3rd International Conference on Smart Energy Systems and 4th Generation District Heating

Copenhagen, 12–13 September 2017
Modelling participation in the Polish Day-Ahead Market (DAM) using a district heating company as a case

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COPENHAGEN, 12 SEPTEMBER 2017
Project SUPREME

SUPREME – Twinning for a sustainable, proactive research partnership in distributed Energy systems planning, modeling and management

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Department of Development and Planning

EMD International A/S
Structure of value chain in energy sector in Poland

Source: Aleksander Gabryś: Energy sector in Poland
### Key players in energy sector – business entities

<table>
<thead>
<tr>
<th>Business Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and fuel supply</td>
</tr>
<tr>
<td>Power Generation</td>
</tr>
<tr>
<td>Transmission</td>
</tr>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td>Wholesale</td>
</tr>
<tr>
<td>Retail</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certificates of origin trading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not compulsory</td>
</tr>
<tr>
<td>ERO assigns certificates of origin for RES</td>
</tr>
<tr>
<td>Control of measurements and data validation on requests dedicated to ERO on behalf of the responsible entity</td>
</tr>
<tr>
<td>Not compulsory</td>
</tr>
<tr>
<td>ERO controls responsibilities of buying and writing-off certificates of origin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tariffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ERO regulations</td>
</tr>
<tr>
<td>No ERO regulations</td>
</tr>
<tr>
<td>Tariffs are regulated by ERO</td>
</tr>
<tr>
<td>No ERO regulations</td>
</tr>
<tr>
<td>So called household tariff – G is regulated by ERO</td>
</tr>
</tbody>
</table>

Source: Aleksander Gabryś: Energy sector in Poland

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www.4dh.eu    www.reinvestproject.eu    www.heatroadmap.eu
The National Power System

Map of Polish transmission grid

Selected consolidated capital groups: territorial range (criterion – area of operation of distribution system operators within groups), group members, business activity

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Energy production in Poland

Electricity generation in Poland by source

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Location of newly-created energy blocks
Main Energy policies (national level)

- Act of 10 April The Energy Law
- Act of 20 February 2015 on renewable sources
- Act of 15 April 2011 on Energy efficiency
- Act of 29 August 2014 on Energy Performance of Buildings
- Ordinance of Minister of Infrastructure and Development on the methodology for determining the energy performance of a building or part of a building and energy performance certificates
- The national plan aimed at increasing the number of buildings with low energy consumption
- Energy Policy of Poland until 2030 of November 2009
Towarowa Giełda Energii SA (TGE) was established at the end of 1999. In the first six months, from registration of its business operations, it has launched the Day Ahead Market (electricity spot market). In 2003, TGE was the first and so-far only entity to obtain a license to run a commodity exchange market from the Financial Supervision Commission (KNF).

The key areas of TGE operations are:

- **Day Ahead Market (DAM),**
- **Intraday Market (IDM),**
- **Day Ahead Market gas (DAMg),**
- **Commodity Forward Instruments Market with Physical Delivery (CFIM),**
- **Commodity Forward Instruments Market with Physical Delivery gas (CFIMg),**
- **Property Rights Market for Renewable Energy Sources and Co-generation, (PRM)**
- **CO2 Emission Allowance Market (EAM).**
Day-Ahead Market

- In 2015, prices decreased by 13% yoy compared to an increase of 17% in 2014. The average hourly price of electricity on the TGE Day-Ahead Market came to 156.95 PLN/MWh in this period (179.93 PLN/MWh in 2014).
- For peak hours (on weekdays, from 8:00 a.m. to and including 10:00 p.m.), the price dynamic was nearly double. The 2015 average equaled 186.63 PLN/MWh, i.e. it declined by 20% compared to the preceding year (in 2014, peak hour prices increased by 31% on an annual basis).
- The volatility of the electricity price across 12 months was much higher than in 2014. The highest decrease (19%) came in Q4 2015 versus the same quarter in 2014. In Q3, the lowest decrease (9%) was observed. In contrast, prices fell by 10% and 12% in Q1 and Q2, respectively, compared to the same quarters in 2014.

The Polish Day Ahead 2016 prices has an average of 160 PLN/MWh (37,69 EUR/MWh).

