The Basis of Financing and Economic Efficiency of Biogas Plants After the End of a Fixed Feed-In Tariff

Michael Köttner
19.03.2019, Paris
Content

• Biogas – Today vs. Tomorrow
• Arguments beyond economic factors:
  ✓ Regional distribution
  ✓ Marketing through direct grid connection and distribution
  ✓ Fertilizer business
  ✓ Flexible production of electricity
  ✓ Gas use from slurry and digestate storages
  ✓ Gate fee tariff
  ✓ Improve political acceptance
  ✓ Indirect value
  ✓ Biogas upgrading
Number of biogas plants in Europe

17,358 biogas plants in Europe
8,728 MWel total installed electric capacity
1% market growth in 2016
Development of the number of biogas plants and the total installed electric output in MW in Germany (as of 05/2018)
Development of the number of biogas plants, installed electric capacity and the work-relevant electric capacity annually in Germany (05/2018)
Development of the rated power and electricity production of biogas plants in Germany
Biogas – Today vs. Tomorrow
Energy crops are becoming less economically feasible; Many BGPs are losing the support through Feed-in Tariff.

Icons made by Zlatko Najdenouski.
Biogas - Tomorrow

Solution for manure and biowaste management

Solution for fertilizer production

Icons made by Zlatko Najdenouski
Regional distribution
Regionalstrom – Regional electricity

- Decentralized electricity production and consumption
- The producers have the possibility to have their energy labeled as green
  **BUT**
- Direct marketing is not possible
- Double marketing ban → the energy that uses feed-in tariff can’t be also labeled as green
- Pros:
  - Reduced requirements for the expansion of high-voltage power grid
  - More added value locally
  - More transparency → the consumers can identify the electricity producers in their region and know what portion of their electricity comes from renewable sources
Regionalstrom – Regional electricity

1 €cent/kWh goes to the BUND for the promotion of regional power plants, energy-saving projects and nature conservation.
Regionalstrom - Geberit

- Geberit uses the biomethane and electricity from the BGP
- Agreement through BUND Regionalstrom
- Together they developed 10 criteria for sustainable production of premium biogas

Source: http://www.energiepark-hahnennest.de/Biogasanlage

AHK Geschäftsreise, 19.03.2019, Paris
Energy suppliers - Examples

- 100 % electricity from renewable energies
- Gas: 90 % from natural gas, and 10 % from biogas produced with 100 % manure and biowaste

- 100% electricity from renewable energies
- Gas: the price changes with the quantity of biogas
  - 10 % biogas → 5,45 €cent/kWh
  - 20 % biogas → 5,95 €cent/kWh
  - 100 % biogas → 9,95 €cent/kWh

- 100 % electricity from renewable energies
- Gas: 5 % biogas
Marketing through direct grid connection and distribution
Güllebörse

- Agricultural cooperatives
- Sharing service:
  - Animal manure
  - Digestate (not from WWTP)
NADU by Agro Energie Hohenlohe

- Manure: pig and cattle
- Residues from vegetable processing: lettuce leaves, pumpkin

Granule organic fertiliser
Energiehof Weitenau

Separation solid liquid

Liquid enters a vacuum evaporation unit

Concentrated nutrients

Water evaporation

Ammonium sulphate solution

Crystallization of the solution

Mineral organic fertiliser

Water evaporation

Ammonium sulphate solution

Crystallization of the solution

Mineral organic fertiliser
Flexible production of electricity

Icons made by Zlatko Najdenouski
Flexible production of electricity

- Production of electricity when its price is at its highest
- Possibility that other renewable energies don’t have

- Biogas storages are necessary → Need of big investments
- So far additional income is minimal due to the low energy prices

Gas storage: 1,040 m³
# Electricity price at Stock Exchange

<table>
<thead>
<tr>
<th>Time</th>
<th>Mo 13.10</th>
<th>Di 14.10</th>
<th>Mi 15.10</th>
<th>Do 16.10</th>
<th>Fr. 17.10</th>
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<td>2,146</td>
<td>0,876</td>
<td>2,085</td>
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</table>
Electricity demand chart
Electricity demand chart
Gas use from slurry and digestate storages
Covering slurry and digestate storage – Benefits

