Distributed CHP units in Denmark are too quickly reducing their electricity production

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Online Presentations

On the following links you can view the current and historic operation of the Danish electricity system as well as examples of the current and historic operation of three Danish energy plants.

Electricity production
Electricity production right now throughout Denmark

Energy plants
- Ringkøbing District Heating
- Skagen District Heating
- Hvide Sande District Heating
- Sviby District Heating
Central power plants was stopped this summer
The electrical infrastructure in Denmark in 1985. Red circles indicate central power plants, yellow circles DHCP CHP and secondary producers above 500 kW
The electrical infrastructure in Denmark in 2015. Red circles indicate central power plants, yellow circles DHCP CHP and secondary producers above 500 kW.
Electrical capacity in Denmark

- Central power plants
- DHCP CHP
- Secondary producers
- Wind turbines
- PV

Year:
- 1994
- 2005
- 2014
Yearly electricity productions at Danish distributed CHP.
Phase 1: DHCP CHP displaces fossil fuelled power plants
Phase 2: DHCP CHP participates in the integration of fluctuating RES
Phase 3: DHCP CHP primarily delivers needed electrical capacity in few hours
NOTICE:

There is no CHP in a 100% renewable energy system

CHP is a transitional technology
The Danish TSO, Energinet.dk’s plans for 100% renewable energy shows that the present CHP production in Denmark of 90 PJ-heat is in 2035 down to 40 PJ-heat and in 2050 down to 5 PJ-heat.
The Danish triple tariff

- Payment for reducing fossil fuel use at power plants
- Payment for reducing variable operating costs at power plants
- Payment for reducing fixed operating costs at power plants
- Payment for reducing the need for new power plants
- Payment for reducing the need for transmission grid expansion
- Payment for reducing the need for distribution grid expansion
- Payment for reducing grid loss in transmission grids
- Payment for reducing grid loss in distribution grids
<table>
<thead>
<tr>
<th>Working days</th>
<th>Low load</th>
<th>High load</th>
<th>Peak load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter (October-March)</td>
<td>21.00–06.00</td>
<td>06.00–08.00</td>
<td>08.00–12.00</td>
</tr>
<tr>
<td></td>
<td>All holidays</td>
<td>12.00–17.00</td>
<td>17.00–19.00</td>
</tr>
<tr>
<td></td>
<td>All weekends</td>
<td>19.00–21.00</td>
<td></td>
</tr>
<tr>
<td>Summer (April-September)</td>
<td>21.00–06.00</td>
<td>06.00–08.00</td>
<td>08.00–12.00</td>
</tr>
<tr>
<td></td>
<td>All holidays</td>
<td>12.00–21.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All weekends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUR/MWh</td>
<td>Low load</td>
<td>High load</td>
<td>Peak load</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Saved fuel costs at power plants</td>
<td>21,85</td>
<td>21,85</td>
<td>21,85</td>
</tr>
<tr>
<td>Saved variable operating costs at power plants</td>
<td>2,54</td>
<td>2,54</td>
<td>2,54</td>
</tr>
<tr>
<td>Saved fixed operating costs at power plants</td>
<td>0,00</td>
<td>3,92</td>
<td>6,30</td>
</tr>
<tr>
<td>Saved investment costs at power plants</td>
<td>0,00</td>
<td>20,44</td>
<td>32,82</td>
</tr>
<tr>
<td><strong>Total saved at power plants</strong></td>
<td><strong>24,39</strong></td>
<td><strong>48,76</strong></td>
<td><strong>63,51</strong></td>
</tr>
<tr>
<td>Saved grid loss at 150 + 400 kV</td>
<td>0,70</td>
<td>2,14</td>
<td>3,13</td>
</tr>
<tr>
<td>Saved grid expansion, 150 kV</td>
<td>0,00</td>
<td>6,46</td>
<td>10,36</td>
</tr>
<tr>
<td><strong>Total saved on 150/60 kV-transformer</strong></td>
<td><strong>25,10</strong></td>
<td><strong>57,35</strong></td>
<td><strong>77,01</strong></td>
</tr>
<tr>
<td>Saved grid loss at 60 kV</td>
<td>0,54</td>
<td>1,90</td>
<td>2,88</td>
</tr>
<tr>
<td>Saved grid expansion, 60 kV</td>
<td>0,00</td>
<td>2,15</td>
<td>3,46</td>
</tr>
<tr>
<td><strong>To be paid for electricity delivered at 60/10 kV-transformer</strong></td>
<td><strong>25,63</strong></td>
<td><strong>61,40</strong></td>
<td><strong>83,34</strong></td>
</tr>
<tr>
<td>Saved grid loss at 10 kV</td>
<td>0,36</td>
<td>1,70</td>
<td>3,02</td>
</tr>
<tr>
<td>Saved grid expansion, 10 kV</td>
<td>0,00</td>
<td>1,22</td>
<td>1,95</td>
</tr>
<tr>
<td><strong>To be paid for electricity delivered to the 10 kV-grid</strong></td>
<td><strong>26,00</strong></td>
<td><strong>64,32</strong></td>
<td><strong>88,31</strong></td>
</tr>
<tr>
<td>Saved grid loss at 0.4 kV</td>
<td>0,75</td>
<td>3,46</td>
<td>6,44</td>
</tr>
<tr>
<td>Saved grid expansion, 0.4 kV</td>
<td>0,00</td>
<td>1,22</td>
<td>1,95</td>
</tr>
<tr>
<td><strong>To be paid for electricity delivered to the low voltage-grid</strong></td>
<td><strong>26,75</strong></td>
<td><strong>68,99</strong></td>
<td><strong>96,71</strong></td>
</tr>
</tbody>
</table>
Tax free fuel consumption = Exported electricity/0,67
Simulated operation of CHP production at triple tariff

https://www.emd.dk/energypro/
Simulated operation of CHP production at Day Ahead market

https://www.emd.dk/energypro/
Monthly capacity payment replaced the triple tariff
A production unit made at https://www.emd.dk/plants/rfvv/, belonging to the future 😊
Thank you for your attention!
ACER’s general framework for the organization of the electricity markets

- Frequency containment reserves
- Frequency restoration reserves
- Replacement Reserves
- Intra day whole sale market
- Day ahead whole sale market
Often these three reserves are numbered:

Frequency containment reserves = Primary reserves
Frequency restoration reserves = Secondary reserves
Replacement Reserves = Tertiary reserves
SEC VICTORIA
SYNCHRONOUS CONDENSER
125000 KVA 750±5% 50±5% 22000 V
Den optimale løsning kan være en kombination af central produktion på værket og booster produktion i de enkelte bygninger.