Methane to Markets Partnership Expo
30 October - 1 November 2007
China World Hotel, Beijing, China

**German and European Biogas Experience**

*Katrin Pietzsch, IBBK, Germany*

1. German Biogas potential and substrates supplied
2. Regulatory Climate - Germany & Europe
3. Applied Technologies
4. Summary
The International Biogas and Bioenergy Competence Center (IBBK) is an amalgamation and network of experts and companies, as well as interest groups and educational institutes in the field of biogas and bioenergy. The work of the IBBK covers regional, national and international activities. The Competence Centre is setting up an additional impulse beyond the traditional lobby work and is striving to cover the growing demand for independent, neutral dissemination of information in the field of biogas and bioenergy. The main emphasis is in educational and project work.

**The services of IBBK are:**

- Consulting
- Studies
- International Cooperation
- Seminars, Conferences
- Fieldtrips, Study Tours
- Lobby work
Biogas potential in Germany from...

Total potential of biogas production in Germany:

- 24 billion m³
- Corresponding energy production:
  - Electricity: 50 million MWh
  - Heat: 72 million MWh

Source: P. Weiland FAL BS
Feedstock in German Biogas Plants

- Industrial and agricultural residues
- Biowaste
- Energy crops
- Animal excrements

Survey data from:
1. Survey (6/05)
2. Survey (12/05)
3. Survey (12/06)
Energy utilisation from Biogas plants

- Electricity: 38%
- Losses: 20%
- Process Heat: 15%
- External Heat: 50%
## Regulatory Climate - German feed-in tariffs 2007

<table>
<thead>
<tr>
<th>Basic Compensation</th>
<th>Up to 150 kW_{el}</th>
<th>Up to 500 kW_{el}</th>
<th>Up to 5 MW_{el}</th>
<th>over 5 MW_{el}</th>
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<tbody>
<tr>
<td><strong>Old plants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New Plants</strong></td>
<td>10.99</td>
<td>9.46</td>
<td>8.51</td>
<td>8.03</td>
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<tr>
<td><strong>Bonus for energy crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Old plants</strong></td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td><strong>New plants</strong></td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td><strong>CHP Bonus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Old plants</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>New plants</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Technology Bonus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Old plants</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>New plants</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td><strong>(only if CHP condition is fulfilled)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Old plants</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>New plants</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>
Regulatory Climate - Results 1

- **Amount of biogas plants:**
  - 186 in 1994
  - 370 in 1996
  - 450 in 1997
  - 617 in 1998
  - 850 in 1999
  - 1050 in 2000
  - 1350 in 2001
  - 1600 in 2002
  - 1700 in 2003
  - 2000 in 2004
  - 2600 in 2005
  - 4500 in 2006
  - 3500 in 2007

- **Average el. power installed [kW]:**
  - 139 kW in 1992
  - 159 kW in 1993
  - 186 kW in 1994
  - 274 kW in 1995
  - 370 kW in 1996
  - 450 kW in 1997
  - 617 kW in 1998
  - 850 kW in 1999
  - 1050 kW in 2000
  - 1350 kW in 2001
  - 1600 kW in 2002
  - 1700 kW in 2003
  - 2000 kW in 2004
  - 2600 kW in 2005
  - 4500 kW in 2006
  - 3500 kW in 2007

- **Total el. power installed [MW]:**
  - 0 MW in 1992
  - 500 MW in 1995
  - 1000 MW in 1999
  - 1500 MW in 2004
  - 2000 MW in 2007