- Reduction of odor and greenhouse gas emissions
- Avoidance of rainwater into the storage → reduction of digestate spreading costs
- Conservation of fertilization value and nitrate concentration
- Biogas collection
  → use of biogas as substitute fuel for oil
  → production of electricity with a small generator
  In some countries there are limits on the electric power installation. Exceeding the threshold means paying a tax → The limit in Germany is 10 kWel
Covered tank - Biolectric – Belgium

A ready-to-use pocket digester with a capacity from 10 kWel to 44 kWel

⚠️ Some countries don’t authorize the installation of this plant!
Waste treatment fee
Definition

- **Gate fee**: charge collected for a quantity of waste received at the waste processing facility
- It can be applied both on surplus manure and organic waste
- Revenue
- Especially important for BGP that treat organic waste from households
Example – Gate Fee in the UK in 2016

- Prices in £/tonne
- MRF: Materials Recovery Facility
- EfW: Energy from Waste – Incineration with energy recovery

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Materials / Type of facility / Grade</th>
<th>Median</th>
<th>Mode$^2$</th>
<th>Range$^3$</th>
<th>No of gate fees reported</th>
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</thead>
<tbody>
<tr>
<td>MRF</td>
<td>All contracts (4 materials or more)</td>
<td>£15</td>
<td>£0 to £5</td>
<td>-£77 to £90</td>
<td>94</td>
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<tr>
<td>Organics</td>
<td>In-Vessel Composting (IVC)$^4$</td>
<td>£46</td>
<td>£45 to £50</td>
<td>£28 to £60</td>
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<tr>
<td></td>
<td>Anaerobic Digestion (AD)</td>
<td>£29</td>
<td>£35 to £40</td>
<td>£0 to £65</td>
<td>64</td>
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<tr>
<td>EfW$^5$</td>
<td>All</td>
<td>£83</td>
<td>£50 to £55</td>
<td>£26 to £144</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Pre-2000 facilities</td>
<td>£56</td>
<td>£50 to £55</td>
<td>£26 to £90</td>
<td>22</td>
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<tr>
<td></td>
<td>Post-2000 facilities</td>
<td>£91</td>
<td>£80 to £85</td>
<td>£50 to £144</td>
<td>34</td>
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<tr>
<td>Landfill</td>
<td>Non-hazardous waste including landfill tax$^6$</td>
<td>£107</td>
<td>£99 to £104</td>
<td>£89 to £149</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Non-hazardous waste</td>
<td>£22</td>
<td>£15 to £20</td>
<td>£5 to £64</td>
<td>90</td>
</tr>
</tbody>
</table>

$^1$ All gate fees reported excluding haulage costs.
$^2$ Mode is the gate fee range (in £5 increments) which received the most responses in the survey data.
$^3$ Range lists simply the ranges between the maximum and minimum data points in the survey data collected.
$^4$ IVC gate fee is for mixed food and green waste.
$^5$ Incineration with energy recovery.
$^6$ The standard rate of landfill tax for 2016/17 is £84.40/tonne.
Example – Gate Fee in the UK in 2016 – Contract

Authorities sending material to an AD plant
- Under a contract: 79%
- Under no contract: 21%

Contract duration
- ≤ 23 years
- ≤ 15 years
- ≤ 9 years
- ≤ 5 years
Improve political acceptance


- Reduction of GHG emissions
- Recycling effect of biogas
- Energy independence
- Diversification of energy supply
- AD gives farms & rural areas new perspectives
Greenhouse gas emissions [gCO₂eq/kWel]

- Brown coal: 1070 gCO₂eq/kWel
- Hard coal: 919 gCO₂eq/kWel
- Natural gas: 430 gCO₂eq/kWel
- Biogas from energy crops: 300 gCO₂eq/kWel
- Photovoltaics: 55 gCO₂eq/kWel
- Wind power: 10 gCO₂eq/kWel
- Biogas from slurry: -100 gCO₂eq/kWel
Greenhouse gas emission avoidance [tCO$_2$eq/t DM]

Tons of CO$_2$eq avoidance for each ton of dry matter, if the manure reaches the biogas plant within a month after its production.

