Status of Biogas Upgrading in Germany

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Biogas plants in Germany

- 4,300 biogas plants
- 1,500 MW_{el}
- Only < 30% of new biogas plants sell the surplus heat to customers

- Electric power was the main aim of Germany’s biogas producers due to the high EEG-compensation.
- The utilization of surplus heat has become vital importance because of the rising prices for substrates.
- Missing legislative regulations hindered the upgrading and injection of biogas into the natural gas grid.
History of biogas upgrading in Germany

- **June 2006**
  Jameln is the first biogas upgrading plant in Germany for producing biomethane for a filling station (Genosorb).

- **December 2006**
  Pliening/Bavaria and Straelen/NRW are the first biogas plants with gas injection (PSA).

- **June 2009**
  Güstrow is the largest upgrading plant of the world (PWS). Capacity: 46 mill. m³ biomethane/a.
Requirements for biomethane production and injection

- Privileged access to the gas grid.
- Standardization of gas quality.
- Standardized measurement requirements for grid access with calibratable analyzers.
- Practicable rules for balancing of biogas injection and take-out.
- Support for green electricity, green vehicle fuel and green heat supply (technology bonus for biogas upgrading).
The access to the gas grid is privileged for upgraded biogas (connection pipe < 10 km).

The gas grid operator has to finance 50% of the gas grid connection costs.

The biomethane producer has to fulfill the standardized quality requirements for biomethane (DVGW G 260, DVGW G262) which are independent of local gas quality.

The grid operator has to adjust the gas quality to be injected (Wobbe-Index, pressure, odorization).

Feed-in and take-out is balanced on a yearly basis with 25 % flexibility.

The grid operator has to pay 0,7 Cent/kWh for avoided grid costs.
Renewable Energy Act (EEG)

- Covering of CHP plants that use virtual biomethane transported by the natural gas grid.
- Technology bonus for biogas upgrading: 2 Cent/kWh up to 350 Nm³/h, 1 Cent/kWh up to 700 Nm³/h biomethane.
- Priority in electric grid connection.
- Guaranteed feed-in tariffs for electricity for 20 years from commissioning.
- Compensation dependent on the CHP-capacity.
Objectives of the German Government

- Substitution of 6 bill. m\(^3\) natural gas by biomethane up to 2020. Today 3 % of this target is fulfilled by 21 running injection plants. In 2010 around 5 % of this target will be fulfilled.

- Around 1,000 biogas upgrading plants with an investment of 10 bill. Euro are necessary to reach the objective of the Government.

- In 2030 biomethane should cover 10 bill. m\(^3\) of current natural gas consumption.
23 Biomethane plants are in operation

Total raw biogas upgrading capacity: 23,750 Nm³/h
(0.2 bill m³ biomethane per year)

5 Plants will start in spring 2010

20 Plants are under development and construction
Most of the upgraded and injected biogas is used in CHP in order to receive the compensation for electricity and heat according the Renewable Energy Sources Act (EEG).

Only two plants (Bottrop, Jameln) produce biomethane for the direct utilization in a local filling station.

A little part of biogas is used as vehicle fuel in form of a mixture of natural gas/biomethane.

A little quota is exploited for substituting natural gas (green gas).
Gas quality for grid injection

- **Exchange Gas**
  Exchange gas must have the same quality standards as conventional natural gas. It can be mixed with natural gas in each ratio.

- **Accessory Gas**
  Accessory gas possesses a composition that is not equivalent to that of natural gas, and can only be injected into the grid beneath a certain threshold.
### Application of different upgrading technologies

<table>
<thead>
<tr>
<th>Plant number</th>
<th>PSA</th>
<th>PWS</th>
<th>Genosorb</th>
<th>MEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant number</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Proportion [%]</td>
<td>44</td>
<td>22</td>
<td>13</td>
<td>21</td>
</tr>
</tbody>
</table>
Biomethane productivity of 34 upgrading plants in operation and construction
The biggest upgrading plants in Germany

<table>
<thead>
<tr>
<th>Facts</th>
<th>Könner I</th>
<th>Schwandorf</th>
<th>Güstrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrading process</td>
<td>PWS</td>
<td>PSA</td>
<td>PWS</td>
</tr>
<tr>
<td>Start of operation</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>Feed-in capacity [Nm³/h]</td>
<td>650</td>
<td>1,060</td>
<td>5,400</td>
</tr>
<tr>
<td>Pressure level [bar]</td>
<td>16</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Substrate input [t/a]</td>
<td>51,500</td>
<td>80,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Investment [Mill. €]</td>
<td>9</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>
Biogas upgrading plant Güstrow (PWS)

450,000 t/a Energy crops  20 Fermenter
46 mill m³/a Bio-CNG,  160 mill kWhₐₐₑ/l/a,  180 mill kWhₐₐ₉ₜₐ/h/a
Biomethane as vehicle fuel

- Biomethane as vehicle fuel is free of tax up to 2015.
- It is examined to make a mixture of 20% biomethane and 80% natural gas also free of tax.
Biomethane as vehicle fuel

- Low pollutant-emission
- Low CO₂-emission
- 4.9 kg biomethane per 100 km

80,000 CNG/bio-CNG cars in Germany

Strong increase of the market

Development of special CNG/bio-CNG cars by German car manufacturer, e.g. VW Passat EcoFuel with 5 EcoStars
Interest of VW on biomethane

- Volkswagen has created a new trademark for biogas: SunGas
- Volkswagen operates a first filling station together with Raiffeisen eG
- Volkswagen supports the application of biomethane as vehicle fuel
### Methane slip

<table>
<thead>
<tr>
<th>Upgrading process</th>
<th>PSA</th>
<th>PWS</th>
<th>Genosorb</th>
<th>MEA/DMEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane slip [%]</td>
<td>2 - 5</td>
<td>2 - 3</td>
<td>2 - 4</td>
<td>&gt; 0,1</td>
</tr>
</tbody>
</table>

- The methane slip is limited to 1 % up to 2011 and later 0,5 %.
- For receiving the technology bonus (EEG) a maximum methane slip of 0,5 % is allowed.
- Only the MEA/DMEA washing processes fulfill this threshold value without post-treatment of the off-gas.
Summary and Outlook

- Improvements in the legislative framework have led to a boom in biogas upgrading.
- The first upgrading plant was built in 2006 and today Germany has biggest installed biogas upgrading capacity of the world.
- 23 plants are in operation and 25 plants are in construction and development.
- PSA is the leading technology but PWS and chemical absorption with MEA/DMEA is gaining increasing importance.
- The upgraded gas is mainly used in CHP plants and only a small part is used in the transport sector.
- Within the next 10 years around 1,000 biogas upgrading plants will be constructed in Germany.
Many thanks for your attention!
## Pliening: The first biomethane injection plant

**Operation start date**: 12/2006  
**Upgrade process**: PSA  
**Feed-in capacity [Nm³/h]**: 485  
**Pressure level [bar]**: 40  
**Investment [Mill. €]**: 10