INFORSE-Europe Sustainable Energy NGO Seminar
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http://www.inforse.org/europe/seminar_2011_Hamburg.htm
1. Overview of the E.ON Hanse Wärme GmbH
2. Renewable energies in the heating market
3. Long-term thermal storage: example Hamburg-Karlishöhe
4. Overcoming of technical obstacles of the solar thermal energy: project ‘multifunctional storage’
5. Overcoming of economical obstacles of the solar thermal energy (pilot project Hamburg)
6. Prospect

E.ON Hanse Wärme GmbH is the major branch company of this nature in the E.ON regional area. Company data 2010:

- Balance-sheet total: 211 m €
- Net sales: 137 m €
- Investments: 15 m €
- Employees: 180
- Heat production: 1.625 GWh
- Power generation in CHP: 260 GWh
- Plants: ca. 900
- Heating networks: ca. 120
- Cogeneration (CHP) plants: ca. 150
• Integrated quality-, health- and safety protection management system DIN EN ISO 9001 / 14001 and OHSAS 18001, certified 2003...2012
• Environmental partnership Hamburg since 2003
• Health and safety protection partnership Hamburg since 2005

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Chances for renewable energies - the heating market

<table>
<thead>
<tr>
<th>Heat generation from renewable energies [TWh]</th>
<th>1997</th>
<th>2007</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>48.6</td>
<td>84.2</td>
<td>95.7</td>
</tr>
<tr>
<td>Biogenic share of domestic waste</td>
<td>2.3</td>
<td>4.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Solar thermal energy [13 Mio. m²]</td>
<td>0.7</td>
<td>3.7</td>
<td>4.8</td>
</tr>
<tr>
<td>Geothermal energy</td>
<td>1.3</td>
<td>2.3</td>
<td>5.0</td>
</tr>
</tbody>
</table>

• The share of the renewable energies rose in 2009 up to 8.4%, growth rate 1.0% p.a., tendency rising
• The fuel 'wood' dominates the position 'biomass'
• Only the biogenic share of domestic waste is important for the public district heating supply.
The district heating market is (not yet) a market for biomass and renewable energies

### Primary energy effort of district heating supply

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coal</td>
<td>21.1%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Brown coal</td>
<td>7.1%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Mineral oil</td>
<td>1.9%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Natural gas</td>
<td>48.8%</td>
<td>47.2%</td>
</tr>
<tr>
<td>Waste etc.</td>
<td>21.1%</td>
<td>21.0%</td>
</tr>
</tbody>
</table>

### Heating network feeding 2006...2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass CHP</td>
<td>56.9</td>
<td>39.8</td>
<td>27.4</td>
<td>16.4</td>
<td>3.8</td>
<td>3.5%</td>
</tr>
<tr>
<td>Wood</td>
<td>8.1</td>
<td>10.2</td>
<td>12.1</td>
<td>5.8</td>
<td>5.2</td>
<td>0.5%</td>
</tr>
<tr>
<td>Landfill gas CHP</td>
<td>1.5</td>
<td>1.3</td>
<td>1.4</td>
<td>0.9</td>
<td>0.3</td>
<td>0.1%</td>
</tr>
<tr>
<td>Solar</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.0%</td>
</tr>
<tr>
<td>Industrial waste heat</td>
<td>1.5</td>
<td>1.9</td>
<td>4.6</td>
<td>6.7</td>
<td>7.9</td>
<td>0.1%</td>
</tr>
<tr>
<td>Sum renewables</td>
<td>68.0</td>
<td>53.0</td>
<td>45.6</td>
<td>30.2</td>
<td>17.6</td>
<td>4.2%</td>
</tr>
<tr>
<td>Waste combustion CHP</td>
<td>265.5</td>
<td>270.1</td>
<td>257.7</td>
<td>274.9</td>
<td>245.4</td>
<td>16.3%</td>
</tr>
<tr>
<td>Natural gas CHP</td>
<td>370.0</td>
<td>373.8</td>
<td>400.2</td>
<td>369.7</td>
<td>355.6</td>
<td>22.8%</td>
</tr>
<tr>
<td>Natural gas CHP, partners</td>
<td>12.3</td>
<td>10.5</td>
<td></td>
<td></td>
<td></td>
<td>0.8%</td>
</tr>
<tr>
<td>Coal CHP, partners</td>
<td>31.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.9%</td>
</tr>
<tr>
<td>Natural gas, boiler firing</td>
<td>877.6</td>
<td>889.8</td>
<td>834.2</td>
<td>802.1</td>
<td>1,074.7</td>
<td>54.0%</td>
</tr>
<tr>
<td>Heating networks feed-in</td>
<td>1,625.0</td>
<td>1,597.3</td>
<td>1,537.7</td>
<td>1,476.9</td>
<td>1,693.3</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Biogas heating in district heating supply of E.ON Hanse Wärme