Source: German Biogas Association 2007
Regulatory Climate - Results 2

The image displays two maps of Germany with different color codes indicating the number of biogas plants per region. The left map shows biogasanlagenzahl with colors representing 1, 2-5, and >6. The right map displays Anlagenanzahl with colors indicating 1, 2-10, 11-20, 21-40, and more than 40, with a legend stating 'keine Daten' (no data).
<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of Plants</td>
<td>2.600</td>
<td>3.500</td>
<td>?</td>
</tr>
<tr>
<td>Installed capacity</td>
<td>650</td>
<td>1.100 MW</td>
<td>9.500 MW</td>
</tr>
<tr>
<td>Electrical energy</td>
<td>2.8 TWh/a</td>
<td>&gt;5 TWh/a</td>
<td>76 TWh/a</td>
</tr>
<tr>
<td>Fraction in german power production</td>
<td>0.5%</td>
<td>&gt; 1%</td>
<td>ca. 17%</td>
</tr>
<tr>
<td>Turnover of Industry</td>
<td>490 Mio.</td>
<td>&gt; 1 Mrd.</td>
<td>7.6 Mrd.</td>
</tr>
<tr>
<td>Turnover of Operators</td>
<td>360 Mio</td>
<td>650 Mio</td>
<td>11.1 Mrd</td>
</tr>
<tr>
<td>Fraction in export</td>
<td>8%</td>
<td>12%</td>
<td>&gt; 30%</td>
</tr>
<tr>
<td>Employment</td>
<td>5.000</td>
<td>10.000</td>
<td>85.000</td>
</tr>
<tr>
<td>CO₂ Reduction</td>
<td>2.5 Mio t/a</td>
<td>5 Mio t/a</td>
<td>103 Mio t/a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Tarif Range [€Cent/kWh]</th>
<th>Tarrif System</th>
<th>Amount of agricultural Biogas Plants</th>
<th>Installed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>6 – 9</td>
<td>Green certificates (Quota system)</td>
<td>6</td>
<td>12.62 MW</td>
</tr>
<tr>
<td>Germany</td>
<td>8.4 – 21.3</td>
<td>20 years fixed Tariffs</td>
<td>&gt; 3000</td>
<td>1100 MW</td>
</tr>
<tr>
<td>Denmark</td>
<td>8</td>
<td>10 years fixed Price</td>
<td>58 (single farm)</td>
<td>40 MW</td>
</tr>
<tr>
<td>Finland</td>
<td>3.1</td>
<td>Tax reduction, Market Price</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>11 - 14</td>
<td>Fixed Price since August 2006,</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Greece</td>
<td>7</td>
<td>Fixed for 10 years</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Great Britain</td>
<td>11 – 12.47</td>
<td>Quota system (variable)</td>
<td>&lt; 20</td>
<td>&lt; 2 MW</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.765 – 5.916</td>
<td>Green Certificates (variable)</td>
<td>5</td>
<td>0.2 MW</td>
</tr>
<tr>
<td>Italy</td>
<td>6.5 + 12.40</td>
<td>Electricity stock exchange + Green Certificates (Quota system, variable)</td>
<td>120 in Southtirol and North Italy</td>
<td>81.64 MW</td>
</tr>
<tr>
<td>Netherlands</td>
<td>9.7</td>
<td>Until End 2006</td>
<td>30</td>
<td>3.8 MW</td>
</tr>
<tr>
<td>Austria</td>
<td>10.3 – 16.5</td>
<td>13 years fixed price until end 2004 approval and building until end 2007, at the moment not enough incentive for new projects</td>
<td>159 + 150 until End 2007</td>
<td>29 + 40 MW until End 2007</td>
</tr>
<tr>
<td>Poland</td>
<td>7,8</td>
<td>Market price + Green Certificate (variable)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Portugal</td>
<td>6.1984</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>Up to 16,5</td>
<td>Fixed price since June 2007</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sweden</td>
<td>-</td>
<td>Green Certificates / Market price + 25% Subsidy (Biogas as a vehicle fuel, no Electricity production)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Switzerland</td>
<td>10</td>
<td>Fixed price, difficult application procedures</td>
<td>71</td>
<td>n/a mostly heat utilisation</td>
</tr>
</tbody>
</table>
Technology applied - Digestion System

1) Wet Fermentation
   - Completely mixed digester
   - Plug flow digester

2) Dry Fermentation
   - Plug flow digester
   - Garage type batch digester
Technology applied - Wet digestion

Advantages:
- simple digester repair
- integrated gas holder
- well weather prooved
- easy indication of gas yield

Disadvantages:
- more expensive than one cover
- not 100% gastight
- permanent energy consumption through air fan
Technology applied - Stainless steel digester
Advantages:
- digesting high solids content
- high loading rate possible
- little short cut flow
- automatic sand drain
- complete mixing
- high digester productivity
- Suitable for dry digestion

Disadvantages:
- high price
- only possible with after digester
- limited in size
Technology applied - Horizontal digester

Concrete

Steel
Technology applied - „Garage Type“ Digester
Dry Fermentation System for Biomass over 20% DS

Principal Function
Technologies applied - Ideal set-up
## Agricultural Biogas Basic Investment Figures

