Flexibility options of CHP: bringing together renewable energies and efficiency
(German example)

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The question

• Growing share of fluctuating wind and solar power is changing the generation requirements

• How does cogeneration fit into these requirements?
Development of RES supply share in Germany

Quelle: BMU; Stand: 03/2014

www.unendlich-viel-energie.de
RES objectives of the German „Energiewende“

RES-share in electricity consumption
Historical development and targets

- Historisch
- EEG12
- EEG14 oberer Wert
- EEG14 unterer Wert
- Trend aktueller Plan
Growing „needles“ call for flexibility

- **20% Wind & Solar**
- **40% Wind & Solar**
- **80% Wind & Solar**

**Source:** Prof. Dr.-Ing. habil. Ingo Stadler/ Westfalen Wind GmbH
Perspectives

2030 expected Residual loads (blue)

Source: Norbert Krzikalla et al. (BET): *Möglichkeiten zum Ausgleich fluktuierender Einspeisungen aus Erneuerbaren Energien*, April 2013
Does cogeneration fit into these new requirements?
Example CHP load in 2005

Source: FfE, CO2-Verminderung in Deutschland, 2009
Electricity and heat demand over the year

Office building 12,000 m³

Source: Transferstelle Bingen
Electricity demand over one day

Example apartment house
Load curve of a District heating system

Source: Prognos
Sorted annual heat load curve district heating

CHP design & operation **without** heat storage

![Graph showing heat load curve with Boiler and CHP sections]
CHP design & operation with heat storage
Example.
Week 12-19.8.14

Power exchange prices give incentives to switch CHP on or out

Negative Prices: unflexible „must-run“-power plants overburden the export market

Market as control center: EPEX-Prices indicate the relative scarcity

Source: -- power price EPEX-Spot
Example CHP plant flexible operation

- 420 kW existing + 1.562 kW additional
- Schedule winter week: many operating hours
- Due to higher capacity more CHP heat production → higher overall efficiency

EPEX price

demand-oriented operation: tranquility for the low price time

Power production

Heat production

Heat storage recharging and discharging in the daily rhythm
Spring Week: low number of operating hours

Operation at high price hours only

Heat storage: bridging rest together with small CHP
Example of a Danish CHP with heat storage (Ringkøbing)
Heat oriented CHP design & operation

Sorted annual heat load

Boiler

CHP
Power oriented CHP & operation

Sorted annual heat load

CHP
Monvalent design

Heat load MW

Days of the year

CHP
In cold and very cold hours, PV generation is low.

Source: Prognos AG
Correlation between DH CHP and wind power

- In cold and very cold hours, wind power generation is low.
- High wind power generation in the transition period.

Source: Prognos AG
CHP Roadmap compatible with RES development?

- **Business level economic potential**
- **Socio-economic potential**

<table>
<thead>
<tr>
<th>Year</th>
<th>Reference Scenario</th>
<th>Target Scenario</th>
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<tbody>
<tr>
<td>2013</td>
<td>521 TWh/a</td>
<td>244 TWh/a</td>
</tr>
<tr>
<td>2020</td>
<td>439 TWh/a</td>
<td>378 TWh/a</td>
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<tr>
<td>2030</td>
<td>381 TWh/a</td>
<td>271 TWh/a</td>
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<tr>
<td>2040</td>
<td>325 TWh/a</td>
<td>210 TWh/a</td>
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<tr>
<td>2050</td>
<td>253 TWh/a</td>
<td>147 TWh/a</td>
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</tbody>
</table>

- **CHP potential**
- **CHP compatible power generation**

185 TWh/a CODE2 CHP Roadmap
• CHP is not only the most efficient way of power production but also the most efficient way of heat production.

• As heat will be needed for room heating and industrial processes also on the long run in the future, the electricity produced as a by-product to heat (i.e. in cogeneration) has the same ecological value as wind or solar power, because not using this electricity source would mean squandering it.

• “Saving energy is the best energy source.”
Some more aspects

- CHP can very well interact with
  - electrical heat pumps
    - CHP generate electricity in high price hours
    - HP use electricity in low price hours
  - Power-to-heat systems
- CHP can also use „wind gas“ from „power-to-gas“-systems
Some pictures
Modern CHP with a heat storage
Biogas CHP with gas storage

- 1,500 m³ biogas storage
- 1200 kW el
- 1224 kW th
- CO2 saving 7,000 ton per year
2 medium sized CHP plants in Denmark with heat storage tanks
The future
Cogeneration for the people
The future of electricity production will be decentralized

today: Clean, cheaper, more reliable

tomorrow:
Summary

• With growing shares of fluctuation power production from wind and solar more and more flexible production technologies are needed to cover the residual loads.

• Modern CHP technologies are flexible and – different to electricity only power plants – also high efficient. The CHP electricity will be produced in times with low wind and solar power production and high electricity prices, which indicate the relative scarcity on the market. By use of appropriate heat storage tanks the heat produced in cogeneration with electricity can be used later, as heat demand pattern is different from the residual electricity demand pattern.

• With CHP the residual electricity demand can be completely covered and thus security of supply be ensured without power-only-plants, i.e. without any compromise regarding energy efficiency. So we do not need new power only plants in future, neither for energy efficiency nor for security of supply.

• A growing CHP share means an intelligent and cost effective interaction between covering electricity supply and heat supply – considering all objectives
  – security of supply,
  – economy,
  – decarbonisation
  – using limited energy resources as efficient as possible.
Thank you for your kind attention

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