Aggregated units and control reserve

Control reserve market and pre-qualification in Germany

Workshop on Power System Testing, Arnhem, 2017-03-21
Aggregated units and control reserve
Control reserve market and pre-qualification in Germany

Frequency control reserve markets
- Type of reserve and dynamic hierarchy
- Reserve procurement schemes
- Market specifications

Pre-qualification
- Technical requirements
- Pooling for secondary reserve provision
Type of reserve and dynamic hierarchy
Primary reserve procurement scheme

- Main procurement schemes in Europe
  - Organized market (orange)
  - Mandatory provision (green)

Possible procurement schemes, actual situation partially changed since 2012

Source: Entso-e survey 2012

Heckmann, Control reserve market and pre-qualification
Secondary reserve procurement scheme - capacity

Main procurement schemes in Europe
- Organized market (orange)
- Mandatory offers or provision (red, green and blue)

Possible procurement schemes, actual situation partially changed since 2012

Source: Entso-e survey 2012

Heckmann, Control reserve market and pre-qualification
Secondary reserve procurement scheme - energy

Main procurement schemes in Europe
- Organized market (purple)
- No energy procurement (red)

Possible procurement schemes, actual situation partially changed since 2012

Source: Entso-e survey 2012
Market specification of control reserves in Germany

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tender period</td>
<td>Weekly</td>
<td>Weekly</td>
</tr>
<tr>
<td>Product differentiation</td>
<td>Symmetric product, min lot size 1 MW</td>
<td>Separated products, positive and negative, min lot size 5 MW</td>
</tr>
<tr>
<td>Call for tender</td>
<td>merit-order capacity price</td>
<td>Double merit-order capacity price</td>
</tr>
<tr>
<td>Remuneration</td>
<td>Pay as bid</td>
<td>Pay as bid</td>
</tr>
<tr>
<td>Cost recovery TSO</td>
<td>Grid user</td>
<td>1) Grid user</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Balancing Responsible Party</td>
</tr>
<tr>
<td>Number of prequalified providers as of March 2017 (July 2014)</td>
<td>22 (20)</td>
<td>37 (27)</td>
</tr>
</tbody>
</table>

Heckmann, Control reserve market and pre-qualification
Market volume of control reserves in Germany

- Average peak demand: ~ 70 GW
  - Primary reserve: ~ 0.6 GW, ~ 0.8 % / secondary reserve: ~ 2.0 GW, ~ 2.9 %

- International primary control reserve cooperation
  - coupling of German, Belgian, Dutch, French, Swiss and Austrian markets
  - 1250 GW in total (as of Jan. 16, 2017)
  - maximum export allowed is 30% of the country's individual need
  - Denmark to be included in a later stage

Contracted operational reserves in Germany, average in 2014

- FCR+  -2831
- FCR-  -1944
- aFRR+  -568
- aFRR-  568
- mFRR+  2020
- mFRR-  2479

Source: Consentec
### Market volume of primary control reserves – tendering results

- Demand and market based results of the joint tendering of the primary control reserve cooperation (German, Belgian, Dutch, French, Swiss and Austrian markets)

<table>
<thead>
<tr>
<th>Calendar week</th>
<th>Primary control reserve demand (MW)</th>
<th>Average capacity price (EUR/MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-2017</td>
<td>1.406</td>
<td>2.769,49</td>
</tr>
<tr>
<td>7-2017</td>
<td>1.412</td>
<td>2.906,39</td>
</tr>
<tr>
<td>8-2017</td>
<td>1.412</td>
<td>3.263,87</td>
</tr>
<tr>
<td>9-2017</td>
<td>1.374</td>
<td>3.102,67</td>
</tr>
<tr>
<td>10-2017</td>
<td>1.374</td>
<td>2.954,35</td>
</tr>
<tr>
<td>11-2017</td>
<td>1.368</td>
<td>2.765,06</td>
</tr>
</tbody>
</table>

Source: https://www.regelleistung.net
Market volume of secondary control reserves – tendering results for capacity in Germany

- Demand netting of the activated reserves within the international grid control cooperation (German, Belgian, Dutch, French, Swiss, Austrian and Czech control zones (but so far no joint tenders as for primary control)

<table>
<thead>
<tr>
<th>Calendar week</th>
<th>Secondary control reserve demand, pos. / neg. (MW)</th>
<th>Peak average capacity price pos. / neg. (EUR/MW)</th>
<th>Off-Peak average capacity price pos. / neg. (EUR/MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-2017</td>
<td>1.902 / 1.832</td>
<td>258,64 / 0,11</td>
<td>216,46 / 21,45</td>
</tr>
<tr>
<td>7-2017</td>
<td>1.902 / 1.832</td>
<td>264,74 / 0,00</td>
<td>207,58 / 24,50</td>
</tr>
<tr>
<td>8-2017</td>
<td>1.902 / 1.832</td>
<td>249,60 / 0,00</td>
<td>207,64 / 49,06</td>
</tr>
<tr>
<td>9-2017</td>
<td>1.902 / 1.832</td>
<td>221,39 / 0,00</td>
<td>203,74 / 78,44</td>
</tr>
<tr>
<td>10-2017</td>
<td>1.902 / 1.832</td>
<td>186,43 / 0,00</td>
<td>178,30 / 87,30</td>
</tr>
<tr>
<td>11-2017</td>
<td>1.902 / 1.832</td>
<td>157,49 / 0,00</td>
<td>162,23 / 70,27</td>
</tr>
</tbody>
</table>

Source: https://www.regelleistung.net
Pre-qualification – primary control reserve

- Verification of technical capability

- Communication requirements
  - 2 redundant systems and guaranteed availability more than 95%
  - Delay time end-to-end max. 5s
  - Cyber security (mandatory media break, ...)
Pre-qualification – secondary control reserve

Source: https://www.regelleistung.net
Pre-qualification – actual gradients 1/2

Set point

Actual value has to be within the yellow area

Possible pool gradient

Ideal minimum gradient

Least gradient single unit

Source: German Transmission Code 2007 Annex D2 Part 2
Pre-qualification – actual gradients 2/2

Set point

Actual value has to be within the yellow area

Possible pool gradient

Ideal minimum gradient

Least gradient single unit

Source: German Transmission Code 2007 Annex D2 Part 2
Pre-qualification – contracted and actual gradients 2/2

Set point

Actual value has to be within the yellow area

Ideal minimum gradient

Least gradient single unit

Source: German Transmission Code 2007 Annex D2 Part 2
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