Capacity mechanisms under scrutiny

Capacity mechanisms in Europe

7 December 2018
Outline

1. Why Capacity Remuneration Mechanisms?
2. CRM design choices
3. Lessons from the US Experience
4. Lessons from the GB Experience
5. Key take-aways
Capacity Remuneration Mechanisms are seen by many jurisdictions as a necessity for system reliability.

### Missing Money Problem
- Prices in energy only markets don’t rise high enough or often enough
  - Inadequate revenues to cover existing generator’s “going forward costs”
  - Insufficient incentives for new capacity

### Causes
- Regulated price caps to prevent manipulation
- Fear from market participants of perceived market manipulation
- Impact of intermittent renewables on energy prices and revenues for traditional generation
Outline

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2. CRM design choices

3. Lessons from the US Experience

4. Lessons from the GB Experience

5. Key take-aways
What are the main CRM design choices?

**Price-based CRM**
- ‘Adder’ to an energy price
- Do not directly result in a target level of capacity
- Capacity payments can be targeted or market-wide

**Targeted CRM**
- Usually segregated from the energy market
- ‘Back-stop’ to the energy market
- Where support for all new capacity becomes necessary, segregation from the energy market is no longer possible

**Market-wide**
- Critical choice between:
  - Centralised auction
  - Decentralised obligation
In Europe there are a range of mechanisms in place:

- **GB**: Upcoming T-4 2022/23 postponed indefinitely by the General Court of the European Union.
- **Sweden and Finland**: Strategic reserve (with phase-out provisions).
- **Belgium**: The efficacy of the 2016 scheme has led to re-approval by the EC.
- **Netherlands**: Strategic reserve model developed in 2003 but never activated.
- **Ireland**: All-island capacity mechanism approved in Nov 2017. First T-4 auction to be run on 6th Dec 2018.
- **France**: To manage cold spells in winter and has a stated objective of encouraging DSR.
- **Portugal**: Capacity payments since 2010. Currently suspended.
- **Spain**: Significant redesign required to comply with EC guidelines.
- **Germany**: 2018 CRM approved to help manage nuclear decommissioning.
- **Greece**: 2-year extension of the 2014 demand response scheme.
- **Poland**: Market-wide capacity mechanism. First auction to be held on 15 Nov 2018 for 23 GW of capacity in 2021.
- **Italy**: Market-wide capacity mechanism.

**Legend**

- **Capacity Payment**
- **Strategic Reserve**
- **Reliability option**
- **Capacity obligation**
- **Capacity auction**
The choice of CRM design needs to be clearly responsive to identified issues

Well designed capacity markets start with clear objectives, comprise clearly defined products and address interactions between energy and AS markets

**Issues**

**Why** is the market design inefficient without a capacity market?
- Price suppression?
- Investment risks?
- Unresponsive demand?
- Poorly designed AS markets?

**Integration** with energy and AS markets
- Capacity markets need to work alongside energy and AS markets

**Non discrimination** between resource types
- Undue discrimination can limit efficiency and create distortions in other markets

**Design Response**

Well-defined resource adequacy objectives
- Meet seasonal/annual peak?
- Meet ramping/flexibility constraints?
- System-wide or location specific?

Clearly defined capacity products
- Ability of resources to meet objectives
- Integration with energy and AS markets

Well defined obligations and penalties
- Ensure quality and compliance without bias against certain resources

**Market Design and Auction Rules**
*Design integrity reduces regulatory risk and improves investment climate*
Market reform without unintended consequences is difficult given market interactions.
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Capacity Markets continue to surprise participants as outcomes change with market fundamentals and new rules.

