Biogas electricity generation in Germany - its development and policy -

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Content

• Facts about biogas production in Germany

• Feed-in tariffs in Germany

• EEG 2014 and the present situation of biogas generation
  • Connection to the grid and restrictions

• Direct selling, market premium and flexibility premium

• Preparation for EEG 2016 and tenders for biogas

• Conclusion
Structure of the German electricity production

Electricity production in Germany in 2015

30 % renewable energies

- Fossil energy: 453 Mrd. kWh
  - Nuclear power: 14.1%
  - Brown coal: 24%
  - Anthracite coal: 18.2%
- Natural gas: 8.8%
- Renewable energy: 194 Mrd. kWh
  - Wind energy: 13.3%
  - Biomass incl. biogas: 7.7%
  - Photovoltaics: 5.9%
  - Hydro power: 3%

Daten: BDEW Prognose für 2015  Stand: 21.12.15
cc  STROM-REPORT.DE
### Biogas sector: Statistics on Germany

(as of 11/2015)

<table>
<thead>
<tr>
<th>Category</th>
<th>Forecast 2014*</th>
<th>Forecast 2015**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of biogas plants (biogas plants with biomethane injection)</td>
<td>8.726 (178)</td>
<td>8.928 (190)</td>
</tr>
<tr>
<td>Installed electric capacity in MW</td>
<td>3.905</td>
<td>4.177</td>
</tr>
<tr>
<td>Gross electricity production in TWh per year</td>
<td>32.08</td>
<td>32.67</td>
</tr>
<tr>
<td>Households supplied with biogas-based electricity in millions</td>
<td>9.2</td>
<td>9.3</td>
</tr>
<tr>
<td>CO₂ reduction by biogas in million tons</td>
<td>20.8</td>
<td>21.2</td>
</tr>
<tr>
<td>Turnover in Germany in Euro</td>
<td>9.1 Billion</td>
<td>9.2 Billion</td>
</tr>
<tr>
<td>Jobs in the biogas sector</td>
<td>45,000</td>
<td>44,000</td>
</tr>
</tbody>
</table>

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* Own extrapolation based on country data/data from energy supplier

** Based on a expert survey
How did biogas generation in Germany start?

Around 1990, the first biogas plants were built. These plants were mainly small agricultural plants and waste fermentation plants.

- **The aim of the farmers:**
  - to use liquid and solid manure, feed leftovers and other waste materials in a useful way.
  - to generate electricity and heat for its own operation and
  - to protect the climate and avoid greenhouse gas emissions.

  ➔ These were very simple self-made plants, which were only economically in the rarest cases. The plants were built out of idealism and curiosity.

- **The aim of the communities:**
  - The expensive processing of waste materials was supposed to be cheaper through fermenting.
Where does the biogas production take place today?

- **Structure of biogas plants in Germany:**
  - About 90% of the biogas plants are operated by farmers.
  - Less than 10% of the biogas plants are operated outside of agriculture.

- **This is also reflected through the feedstock of German biogas plants:**
  - 95% of the plants are operated with liquid and solid manure, agricultural by-products and renewable primary products.
  - Only about 5% of the plants are operated with biowaste.
Feedstock in German biogas plants

% by weight

- 52% Liquid & solid manure
- 43% Energy crops
- 2% Industrial, commercial & agricultural residues
- 3% Household waste

% by energy output

- 79% Liquid & solid manure
- 14% Energy crops
- 3% Industrial, commercial & agricultural residues
- 4% Household waste

Abbildung 4-7: Masse- und energiebezogener Substrateinsatz in Biogasanlagen (DEFZ-Betreiberbefragung 2015, Bezugsjahr 2014)
Why has the use of energy crops been promoted?

→ About the year 2000 Germany has had a strong overproduction of food

• This overproduction led to a strong price reduction for agricultural products.
• Farmers were forced to set aside about 1 million hectares of agricultural area.
• Farmers were restricted in their production.

• These set-aside land had to be maintained anyway.
• The farmers need a new source of income.
• The existing agricultural area was supposed to be used wisely:
  → Energy from biomass → High energy output

• Regional agricultural value and economic cycles were supposed to be promoted → Additional income for agriculture
What feedstock is used in biowaste plants?

