The role of CHP and district heat in Europe

Dr. Markus Blesl

1 Institut für Energiewirtschaft und Rationelle Energieanwendung, Universität Stuttgart

International Seminar on DHC/CHP
“DHC/CHP TOWARD FUTURE”
15-17 November 2006, at Center, Seoul, Korea
Statistic of District heat generation in Europe (EU25)

- Slovenia
- Hungary
- Slovak Republic
- Czech Republic
- Poland
- Lithuania
- Latvia
- Estonia
- Greece
- Italy
- France
- United Kingdom
- Belgien
- Netherlands
- Austria
- Germany
- Denmark
- Sweden
- Finland

District heat generation in [PJ]

Year:
- 1990
- 1995
- 2000
- 2003

Markus Blesl
The role of CHP and DH in Europe
16 November 2006
Fuel used in residential for heating and hot water
(in 2003)
Net electricity generation of CHP in Europe (EU25) – Statistic / Problems

- Slovakia
- Poland
- Hungary
- Estonia
- Czech
- Sweden
- Ireland
- Greece
- France
- Finland
- Denmark
- Austria
- Portugal
- UK
- Spain
- Netherlands
- Belgium
- Italy
- Germany

0 50 100 150 200 250 300 350 400 450

Net electricity generation of CHP in [TWh]

2000
Statistic
2000
FW308
2002
Statistic

Markus Blesl
The role of CHP and DH in Europe
16 November 2006
Policy measures in the European electricity market

- Liberalisation of the electricity market (directive of the EC from 1997 (96/92/EG) and 2003 (2003/54/EG)
- Kyoto-Protocol and Emission trading
- Renewable Energy Directive (directive of the EC 2003/54/EG)
- Promotion of combined heat and power (directive on promotion of cogeneration based on a useful heat demand in the internal energy market (2004/8/EC))
- Energy infrastructure and security of supply
- Harmonization of the European energy taxation
Electric efficiency of power plant in the future

- 1400 °C ISO temperature
- Improved coal drying
- Target Reinbraun
- Ca. 6 % point
- Ca. 7 – 8 % points (Advanced Cycles)

Bar chart showing:
- Hard coal plant
- Hard coal IGCC
- Coal IGCC with CCS
- Lignite
- Gas CC

Electricity net efficiency in [%]
Electrical efficiency of CHP in the future

- Hard coal condensing CHP 500MW
- Hard coal backpressure 200 MW
- Gas condensing CHP 200 MW
- Gas backpressure 200 MW

Net electric efficiency in [%]

η_{el} bei max. P
η_{el} bei max. Q
η_{th} bei max. Q
Specific investment cost of different power plants and CHP-plants

Spec. investment cost [€/kWel]

<table>
<thead>
<tr>
<th>Year</th>
<th>Lignite plant 1050</th>
<th>Hard coal 500 MW</th>
<th>Hard coal BKP-CHP 200 MW</th>
<th>Hard coal plant 800 MW</th>
<th>Gas CHP-Cond. 200 MW</th>
<th>Gas natural gas BKP-CHP 200 MW</th>
<th>Gas CC 800 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1200</td>
<td>1100</td>
<td>1000</td>
<td>900</td>
<td>800</td>
<td>700</td>
<td>600</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Difference depending on the power classes

Project Westfalen

Lippendorf

Rheinbraun

Markus Blesl  The role of CHP and DH in Europe  16 November 2006  8
Model of the Electricity and Gas market – TIMES-EG
TIMES – EG (European Electricity and Gas Market)

• Technical, ecological and economical optimisation model based on the model generator TIMES
• Technology oriented bottom-up model with prefect foresight
• 30 region model (EU 25 + Ro, Bu, Tu, N, CH)
• Detailed power generation sector based on a IER power plant database with 25,000 units included
• Country specific differences for characterisation of new power plants and CHP (CO₂ sequestration and capture options included)
• Detailed electricity exchange balances based on ETSO statistics
• Consideration of CHP expansion options
• Renewable potential (onshore wind, offshore wind, geothermal, biomass, biogas, hydro (small, middle, large))
• Country specific availability factors for renewable
• Country specific heat and electricity demand reduction options
• GHG/ Pollutants : CO₂, CH₄, N₂O, NOₓ, SOₓ, particles included
Scenario definition

Reference case (REF)

- no strict climate policy or additional promotion of any technology or energy carrier

CO₂-reduction scenarios (Kyoto target and beyond - in 2010 8 % and in 2030 15.6 % CO₂-emission reduction compared with 1990):

- CO₂ - Emission target emission targets have to be met without any contribution of the residential sector (RED_ELEC)

- CO₂-reductions based on CHP plants in the residential sector are taken into account to fulfil the reduction target target for the EU25 (FLEX)

Renewable scenarios:

- Renewable electricity consumption targets for EU25 (EU_RES) (21.5 % in 2010 and 40 % in 2030)
Net electricity generation by energy carriers in EU25

- **1990**: 1000 TWh
- **1995**: 1200 TWh
- **2000**: 1600 TWh
- **2010**: 2400 TWh
- **2020**: 3400 TWh
- **2030**: 4000 TWh

Legend:
- **PV**
- **Hard coal**
- **Lignite**
- **Oil**
- **Natural gas**
- **Nuclear**
- **Geothermal**
- **Hydrogen**
- **Hydro**
- **Wind**
- **Others**
Net electricity generation of CHP plants in the EU-25 by energy carriers in different cases

- Statistic
- coal
- oil
- natural gas
- others

1990: REF
1995: RED_ELEC
2000: FLEX
2010: EU_RES
2020: REF
2030: RED_ELEC

Net electricity generation of CHP in [TWh]
District heat generation in the EU25 by aggregated regions

District heat generation in [PJ]

EU 10
NORDIC
Austria
UK / Ireland
Spain/Portugal
France
BENELUX
Italy
Germany
Influence of the reduction targets to the total CO2 emissions in the different scenarios for the EU25
Conclusions

• Depending on the countries in Europe the development of DH will be different because the starting point is of economical growth, national existing laws or cross-subsidies for competitor’s energy carriers.

• Additional co-generated electric power is produced tendentiously out of natural gas and biomass. The share of district heat from CHP plants gradually rises instead from heating plants.

• If all sectors were included efficiently in an emission trading system, the whole system would be improved. DH systems have equal competitive conditions in the heat and electricity market.

• The progression of district heat crucially depends on the costs of opening up new district heating supply areas in the future. Only provided that the costs of the extension of supply areas and the costs of starting losses reduce significantly, new district heating supply areas can be opened up economically.
Thank you for your attention!