SIGNIFICANCE OF THE FORECAST IN THE SHORT TERM POWER TRADING

Efi Gogolou

Barcelona June 2016
Statkraft at a glance

Installed capacity
17 600 MW

Power production (2013)
56 TWh

97% renewable energy

3 600 employees

* 2013 figures. Includes:
- Statkraft’s share of installed capacity
- Statkraft SF’s share of installed capacity in Laos
A major energy trader

- Statkraft is a major player on Europe’s power exchanges
- The Group has special expertise within physical and financial power trading
- Statkraft is active in all energy-related commodities, offering origination and energy service agreements
- The Group is continually expanding power trading activities in Europe
Wind power

- **Germany**
  - More than 1000 Onshore wind farms: 8,33 GW
  - Ocean Breeze Offshore wind farm: 400 MW
  - Total Installed capacity: 8.7 GW

- **Norway**
  - Onshore wind farms Hitra, Kjøllefjord and Smøla
  - Installed capacity: 244 MW

- **Sweden**
  - Onshore wind farms Em and Stamåsen
  - Installed capacity: 69 MW

- **United Kingdom**
  - Onshore wind farms Alltwalis and Baillie, offshore wind farm Sheringham Shoal* and several PPAs
  - Installed capacity: 1850 MW

*Owned 50/50 with Statoil*
Solar power

- **Germany**
  - Total Installed capacity: 746 MW
  - 153 Solar Plants

- **United Kingdom**
  - Installed capacity: 233 MW
  - 132 Solar Plants
Traditional trading

Coal plants

Turbine
Transformer
Gas plants

Transformers
Condenser
Nuclear plants

River
Coal
Cooling Water
Power
Traded volume

time
Renewable energy trading

- Renewable energy is intermittent
- Priority dispatch on transmission lines
- Expected balancing volume: Intraday forecast – Day ahead forecast volume
EEG Portfolio in Germany

Example of Dayahead (red) and Intraday (green) Wind Forecast

- Germany: Market Premium Model -> financial bonus for renewable sources
- UK: PPAs benchmarked against the Market Index Price Operators’ profit margin ~90-99% of MIP
- Forecast-Production -> Imbalance (Prices ≠ MIP)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Installed Capacity MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>8700</td>
</tr>
<tr>
<td>Bio</td>
<td>200</td>
</tr>
<tr>
<td>Hydro</td>
<td>28</td>
</tr>
<tr>
<td>Solar</td>
<td>426</td>
</tr>
</tbody>
</table>
Trading German Power Intraday

- Our trades take place between the day-ahead auction EPEX Spot and the physical delivery.
- We continuously trade quarter-hour, hour and block products. Gate closure is 30 minutes before begin of delivery.
Our trades take place between the day-ahead auction and the APX closure.

We continuously trade half hour and block products. Gate closure is 60 minutes before begin of delivery.
Wind is a price driver

- The Grid publishes the forecasted demand for the following day -> expectations for prices -> schedule of plants to run or not accordingly

- Wind and solar forecast are a part of the expected supply -> fluctuations of forecast affect the supply-demand equilibrium -> prices

**Example:**

- UK Wind production – Wind forecast = 2GWs
- Demand > Supply
- Buyers in the market will have to pay more in order to secure the power they need
- Prices rising
- Generators with higher production costs start producing
Example: Date 24.05.2014

Parks: Sheringham Shoal I & Sheringham Shoal II

Forecast delivery 11.53
27.33 MW

Forecast delivery 12.13
14.53 MW

Forecast delivery 13.11
6.53 MW

Forecast delivery 15.30
5.32 MW
Sheringham Shoal I

Non tradable period

MW 60

21:30
Wind forecast... affects the prices

D-A prices  I-D prices
CORRECTIONS OF THE CLOSED PERIODS

00:00

<table>
<thead>
<tr>
<th>Time</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>64,0 MW</td>
<td>134 MW</td>
</tr>
<tr>
<td>01:04</td>
<td>0,4 MW</td>
<td>69,4 MW</td>
</tr>
<tr>
<td></td>
<td>233,8 MW</td>
<td>90,2 MW</td>
</tr>
</tbody>
</table>