- **Bidding restrictions due to market power concerns**
- **Large plant retirement**
- **Increase in CONE; new trans. rules**
- **Coal retirements and transmission constraints result in new plant with price-setting power at CONE**
- **Rule change removed price floor, plants retired as a result, and new entry set price**
- **New CCGT development driven by low gas prices**
- **Significant new DSM**

The chart shows a timeline of nominal USD/kW-yr from 2007-08 to 2021-22, with different regions and entities like PJM - RTO, PJM - Eastern MAAC, PJM-Comed, PJM-ATSI, NYISO - NYC, ISONE - All, MISO-Zone 7, and MISO Zone 4, indicating various trends and events in capacity markets.
There are some common themes from the performance of U.S. capacity markets over the last ten years

| Rule changes can impact price volatility | Implementation of more gently sloped demand curves  
|                                          | Treatment of transmission constraints have led to significant price changes |
| Widespread incentives to exert market power require constant monitoring | Need to introduce must offer requirements and offer price mitigations to avoid capacity withholding |
| Supply mix is responsive to price signals | Highest quantity of new generation located in “constrained” zones  
|                                          | Capacity retirements due to insufficient price incentives to support costly retrofits |
| Product definition can drive the mix of resources offered | Scale of DSR participation largely driven by the existence of a tailored DSR product |
| Incremental auctions can reduce the effectiveness of the market | In PJM, incremental auctions have been used as an “escape valve” for DSR to purchase back previous obligations  
|                                          | Reliant on accurate load forecasts by market operators |
| Performance incentives continue to be a key area of review | Polar Vortex in the northeast of the U.S. provided evidence that better product definition and more stringent penalties were required |
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Major trends…

**New Prequalified Technology Mix**

- **CCGT** 67%
- **Peaking (Transmission)** 20%
- **Peaking (Distribution)** 5%
- **Other** 8%
- **Interconnector** 52%
- **DSR** 12%
- **Storage** 15%

**Auction Results**

- Clearing prices remain too low to finance large-scale new gas-fired generation
- Constant stream of changes to all aspects of the CRM Rules and Regulations
- Struggle to address the “small peakers” problem
- Changing dynamics of competition in electricity markets
- Irruption of DSRs and Interconnectors in the latest auctions
DSR participation in the capacity market auctions has grown significantly

- The design of the GB Capacity Market provides incentives for the development of DSR:
  - Transitional Auctions specifically targeting DSR
  - Allows the participation of Unproven DSR
- The participation of DSR in the Capacity Market has been growing over time
  - The first T-4 auction in 2014 awarded contracts to less than 200 MW of DSR
  - The 2016 T-4 auction awarded contracts to over 1.4 GW of DSR
- Unproven DSR makes up the majority of the awarded contracts to DSR in the auctions held to date
- Barriers to further participation include:
  - Inability of DSR to access long-term contracts
  - No time limit on “dispatch” requirement during stress events
By December 2017, almost 5 GW of battery capacity had pre-qualified for the 2017 T-4 auction.

Following changes to the applicable derating factors for batteries announced in early December, over 1.5 GW of short-duration batteries opted out of the auction.

Only 150 MW were successful in the auction, compared to 500 MW in the 2016 T-4 auction.

### Change in Pre-qualified Battery Storage in 2017 T-4 after De-rating Changes

<table>
<thead>
<tr>
<th>Battery duration (hours)</th>
<th>Derating Factor (% of Capacity) 2014 T-4</th>
<th>Derating Factor (% of capacity) 2017 T-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>97.38%</td>
<td>17.89%</td>
</tr>
<tr>
<td>1</td>
<td>97.38%</td>
<td>36.44%</td>
</tr>
<tr>
<td>1.5</td>
<td>97.38%</td>
<td>52.28%</td>
</tr>
<tr>
<td>2</td>
<td>97.38%</td>
<td>64.79%</td>
</tr>
<tr>
<td>2.5</td>
<td>97.38%</td>
<td>75.47%</td>
</tr>
<tr>
<td>3</td>
<td>97.38%</td>
<td>82.03%</td>
</tr>
<tr>
<td>3.5</td>
<td>97.38%</td>
<td>85.74%</td>
</tr>
<tr>
<td>4</td>
<td>97.38%</td>
<td>96.11%</td>
</tr>
</tbody>
</table>
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Introducing new market mechanisms without distortionary effects is challenging