Average prices in Denmark and Germany in 2016 was:

<table>
<thead>
<tr>
<th>Day Ahead Price, EUR/MWh</th>
<th>DK-West</th>
<th>DK-East</th>
<th>DE European Power Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26,67</td>
<td>29,40</td>
<td>28,98</td>
</tr>
</tbody>
</table>

Daily Prices on the TGE Day-Ahead Market

Source: TOE based on TGE data
Total domestic monthly demand for electricity

Source: TOE based on PSE data
Prices on Day-Ahead Market in 2016
The new idea of Polish government
Clusters of Energy

In 2016 in Poland worked 428 District Heating companies.

Source: Aalborg University

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As a test case we are using a District Heating company located in Legionowo, central Poland. The company works since 1978 and its main responsibilities are production, transmission and distribution of thermal energy. In addition it also conduct business activity in transactions and distribution of electric energy

3x Electric Power Generation G3516H
PEC Legionowo is also local DSO. District Heating company is owner of local electro energetic system (15 kV) taken over from City Legionowo. In PEC Legionowo the average price for 1 MWh of electricity is equal **180PLN (~43EUR)**.
EnergyPRO analysis

The yearly heat delivered from plant:

<table>
<thead>
<tr>
<th>2016</th>
<th>Contracted power [total]</th>
<th>Use of endusers [TJ]</th>
<th>Gas fuel used [3 engines, cogeneration] [Mtoe]</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>87,781</td>
<td>101.747</td>
<td>-</td>
</tr>
<tr>
<td>February</td>
<td>87,731</td>
<td>70.963</td>
<td>-</td>
</tr>
<tr>
<td>March</td>
<td>87,779</td>
<td>73.504</td>
<td>215310</td>
</tr>
<tr>
<td>April</td>
<td>88,0436</td>
<td>44.517</td>
<td>647434</td>
</tr>
<tr>
<td>May</td>
<td>88,0436</td>
<td>17.285</td>
<td>950818</td>
</tr>
<tr>
<td>June</td>
<td>88,0436</td>
<td>10.832</td>
<td>914906</td>
</tr>
<tr>
<td>July</td>
<td>88,0651</td>
<td>10.096</td>
<td>1003787</td>
</tr>
<tr>
<td>August</td>
<td>88,1592</td>
<td>10.176</td>
<td>999790</td>
</tr>
<tr>
<td>September</td>
<td>87,3232</td>
<td>16.832</td>
<td>943831</td>
</tr>
<tr>
<td>October</td>
<td>87,792</td>
<td>58.357</td>
<td>1016122</td>
</tr>
<tr>
<td>November</td>
<td>87,8882</td>
<td>74.925</td>
<td>984214</td>
</tr>
<tr>
<td>December</td>
<td>87,9243</td>
<td>89.336</td>
<td>882996</td>
</tr>
<tr>
<td>TOTAL/AVERAGE</td>
<td>87,88375</td>
<td>580.571</td>
<td>8559208</td>
</tr>
</tbody>
</table>

CHPs described:

- **CHP**
  - Electrical power: 2000 kW-el
  - Electrical efficiency: 40%
  - Fuel input: 5000 kW-fuel
  - Heat efficiency: 50%
  - Heat power: 2500 kW-heat

Gas prices: 21 PLN/GJ
Heat prices: 40 PLN/GJ

Model of DH in Legionowo
CHP and thermal storage (winter)

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Only CHP (summer)
CHP and thermal storage (summer)
Cash flow

The case without thermal storage and with thermal storage

**Difference: 947 261,00 PLN (223 410,61 €)**

The case where the CHP covers the entire heat demand (without storage and with storage).

**Difference: 1 968 869,00 PLN (464 355,90 €)**
Conclusions

• The Day-Ahead Market in Poland is an interesting option for District Heating companies with CHP units. In the case of use of heat storage profits increase by 5%.

• Very interesting case is when all the heat demand is covered by CHP units. In the case of use of heat storage profits increase by 27%.

• In the case of PEC Legionowo having its own electricity distribution system, the Day-Ahead Market is not as profitable (average energy price on market is 160PLN/MWh, PEC sells energy for 180PLN/MWh)

• The situation on the Polish energy market could be changed when new players appear under the form of Clusters of Energy.
Thank you for your attention

Questions?

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