<table>
<thead>
<tr>
<th>Heating supply</th>
<th>until 2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of heating supplies by external biogas-CHP</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Electrical power output</td>
<td>5.0 MW</td>
<td>6.2 MW</td>
<td>6.5 MW</td>
</tr>
</tbody>
</table>

### Biogas supply (Biogas 52% CH₄)

| Own biogas CHP plants running | 9 | 21 | 25 |
| Electrical power output      | 5.4 MW | 10.7 MW | 13.0 MW |

### Bio natural gas feed-in to natural gas grid

| Plants   | 1 | 2 |
| Capacity (99% CH₄) | 350 m³/h | 700 m³/h |
| Electrical power output | 1.0 MW | 2.5 MW |
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Scheme: concept of the plant
- Storage
- Collector grid
- Heating grid
- Collectors
- Boilers and heat exchangers
Conclusion: solar supported local heating with long-term thermal storage in Hamburg-Bramfeld:

- The solar heat production of 309 kWh/m² in the 5-years-average was within the expected range.
- Solar heat production: 905 MWh in average. Heat losses of the storage system: 400 MWh (!)
- The solar variable gross margin of the heat demand was between 25 and 26%. The heat losses of the storage system were generally too high.
- The combination between 3,000 m² collector surface und 4,500 m³ storage volume proved it’s value.
- Due to temperature-related stretching and several changes of load (day to night), the collector network is unuseable and has to be replaced.
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The future: multifunctional storage ± 10 MW
- Steel tank 4.150 m³
- Cross-section
- Thermal insulation
- Weight sole

Map of the area: Gut Karlshöhe
- Multifunctional heat storage
- Glass energy house
- Exhibition
Solar thermal energy is not predictable

The solar energy feed-in causes rising temperatures of the water flow. Countermeasures:

- First, the fossil fired production capacities are getting reduced, followed by the cogeneration capacities.
- If the total heat demand is less than 10 MW, e.g. on hot summer days, the storage will be charged with a maximum of 10 MW and discharged after sunset.
- We are striving for a combination between forward and return pipe network feed-in. The lowest rotation water amount in the network is controled via bypass at a suitable point.
Solar thermal energy leads to material stress.
The collector network is stressed by temperature changes from
day to night; the pipe material will be altered.

Countermeasures:
• The temperature in the collector circle gets limited to 100 °C
  by variable volume flow rates.
• The feed-in into the heating network can occur when the
temperature in the collector circle is above the temperature
of the network.

Solar thermal energy is expensive

Countermeasures:
• Good locations and roof directions are preferred for the solar
  collectors. The common building s in the network area are multiple-
  family houses with 4 to 8 floors and a flat roof.
• The collectors and heat exchangers should be standardised.
• In addition to the delivery from the district heating, a second heat
  exchanger with feed-in heat-measurement will be installed.
• Expensive installations for heat storage within the buildings cease
to apply.
• The network-using concept allows to allocate the solar heat of one
  or several solar collector systems at a withdrawal point.

The long-term thermal storage has been developed into a
multifunctional storage capable for temperature up to 100 °C. The
new cover of stainless steel and the new thermal insulation are
designed for a technical life-cycle of 50 years.
• The storage is connected by a 3 km extension to the district heating
  system Hamburg-East (120 MWh / 400 MWh). The maximum
storage capacity is 240 MWh (10 MW / 24 hrs.)
• The combined network is connected to several area networks which
  simplifies the hydraulic integration of the solar collectors.
• Heat from solar collectors, renewable energies and surplus heat
  from CHP plants can be stored.
Folie 25

Combined heating network Hamburg-East

Storage
Bramfeld
Waste combustion CHP plant
Rahlstedt
Barsbüttel
Wandsbek

Folie 26

Heat demand at 0 °C in average

Folie 27

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The solar collectors in a standardised performance are connected to the network by heat exchangers. The feed-in is normally connected to the flow. The average temperature of the return water is 55 to 60 °C.