- 143,6 MW for period 3

01:04

<table>
<thead>
<tr>
<th>Time</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>04:42</td>
<td>111,1 MW</td>
<td>115 MW</td>
</tr>
<tr>
<td>6:14</td>
<td>83,9 MW</td>
<td>82,4 MW</td>
</tr>
<tr>
<td></td>
<td>121,0 MW</td>
<td>2,3 MW</td>
</tr>
</tbody>
</table>

- 118,7 MW for period 11
Extreme weather situations: Windstorm Xaver
Extreme weather situations

Storm „Xaver“
2015-12-25 Portfolio Forecast

Wind Forecasts

Onshi

Wind Production [MW]

Time

Outer Quantile  Inner Quantiles  - Day Ahead Nom

1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00

Difference [MW]
# 2015-12-25 Prices

Average Intraday 5 Days to the past and past 5 weeks of current day.
Intraday lower than Spot
Intraday higher than Spot

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>1.6</td>
<td>-1.1</td>
<td>-6.0</td>
<td>-8.7</td>
<td>-2.2</td>
<td>0.1</td>
<td>55.8</td>
<td>2.3</td>
<td>5.3</td>
<td>2.3</td>
</tr>
<tr>
<td>01:00</td>
<td>3.6</td>
<td>0.7</td>
<td>-0.4</td>
<td>-6.0</td>
<td>1.4</td>
<td>-2.6</td>
<td>58.0</td>
<td>7.5</td>
<td>1.9</td>
<td>3.5</td>
</tr>
<tr>
<td>02:00</td>
<td>-1.2</td>
<td>0.8</td>
<td>0.6</td>
<td>-9.8</td>
<td>2.3</td>
<td>-0.2</td>
<td>66.6</td>
<td>6.6</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>03:00</td>
<td>1.1</td>
<td>1.6</td>
<td>0.3</td>
<td>-116</td>
<td>6.5</td>
<td>1.4</td>
<td>32.4</td>
<td>-5.5</td>
<td>3.9</td>
<td>3.6</td>
</tr>
<tr>
<td>04:00</td>
<td>0.3</td>
<td>-0.3</td>
<td>4.5</td>
<td>-8.7</td>
<td>7.7</td>
<td>0.2</td>
<td>24.3</td>
<td>-2.6</td>
<td>1.1</td>
<td>4.6</td>
</tr>
<tr>
<td>05:00</td>
<td>1.7</td>
<td>-1.8</td>
<td>6.5</td>
<td>-6.7</td>
<td>5.9</td>
<td>0.6</td>
<td>30.7</td>
<td>3.4</td>
<td>0.8</td>
<td>-1.1</td>
</tr>
<tr>
<td>06:00</td>
<td>2.4</td>
<td>-0.7</td>
<td>7.3</td>
<td>-8.4</td>
<td>4.3</td>
<td>1.9</td>
<td>0.6</td>
<td>3.4</td>
<td>3.3</td>
<td>-3.3</td>
</tr>
<tr>
<td>07:00</td>
<td>2.9</td>
<td>2</td>
<td>8.4</td>
<td>1.6</td>
<td>4.1</td>
<td>-1.3</td>
<td>-0.8</td>
<td>1.8</td>
<td>10.7</td>
<td>-0.3</td>
</tr>
<tr>
<td>08:00</td>
<td>4.3</td>
<td>3.4</td>
<td>4.9</td>
<td>9</td>
<td>1.9</td>
<td>-1</td>
<td>2.8</td>
<td>5.7</td>
<td>11.7</td>
<td>-12.2</td>
</tr>
<tr>
<td>09:00</td>
<td>-1.1</td>
<td>1.4</td>
<td>2.9</td>
<td>8.8</td>
<td>1.4</td>
<td>1.8</td>
<td>4.7</td>
<td>2.3</td>
<td>13.1</td>
<td>-16.4</td>
</tr>
<tr>
<td>10:00</td>
<td>-2.1</td>
<td>1.7</td>
<td>3.9</td>
<td>5.7</td>
<td>6.2</td>