- Difficult to define a level-playing field if objectives for market mechanisms are outcome-oriented
- Capacity markets are designed to complement energy and ancillary services revenues, so changes in these markets will affect capacity clearing prices
- Whole system approach is required but complex as all players have:
  - multiple revenue opportunities
  - exposures to related charges
- Tension between:
  - Central planning – as per Capacity Market and central procurement model for renewables/nuclear/CCS
  - Bottom-up innovation and decentralised power markets
- Centralised auctions are complex and tend to involve multiple, successive rule changes
- Competition becomes more a matter of arguing over the rules than bidding in the auction: what are the best dispute resolution and governance arrangements?
### GB Outstanding Issues

**Contract duration**
- Concern that 15-year contracts can impact the value of new generation vs. existing generation and may lead to inefficient retirements.
- Eligibility of DSR for 15-year contracts

**Performance incentives (inc. completion milestones)**
- GB performance incentives have led the U.S. proposals, but other issues, like importance of fuel deliveries and capacity construction milestones are still to be tested.
- Majority of DSR contracted in the auction is unproven, with performance yet to be tested.

**Interconnector participation**
- Interconnector-led solution in GB considered temporary. Market developments in Ireland will provide a “live” test ground to solve dichotomy between market coupling and firm delivery requirement for reliability.

**DSR participation**
- DSR participation continuously growing. Penetration and performance of DSR will continue to be reviewed.

**Locational reliability**
- Where resource adequacy has a locational requirement, the capacity market also needs to be locational.

**Market power**
- Market power mitigation was an area of particular focus in the design of the GB capacity market. However, this requires constant monitoring and review.

### Key Learnings from the U.S.

**Contract duration**
- Maximum contract duration in U.S. markets are three years in PJM and seven years in ISO-NE. Both RTOs have successfully attracted c.40 GW of new merchant capacity since 2007.

**Performance incentives (inc. completion milestones)**
- Insufficient incentives for deliverability during times of system stress led to very close calls during the extreme cold weather conditions of the Polar Vortex.
- Under-estimated forced outage rates, lack of firm fuel delivery contracts, and inability to deploy dual fuel capability were some of the key issues cited by market monitors.
- Completion milestones have not been a major issue, except for DSR.

**Interconnector participation**
- Compatibility with market coupling requirements not an issue in the U.S., therefore, participation of externally-located resources requires firm delivery and ability to respond directly to instructions from the RTO where capacity is sold.

**DSR participation**
- Concerns about performance measurement have led to additional auditing requirements for DSR.

**Locational reliability**
- Locational requirements have been a key focus of the U.S. capacity markets. Higher clearing prices in constrained zones have led to additional generation and price convergence in selected zones.

**Market power**
- U.S. markets have continued to implement measures to mitigate market power, most of which have been adopted in some form in GB. U.S. experience highlights need for continued monitoring of misaligned incentives and exertion of market power.
TALKING POINTS AND FIGURES
The GB capacity auction – results of 2014 auction

The 2014 T-4 auction cleared below expectations at £19.40/kW-year. Only one new CCGT secured a contract but then failed to reach financial close

2014 T-4 Auction Results

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Successful</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>New</td>
<td>Existing</td>
<td>New</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCGT</td>
<td>22,836</td>
<td>1,656</td>
<td>4,646</td>
<td>4,563</td>
</tr>
<tr>
<td>Coal</td>
<td>7,474</td>
<td></td>
<td>4,038</td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>3,334</td>
<td></td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>7,876</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (Transmission)</td>
<td>69</td>
<td></td>
<td>34</td>
<td>486</td>
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<tr>
<td>Peaking (Transmission)</td>
<td>2,988</td>
<td></td>
<td>461</td>
<td></td>
</tr>
<tr>
<td>DSR</td>
<td>8</td>
<td>166</td>
<td>20</td>
<td>718</td>
</tr>
<tr>
<td>Other (Distributed)</td>
<td>990</td>
<td>124</td>
<td>79</td>
<td>250</td>
</tr>
<tr>
<td>Peaking (Distributed)</td>
<td>896</td>
<td>841</td>
<td>13</td>
<td>1,060</td>
</tr>
<tr>
<td>Grand Total</td>
<td>46,472</td>
<td>2,787</td>
<td>9,290</td>
<td>7,125</td>
</tr>
</tbody>
</table>