<table>
<thead>
<tr>
<th></th>
<th>Cost Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHP-Plant (Dual Fuel Engine)</td>
<td>700 - 1200 €/kW (120 – 30 kW&lt;sub&gt;el&lt;/sub&gt;)</td>
</tr>
<tr>
<td>CHP-Plant (Gas-Otto-Engine)</td>
<td>500 - 1900 €/kW (400 – 15 kW&lt;sub&gt;el&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Investment Costs per m3 Dig. Vol.</td>
<td>250 - 450 €</td>
</tr>
<tr>
<td>Investment Costs per LU</td>
<td>800 - 2.000 €</td>
</tr>
<tr>
<td>Investment Costs per kW installed electrical Capacity</td>
<td>3.000 - 6.000 € (400 – 30 kW&lt;sub&gt;el&lt;/sub&gt;)</td>
</tr>
</tbody>
</table>
Drivers behind AD in Germany

- **Guaranteed access** to electricity grid at good rates
- **Access** to long term low interest loans
- **Good infrastructure** for supporting those interested in biogas plants
New developments through EEG incentive

- specialized digester and plant technology
- dry fermentation
- automation and controlling
- slurry technology and feed in of solid substrates
- gas upgrading for fuel cells (research & pilot stage)
- biogas in vehicles,
- integrated gas and heat distribution systems

Important Trade Fairs: [www.agritechnica.de](http://www.agritechnica.de), [www.messen-profair.de](http://www.messen-profair.de)
Questions?

Thank you for your attention!

www.biogas-zentrum.de, info@biogas-zentrum.de
Biogas closes life cycles

„In an ecological system all organic material is recycled“

„Energy is produced through this system“
Biogas yields from different substrates

spec. gas yield $m^3_{\text{N.Biogas}}/\text{t substrate}$

- Cow manure, liquid (9% DM) 30
- Pig manure, liquid (7% DM) 30
- Chicken manure (15% DM) 58
- Turkey manure (20% DM) 80
- Vegetable residues (10% DM) 53
- Grass silage (25% DM) 151
- Corn silage (30% DM) 200
- Left over food (20% DM) 220
- Cereal straw (85% DM) 300
- Grease separator (5 / 50% DM) 50
- Colza cake (15% fat) 550
- Left over bread (90% DM) 580
- Wheat whole grain (85% DM) 700
<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity generation</td>
<td>3.03</td>
</tr>
<tr>
<td>Grid conduction costs</td>
<td>6.00</td>
</tr>
<tr>
<td>Costs of measurements</td>
<td>1.10</td>
</tr>
<tr>
<td>Sales / distribution</td>
<td>1.00</td>
</tr>
<tr>
<td>License fee</td>
<td>1.99</td>
</tr>
<tr>
<td>Electricity tax</td>
<td>2.05</td>
</tr>
<tr>
<td>VAT</td>
<td>2.54</td>
</tr>
<tr>
<td>Feed in Law</td>
<td>0.42</td>
</tr>
<tr>
<td>CHP Law</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Quelle: Bundesverband erneuerbare Energien e.V., Dezember 2003
Energetic evaluation of decentralized household waste water treatment

- Amount of waste water comes to 150 l per person and day.
- Contents faeces, organic waste from food preparing and leftovers
- Additional content of detergents, shampoos etc
- Around 0,9 kWhel per person and day can be produced or 150 Euro/year
- Saving of waste water treatment fees up to 10 times as high.
- Saving of connecting fees to the public sewer
Economy of biowaste treatment plants:

- Income of gate fees and energy sales
- High technological standard \(\Rightarrow\) high investment costs
- High approval conditions \(\Rightarrow\) higher costs
- Abolition of agricultural subsidies
- Restricted spreading possibilities
Technology applied - Concrete digester
Key Lessons from the German Experience

Germany:

– Government support in the form of:
  • High price for electricity from AD plants
  • Low interest long term loans

– Numbers of farm based plants doubled in a very short space of time

– Government support has proven to be crucial and very effective

– New energy crop bonus
Potential from Biogas Technology

- 10 Bil. cubic meter Biogas from 10% of the agricultural area (with an Energy production of 62,000 kWh / ha)
  - through optimisation possibly: 100,000 kWh / ha
  - 16 Bil. cubic meter Biomethane (half of the imports from Russia)
  - up to 17% of the German Power Production
  - up to 20% of the German Natural Gas Consumption
  - up to 35% of the German Traffic Fuel Consumption

- Energy Crops have the largest fraction in the potential

- First Successes in biogas specific Energy Crop production