Biogas development in Germany

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Energy
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Incentives for electricity production from biogas in EU

Highest possible support for biogas in 2011

- Plus clear cut on annual new capacity & enlargement of existing plants
- Plus massive reduction for biomethane use

Source: European Biogas Association 2014
BIOMASS IN THE GERMAN ENERGY SYSTEM (FINAL ENERGY CONSUMPTION 2013)

Source: BMU 2013 / DBFZ

Total: 9.288 PJ

FINAL ENERGY SUPPLY (ELECTRICITY, HEAT AND FUEL) FROM BIOMASS 2012

Source: BMU, AGEE-Stat sowie weitere Quellen / DBFZ

Total: 205,5 TWh
Around 7700 biogas plants with electricity production in CHP (combined heat and power) plus sewage sludge digestion and landfill gas

Around 150 Biogas plants with upgrading the biogas to biomethane in operation (further plants projected within the next years)

Source: DBFZ 2014

Development of biogas plants in Germany

Source: Fachverband Biogas 2014
Feedstock for biogas plants 2012

% by weight

% by energy output

Source: DBFZ 2013

Biomethane production in Germany

Source: DBFZ 2014
Biomethane production in Germany

Substrate use in biomethane plants 2006-2013
wet mass based percentages

- Others
- Organic waste
- Agricultural residues
- Cereals
- Maize

Basis: data from 54 plants
Source: DENA 2013

Biomethane use in 2013 based on DENA-questionnairry

<table>
<thead>
<tr>
<th>GWhs/a</th>
<th>3,483</th>
<th>355</th>
<th>170</th>
<th>103</th>
<th>27</th>
<th>2,308</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electricity</td>
<td>Heat</td>
<td>International sale</td>
<td>Vehicle Fuel</td>
<td>Others</td>
<td>Not sold</td>
</tr>
</tbody>
</table>

n=6,447 TWhs/a

Source: DENA
Biogas Sector in Germany at a glance

<table>
<thead>
<tr>
<th></th>
<th>2011*</th>
<th>2012*</th>
<th>Forecast 2013**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of biogas plants</td>
<td>7,180</td>
<td>7,500</td>
<td>7,770</td>
</tr>
<tr>
<td>(thereof plants</td>
<td>(77)</td>
<td>(109)</td>
<td>(124)</td>
</tr>
<tr>
<td>feeding-in biomethane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional installations</td>
<td>1270</td>
<td>340</td>
<td>257</td>
</tr>
<tr>
<td>per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed electric</td>
<td>2,980</td>
<td>3,200</td>
<td>3,360</td>
</tr>
<tr>
<td>capacity in MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(without feeding-in of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>biomethane)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed electric</td>
<td>3,100</td>
<td>3,350</td>
<td>3,530</td>
</tr>
<tr>
<td>capacity in MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(with feeding-in of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>biomethane)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall capacity</td>
<td>86,000</td>
<td>116,000</td>
<td>132,000</td>
</tr>
<tr>
<td>for upgrading of raw</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gas to biomethane (Nm³/h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional electrical</td>
<td>806</td>
<td>255</td>
<td>177</td>
</tr>
<tr>
<td>capacity new</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>installations in MW per</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually net generation</td>
<td>19.1</td>
<td>22.8</td>
<td>24.4</td>
</tr>
<tr>
<td>of electricity in TWh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households supplied</td>
<td>5.5</td>
<td>6.5</td>
<td>7.0</td>
</tr>
<tr>
<td>with electricity from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>biogas in Mio.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of German</td>
<td>3.2</td>
<td>3.9%</td>
<td>4.1</td>
</tr>
<tr>
<td>electricity generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of trade in</td>
<td>8.3</td>
<td>7.3</td>
<td>6.9</td>
</tr>
<tr>
<td>billion Euro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jobs</td>
<td>63,000</td>
<td>45,000</td>
<td>42,000</td>
</tr>
</tbody>
</table>

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* own extrapolation on the basis of data of the German states
** on basis of an expert survey

Potentials and use of biogas substrates 2013

- Energy crops used: 222.2 PJ/a
- Energy crops not used: 26.4 PJ/a
- Animal Excrements Used: 37.6 PJ/a
- Animal Excrements Not used: 40.3 PJ/a
- Municipal Residues used: 11.4 PJ/a
- Municipal Residues not used: 10.4 PJ/a
- Industrial Residues used: 7.9 PJ/a
- Industrial Residues not used: 1.5 PJ/a

Source: DBFZ 2014
Excourse I: source separated biowaste

- 2010: 8.8 Mio. t/a source separated organic municipal waste
- Still in mixed municipal waste: ca. 4.6 Mio. t/a organic waste
- Possible to separate additionally: ca. 2 Mio. t/a organic waste plus wastes from landscape protection measures

- Practice in biogas plants:
  ca. 1.5 Mio. t municipal organic waste

Average substrate mix in biowaste plants

- Excrements: 23%
- Food waste: 14%
- Not sold food: 8%
- Others: 20%
- Source separated: 17%
- Used Fat: 11%
- Energy crops: 7%

Source: Humuswirtschaft & Kompost aktuell 7/8_09
Source separation of biowaste 2010

E = No. of residents

- 65 Mio. E (79%)
- 42 Mio. E (65%)
- 23 Mio. E (35%)
- 17 Mio. E (21%)

Quelle: Schneider 2010 nach UBA, 2010; VHE/BGK 2009

Excourse II: Flexibilisation of Electricity Production

Scenario for 2050: Residual capacities assuming a 100% renewable electricity supply with today's technologies behavior (Fraunhofer IWES)
Demand oriented electricity production

- Substrate → Fermenter → Gasspeicher (variable) → Nachgärer → Biogas → CHP 1 + CHP 2

Gas production over time (green)

Gas storage filling grade over time (yellow)

Electricity production over time (red: CHP 2 + CHP 1)

Size of storage

Source: DBFZ 2014

Use of Flexibility Premium in practice

- > 300 operating plants
- 170 MWel capacity (31.1.2014)
History of Renewables – Where do we go in the future?

Development of electricity generation from renewable energy sources in Germany since 1990

Biogas perspectives in Germany

- Germany: feed in tariffs are politically cut
- Only few new plants expected based on residues
- Potentials for the future are municipal organic waste and optimisation of existing plants
- Biomethane market will change massively, existing plants will increase use of organic residues
- German companies & researchers go international
- Still the role in the energy system transition is very important due to:
  - storability,
  - indepency on international gas trade,
  - flexible use, few renewable alternatives in transport sector,
  - Decentral supply of high quality & standardised gas.
Biogas – Key technology in Energy and material cycle of the future

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