
<td>0%</td>
<td>103</td>
<td>140 205</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>56</td>
<td>150</td>
</tr>
<tr>
<td>40% RES 30% CCS 30% nuclear</td>
<td>0%</td>
<td>55</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: DSM stands for Demand Side Management. The Transmission & additional generation capacity requirements are in units of some unspecified measure.
Traditional (monopoly) flexibility levers

- Grids
- Interconnectors
- Electricity storage
- Generation
Complementary sources of flexibility

- Grids
- Inter-connectors
- Market geography
- Market operations
- Generation
- Electricity storage
Complementary sources of flexibility

- Grids
- Inter-connectors
- Electricity storage
- Generator flexibility
- Market geography
- Market operations
- Energy & services markets
- Capability-driven FCMs
Complementary sources of flexibility

- Grids
- Inter-connectors
- Electricity storage
- Generator flexibility
- Market geography
- Market operations
- Energy & services markets
- Capability-driven FCMs
- Demand participation
- Energy storage
How to ensure reliability and system adequacy? *at the lowest reasonable cost to consumers?*
What are we trying to ensure?

Define “reliable” and “adequate” objectively on the basis of consumer costs and benefits

Assess adequacy regularly, independently and transparently – against clearly defined standards (see point 1)

Consider ALL dimensions of reliability and adequacy – including energy efficiency, demand response and the capacity contributions of unconventional resources
“How much?” depends on “what kind?”

Source: Adapted from *The Power of Transformation* (IEA, 2014)
Saturation, new investment & retirement

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

EU28 (full nameplate capacity for PV and wind)
Saturation, new investment & retirement

Transition period

Market-driven period

MW of capacity additions & retirements

-20
-15
-10
-5
0
5
10
15

Zero-GHG, Total, Conventional
Accept volatility and its consequences...

Net Demand (full year, 27% from variable renewables)

- **Baseload**
- **Mid-merit**
- **Peaking**
...or change the net demand curve

The answer: almost certainly some of both
What are key aspects of adequacy in a high-RES system?

How to operationalize the new flexibility paradigm?

How to adjust market designs?
What are the key aspects of “adequacy”?

*Capacity per se is no longer the best measure of adequacy – the best measure is capabilities*
What are the key aspects of “adequacy”?

The problem: capacity is capacity and is relatively easy to measure – but capability/flexibility....?
A monopoly needs to get this right

- Grids
- Inter-connectors
- Demand participation
- Energy storage
- Electricity storage
- Generator flexibility
- Energy & services markets
- Market geography
- Market operations
- Capability-driven FCMs

Energy solutions
for a changing world
A security-constrained, economic dispatch market needs to get this right

<table>
<thead>
<tr>
<th>System Resource</th>
<th>Full marginal cost (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation capacity (“firm” or “de-rated”)</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>
</tr>
<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

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

Energy solutions for a changing world
What are the effects of liberalization on the energy industry?
What part of the “energy industry”?  

1) We can’t afford a passive customer class anymore - customers must and will demolish traditional business models and give rise to new ones

2) Grids remain regulated monopolies, but otherwise investment becomes more dispersed and will be made in the face of unprecedented uncertainty whether we like it or not – who should bear the risks and reap the rewards of investing under that uncertainty?

3) As investment becomes less centralized and riskier, system operation and services must become more centralized and better at managing risk

N.B. Buy-side mitigation in capacity markets
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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