<td>1.8</td>
<td>5.9</td>
<td>5.8</td>
<td>15.9</td>
<td>-3.3</td>
</tr>
<tr>
<td>11:00</td>
<td>-1.9</td>
<td>2</td>
<td>4.3</td>
<td>3.8</td>
<td>4.8</td>
<td>2.8</td>
<td>9.2</td>
<td>3.4</td>
<td>12.6</td>
<td>-7.3</td>
</tr>
<tr>
<td>12:00</td>
<td>-1.2</td>
<td>-2.2</td>
<td>-0.7</td>
<td>1.7</td>
<td>3.2</td>
<td>9.8</td>
<td>11.9</td>
<td>6.3</td>
<td>10.5</td>
<td>-5.5</td>
</tr>
<tr>
<td>13:00</td>
<td>-1.6</td>
<td>0.6</td>
<td>0.9</td>
<td>2.2</td>
<td>0.6</td>
<td>6.3</td>
<td>6.4</td>
<td>5.8</td>
<td>5.7</td>
<td>-0.2</td>
</tr>
<tr>
<td>14:00</td>
<td>-9.3</td>
<td>1.4</td>
<td>5.3</td>
<td>2.9</td>
<td>1.1</td>
<td>7.3</td>
<td>5.1</td>
<td>2.8</td>
<td>2.4</td>
<td>2.3</td>
</tr>
<tr>
<td>15:00</td>
<td>-8</td>
<td>0.8</td>
<td>1.6</td>
<td>4.3</td>
<td>0.7</td>
<td>7</td>
<td>3.1</td>
<td>-1.5</td>
<td>1.9</td>
<td>-0.4</td>
</tr>
<tr>
<td>16:00</td>
<td>-3.9</td>
<td>-1.8</td>
<td>5.6</td>
<td>5.5</td>
<td>3.9</td>
<td>4.6</td>
<td>0.3</td>
<td>-3</td>
<td>3</td>
<td>-2.8</td>
</tr>
<tr>
<td>17:00</td>
<td>-5.7</td>
<td>-4.4</td>
<td>9.8</td>
<td>4.4</td>
<td>4.9</td>
<td>4.4</td>
<td>-1.8</td>
<td>-10.7</td>
<td>8</td>
<td>5.9</td>
</tr>
<tr>
<td>18:00</td>
<td>2.5</td>
<td>-5.8</td>
<td>9</td>
<td>2.1</td>
<td>4.5</td>
<td>8.3</td>
<td>-1.5</td>
<td>-15.8</td>
<td>6.8</td>
<td>14.5</td>
</tr>
<tr>
<td>19:00</td>
<td>-4.5</td>
<td>-4.4</td>
<td>11.6</td>
<td>1</td>
<td>4.1</td>
<td>6</td>
<td>-1.8</td>
<td>-10.5</td>
<td>12.6</td>
<td>19.8</td>
</tr>
<tr>
<td>20:00</td>
<td>-0.6</td>
<td>-7</td>
<td>6.5</td>
<td>-1</td>
<td>-0.5</td>
<td>11.6</td>
<td>3.5</td>
<td>-1.5</td>
<td>42.8</td>
<td>28</td>
</tr>
<tr>
<td>21:00</td>
<td>1.9</td>
<td>-5.9</td>
<td>4.3</td>
<td>1.5</td>
<td>0.7</td>
<td>14.3</td>
<td>9.1</td>
<td>-0.4</td>
<td>53.6</td>
<td>23.5</td>
</tr>
<tr>
<td>22:00</td>
<td>-2.2</td>
<td>-8.5</td>
<td>3.9</td>
<td>2.8</td>
<td>-2.6</td>
<td>13.8</td>
<td>0.8</td>
<td>-0.3</td>
<td>30.8</td>
<td>29.6</td>
</tr>
<tr>
<td>23:00</td>
<td>-5.2</td>
<td>-13.7</td>
<td>-6.5</td>
<td>3.8</td>
<td>-5</td>
<td>43.7</td>
<td>1</td>
<td>-2.5</td>
<td>18.5</td>
<td>32.7</td>
</tr>
</tbody>
</table>

[Statkraft logo]
EEG Solar

- **Gradients**
  - First drop 7.5 GW
  - Second increase 14 GW
  - -2.7 GW per ¼ hour
  - +4.3 GW per ¼ hour

- **Dayahead ¼-hourly auction**
  - High: 464.37 €/MWh Low: -164.48 €/MWh

- **Intraday prices**
  - 9Q4: High 100 €/MWh, Low -975 €/MWh
  - 10Q1: High 950 €/MWh, Low -130 €/MWh
THANK YOU