In DE only the 17% of manure was treated in biogas plants in 2015: there is still potential to increase the share.
Indirect value
Indirect value

- Improved qualities of liquid manure through AD
- Avoidance of contamination of the ground and surface waters
Positive changes of liquid manure properties through fermentation

**Decomposition of organic substance**
- Decomposition rates $\text{DM}$: up to 40%
- The fermented liquid manure can be pumped and sprayed better compared to raw liquid manure
- The agitation is reduced before the application on land

**Odor reduction**
- Reduction of the odor-causing substances (humid acids, phenols, phenol derivate)

**Sanitization**
- The degree of the sanitization depends on retention time, temperature and applied procedure

**Destroying the weed seeds**
- The germination capacity of the weed seed in the liquid manure decreases more rapidly the longer the seeds are exposed to the AD and the higher the temperature is

**Avoidance of plant corrosion**

**Improvement of the fertilizer value**
- The fermented liquid manure has a better short term N-fertilizer effect
Overall cross-site N use efficiency (% of tot N applied)
Biomethane
Biomethane – Energy Crops
Biomethane – Biowaste, Residues

- Biomethane injected into the gas grid → transformed into electricity, heat or used as gas locally
- Biomethane as vehicle fuel
Biomethane - Tomorrow

- Upgrading to about 98% methane
- Several upgrading technologies already available
- Future Renewable Gas = Biomethane, Green Hydrogen, Power to Methane
- Use locally, in order to have better heat utilization
- Use as household heating
- Use as fuel for NGVs (Natural Gas Vehicles)
- Use of Natural Gas Grid for storage
Biomethane tractor

Two tanks on the left and right of the machine
Biomethane tractor

Full day of farm-work autonomy
## Biomethane-Box - Prodeval – France

**Product Line**

<table>
<thead>
<tr>
<th>km travelled</th>
<th>AgriGNV® 200K</th>
<th>AgriGNV® 350K</th>
<th>AgriGNV® 750K</th>
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<tr>
<td></td>
<td>200 000 km/year</td>
<td>350 000 km/year</td>
<td>750 000 km/year</td>
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<td>Biogas flowrate</td>
<td>3 Nm³/h</td>
<td>5.5 Nm³/h</td>
<td>10 Nm³/h</td>
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<tr>
<td></td>
<td>26 280 Nm³/year</td>
<td>48 180 Nm³/year</td>
<td>87 600 Nm³/year</td>
</tr>
<tr>
<td>BioCNG flowrate</td>
<td>1.140 Nm³/h</td>
<td>2.50 Nm³/h</td>
<td>5 Nm³/h</td>
</tr>
<tr>
<td></td>
<td>12 264 Nm³/year</td>
<td>21 900 Nm³/year</td>
<td>43 800 Nm³/year</td>
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<tr>
<td>Installed power</td>
<td>1 kW</td>
<td>2 kW</td>
<td>2.5 kW</td>
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<tr>
<td>Filling time for light vehicle*</td>
<td>11 h without storage &lt; 5 min with stockage</td>
<td>6 h without storage &lt; 5 min with storage</td>
<td>3 h without storage &lt; 5 min with storage</td>
</tr>
<tr>
<td>Number of vehicles that could be filled in simultaneously</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of full-tank refueling per day</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Dimensions (w x l x h)</td>
<td>1 200 x 1 200 x 2 200 mm</td>
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<td></td>
</tr>
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</table>

*empty tank

Source: [https://www.prodeval.eu/fr/](https://www.prodeval.eu/fr/)

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**Facilitator**

**Biomethane**

**Box**

**Prodeval – France**

**Source**: [https://www.prodeval.eu/fr/](https://www.prodeval.eu/fr/)

**AHK Geschäftsreise, 19.03.2019, Paris**

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Conclusion

• The biogas situation is changing due to the new national legislations
• Energy crops are becoming less economically feasible
• The focus will be on:
  ✓ Different ways of marketing the AD products biogas and digestate
  ✓ Flexible production of electricity: the AD system is the only renewable solution to the flexibility issue of renewable energies
  ✓ Biomethane as a biofuel for transportation and direct heating
  ✓ AD technology as solution for manure and biowaste treatment
Thank you for your attention!

Michael Köttner
19.03.2019, Paris