■ 2.8 GW of new capacity secured contracts of which nearly 1 GW was embedded generation with the remainder, Trafford Power, subsequently failing to reach financial close

■ The new embedded generation was mostly small-scale diesel/gas gensets with relatively high gCO2/MWh emissions

■ A substantial amount of existing CCGTs – 4.6 GW – failed to secure contracts
Impact of network charges

Incentives from transmission charges and other incentive arrangements enabled low efficiency, high emission plant to win 15 year agreements

- Embedded gensets benefitted from incentives to reduce transmission network demand in periods of peak system demand
- Because of their size, other benefits include exclusion from environmental legislation – the Industrial Emissions Directive. Diesel gensets have an intensity of around 0.75 tCO2/MWh.
- Under the Enterprise Investment Scheme, gensets in certain areas gain tax breaks worth up to 15% on annual rate of return

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>LV/MV Connected</th>
<th>EHV Connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levelised Capacity Cost</td>
<td>£/kW-Year</td>
<td>£40</td>
<td>£50</td>
</tr>
<tr>
<td>Transmission and balancing costs</td>
<td>Transmission Losses, TNUoS and BSUoS</td>
<td>£000</td>
<td>£5</td>
</tr>
<tr>
<td>Distribution benefits</td>
<td>Distribution Losses and DUoS</td>
<td>£000</td>
<td>-£7</td>
</tr>
<tr>
<td>Transmission benefits</td>
<td>Transmission Losses, TNUoS, BSUoS</td>
<td>£000</td>
<td>-£45</td>
</tr>
<tr>
<td>Revenues Needed from the Energy and Capacity Market with 50% of embedded benefits</td>
<td>£/kW-Year</td>
<td>£14</td>
<td>£55</td>
</tr>
</tbody>
</table>
2015 T-4 auction also cleared below expectations at £18/kW-year. No CCGTs secured a contract

“In the next 10 years, it’s imperative that we get new gas-fired power stations built. We need to get the right signals in the electricity market to achieve that. We are already consulting on how to improve the Capacity Market. And after this year’s auction we will take stock and ensure it delivers the gas we need.”

(Secretary of State for Energy, November 2015)

2015 T-4 Auction Results

Derated MW

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>New</td>
</tr>
<tr>
<td>CCGT</td>
<td>24,106</td>
<td>1,961</td>
</tr>
<tr>
<td>Coal</td>
<td>2,410</td>
<td>3,072</td>
</tr>
<tr>
<td>Hydro</td>
<td>3,293</td>
<td>87</td>
</tr>
<tr>
<td>Nuclear</td>
<td>7,575</td>
<td></td>
</tr>
<tr>
<td>Interconnector</td>
<td>1,862</td>
<td></td>
</tr>
<tr>
<td>Other (Transmission)</td>
<td>20</td>
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</tr>
<tr>
<td>Peaking (Transmission)</td>
<td>3,604</td>
<td>53</td>
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<tr>
<td>DSR</td>
<td>8</td>
<td>448</td>
</tr>
<tr>
<td>Other (Distributed)</td>
<td>1,144</td>
<td>176</td>
</tr>
<tr>
<td>Peaking (Distributed)</td>
<td>758</td>
<td>950</td>
</tr>
<tr>
<td>Grand Total</td>
<td>44,779</td>
<td>1,575</td>
</tr>
</tbody>
</table>

- 1.1 GW of new embedded generation capacity secured contracts of which the majority is likely to be fuelled by diesel
- After the 2015 auction, Ofgem announced a review of embedded benefits and warned market participants not to rely on grandfathering; existing investments would not be spared the impact of any changes
- The Government also increased the target capacity requirement for the next auction
The GB capacity auction – results of 2016 auction