Internal heat storage in the building and the required control systems are not necessary. Compared to conventional solarthermal systems, this technique reduces the investment.

The amount of heat fed into the network can be released from storage when- or wherever it is required via a supplier’s service installation.

Feed-in and withdrawal will be credited within one balance sheet (8 months from April to November).
Examples:

1. A building, equipped with a solar collector, is connected to the network. The solar heating yield is fed into the network and will be credited in the balance sheet.

2. A building, equipped with a solar collector, is connected to the network. Another connected building is supplied virtually by the solarthermal energy. This building can have a different owner. The heat yields and demands are credited in the balance sheet within the balance period.

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<table>
<thead>
<tr>
<th>Solar network usage – concept description -</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples:</td>
<td></td>
</tr>
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<td>1. A building, equipped with a solar collector, is connected to the network. The solar heating yield is fed into the network and will be credited in the balance sheet.</td>
<td></td>
</tr>
<tr>
<td>2. A building, equipped with a solar collector, is connected to the network. Another connected building is supplied virtually by the solarthermal energy. This building can have a different owner. The heat yields and demands are credited in the balance sheet within the balance period.</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Solar network usage - balance sheet -</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Example for particular case</td>
<td>feed-in</td>
</tr>
<tr>
<td>Solar collector surface</td>
<td>150 m²</td>
</tr>
<tr>
<td>Peak power</td>
<td>75 kW</td>
</tr>
<tr>
<td>Heat yield</td>
<td>60 MWh</td>
</tr>
<tr>
<td>Electricity consumption feed-in</td>
<td>300 kWh</td>
</tr>
<tr>
<td>Balance period (months)</td>
<td>8</td>
</tr>
<tr>
<td>Share of heat yield</td>
<td>89 %</td>
</tr>
<tr>
<td>Heat network feed-in</td>
<td>53 MWh</td>
</tr>
<tr>
<td>Thermal power (-12 °C)</td>
<td>100 kW</td>
</tr>
<tr>
<td>Heat demand of the building</td>
<td>180 MWh</td>
</tr>
<tr>
<td>Within the balance period</td>
<td>90 MWh</td>
</tr>
<tr>
<td>Share of solar energy</td>
<td>29.7%</td>
</tr>
<tr>
<td>Primary energy factor</td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>70.3%</td>
</tr>
<tr>
<td>Solar</td>
<td>29.7%</td>
</tr>
<tr>
<td>In total</td>
<td></td>
</tr>
</tbody>
</table>

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Balance sheet circle

- Feed-in points $n_1, \ldots, n_m$
- Withdrawal points $m_1, \ldots, m_k$
The connection of a solar thermal collector to the network is usually covered by the fixed price [€ p.a.] for the supplied buildings.

- Access to the system, consisting of network, pumps, heat losses, virtual storage, balance sheet etc., is offered for 5,- € / MWh.
- The metering-point of the feed-in is charged with 60 € p.a. (until 100 kW)
- The heat amount fed into the network will be completely credited.

In a customer-to-customer relation, the price for internal heating storage is covered by the system payment of 5,- € / MWh, which is less expensive than the internal storage.

- The variable gross margin of solar thermal energy for heating requirement is maximized up to 50%.
- The primary energy factor of a residential building can be improved in addition to the key figure \( f_{PE,DH} = 0.60 \) of the network.
- Efficient roof orientations and building situations can be used. The solar collectors are getting independent of the building which has to be redeveloped.

Apart from the fact that there is a low heat loss in the collector circle all the solar heat can be used. The losses of the storage are marginal while those of the network are constant.

- The solar heat is covering the network heat losses in summer, will be stored virtually or will be delivered directly to the customer.
- In the balance sheet network heat losses will be ignored.
- Due to the new double insulation, the heat loss in the 4.000 m³-storage is practically zero.
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The projects ‘multifunctional storage system’ and ‘glass energy house’ are a contribution to ‘Green Capital’ Hamburg 2011.
Other models for network usage of heat from renewable energies are in development.
E.ON Hanse Wärme plans to reduce ist CO₂-emissions for heat supply from 120 g / kWh to less than 100 g / kWh in 2015. Back in 1990, the emissions were > 260 g CO₂ / kWh.

Thank you for your attention!