2016 T-4 auction cleared at £22.50/kW-year. A single new 333MW CCGT secured a contract

2016 T-4 Auction Results

**Derated MW**

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Successful</th>
<th></th>
<th>Unsuccessful</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>New</td>
<td>Existing</td>
<td>New</td>
</tr>
<tr>
<td>CCGT</td>
<td>23,534</td>
<td>333</td>
<td>1,400</td>
<td>8,286</td>
</tr>
<tr>
<td>Coal</td>
<td>5,699</td>
<td></td>
<td>2,174</td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>3,411</td>
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<td></td>
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<tr>
<td>Nuclear</td>
<td>7,878</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interconnector</td>
<td>2,342</td>
<td></td>
<td>770</td>
<td></td>
</tr>
<tr>
<td>Other (Transmission)</td>
<td>2,320</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peaking (Transmission)</td>
<td>984</td>
<td>299</td>
<td>1,735</td>
<td>716</td>
</tr>
<tr>
<td>Battery</td>
<td>453</td>
<td></td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>DSR</td>
<td>44</td>
<td>1,367</td>
<td>424</td>
<td></td>
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<tr>
<td>Other (Distributed)</td>
<td>1,064</td>
<td>167</td>
<td>5</td>
<td>91</td>
</tr>
<tr>
<td>Peaking (Distributed)</td>
<td>1,187</td>
<td>1,342</td>
<td>556</td>
<td>1,356</td>
</tr>
<tr>
<td>Grand Total</td>
<td>48,465</td>
<td>3,960</td>
<td>5,870</td>
<td>35,211</td>
</tr>
</tbody>
</table>

- 8 GW of new CCGT exited the auction as prices fell towards £22.50/kW-year
- A new 300 MW OCGT secured a contract but a further 1.5 GW of small scale gensets secured contracts
- A total of 3.4 GW of new embedded generation have secured contracts across the three auctions – and analysts now point to a risk of non-completion with reform to embedded benefits
- Further concerns arise from
  - 1.4 GW of unproven DSR, much of which may in practice be behind-the-meter diesel gensets
  - 450 MW of batteries with a high derating factor but uncertain life
The GB capacity auction – results of 2017 auction

2017 T-4 auction (held in January 2018) cleared at £8.40/kW-year

2017 T-4 Auction Results

**Derated MW**

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Successful</th>
<th>Unsuccessful</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>New</td>
</tr>
<tr>
<td>CCGT</td>
<td>24,324</td>
<td>591</td>
</tr>
<tr>
<td>Coal</td>
<td>2,565</td>
<td>7,724</td>
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<tr>
<td>Hydro/ PS</td>
<td>3,177</td>
<td>74</td>
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<tr>
<td>Nuclear</td>
<td>7,926</td>
<td></td>
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<tr>
<td>Interconnector</td>
<td>2,403</td>
<td>2,155</td>
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<tr>
<td>Other (Transmission)</td>
<td>2,366</td>
<td></td>
</tr>
<tr>
<td>Peaking (Transmission)</td>
<td>831</td>
<td>70</td>
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<tr>
<td>Battery</td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>DSR</td>
<td>46</td>
<td>1,178</td>
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<tr>
<td>Other (Distributed)</td>
<td>1,699</td>
<td>181</td>
</tr>
<tr>
<td>Peaking (Distributed)</td>
<td>975</td>
<td>429</td>
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<tr>
<td><strong>Grand Total</strong></td>
<td><strong>46,313</strong></td>
<td><strong>4,125</strong></td>
</tr>
</tbody>
</table>

- The target capacity for 2021/2022 was 49.2 GW, 2.5 GW lower than the target capacity for the 2020/2021 auction
- With 54.9 GW of existing capacity pre-qualifying for the auction, existing capacity alone exceeded the target by 12%
- Interconnectors secured contracts for 4.56 GW, compared to 2.34 GW secured in the 2020/2021 auction.
- Even though there was a lot of focus on the participation of batteries in the auction, of the 1.3GW (3.3GW connection capacity) of battery projects that prequalified for the auction, only around 150MW were successful.
- Auction results reflect:
  - Declining competitiveness of coal-fired plant
  - Change in bidding behaviour and (perhaps) the expectation of higher revenues in other markets