- Currently, there are about 350 biogas plants that use waste.
- About 90 plants are using municipal (household) waste.
- The separation of household waste is compulsory in Germany!
  ➔ New plants for the treatment of household waste will be built.

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate collected household waste</td>
<td>30.4%</td>
</tr>
<tr>
<td>Slurry from the manufacture of alcohols</td>
<td>15.4%</td>
</tr>
<tr>
<td>Catering waste / food waste</td>
<td>12.8%</td>
</tr>
<tr>
<td>Fat separator contents</td>
<td>11.1%</td>
</tr>
<tr>
<td>Manure</td>
<td>6.8%</td>
</tr>
<tr>
<td>Expired food (household waste)</td>
<td>6.4%</td>
</tr>
<tr>
<td>Garden and park waste (household waste)</td>
<td>5.6%</td>
</tr>
<tr>
<td>Energy crops</td>
<td>2%</td>
</tr>
<tr>
<td>Other biowaste</td>
<td>9.5%</td>
</tr>
</tbody>
</table>
Treatment of sewage sludge in Germany

In Germany sewage sludge is usually not used in biogas plants but used separately in sewage gas plants.

- Sewage sludge is applied rarely and only with large requirements to agricultural areas.
- Most of the sewage sludge in Germany is burned.

Would this sewage sludge be used with biomass in the biogas plant, it would lead to a devaluation of the resulting digestate.

- Sewage gas has an own feed-in tariff in the EEG (renewable energy act).

There are more than 10,000 wastewater treatment plants and about 1250 plants produce sewage gas.

- The majority of the produced sewage gas (over 90%) is used in these treatment plants to generate electricity and heat for their own supply.
What kind of liquid and solid manure is used?

% by weight

<table>
<thead>
<tr>
<th>Manure Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other liquid and solid manure</td>
<td>61%</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>13%</td>
</tr>
<tr>
<td>Solid cattle manure</td>
<td>14%</td>
</tr>
<tr>
<td>Liquid cattle manure</td>
<td>2%</td>
</tr>
<tr>
<td>Solid pig manure</td>
<td>8%</td>
</tr>
<tr>
<td>Liquid pig manure</td>
<td>1%</td>
</tr>
<tr>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

% by energy output

<table>
<thead>
<tr>
<th>Manure Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other liquid and solid manure</td>
<td>47%</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>7%</td>
</tr>
<tr>
<td>Solid cattle manure</td>
<td>14%</td>
</tr>
<tr>
<td>Liquid cattle manure</td>
<td>5%</td>
</tr>
<tr>
<td>Solid pig manure</td>
<td>6%</td>
</tr>
<tr>
<td>Liquid pig manure</td>
<td>20%</td>
</tr>
<tr>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

The purposes for livestock farmers to install biogas plants are to

- reduce offensive odor and  
- distribute the economic risk. ➔ Main purpose

Marion Wiesheu  
08.02.2016
How much liquid and solid manure is still available in Germany?

There are about 300,000 farms in Germany
• 49% of the farms use renewable energy as an additional source of income.

About 200,000 farmers are keeping animals
• About 150,000 farmers are keeping cattle.
• About 30,000 farmers are keeping pigs.
• About 20,000 farmers are keeping chickens, sheeps, goats and horses.
• Every year there are about 180 million tons of liquid and solid manure. Approximately 25% of it is fermented in biogas plants.

We do not know how many farmers with animals have no biogas plant. Many biogas plants are operated by several farmers.
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Development of the number of biogas plants and the total installed electric output in megawatt [MW] in Germany (as of 11/2015)

EEG 2000
- Very simple structure
- Only a basic feed-in tariff
- 250 new plants a year

EEG 2004
- Bonus for energy crops
- Bonus for using heat
- Bonus for new techniques
- 450 new plants a year

EEG 2009
- Bonus for emission reduction
- Bonus for manure
- Bonus for residues from landscape management
- General increase of feed-in tariffs
- 1000 new plants a year

EEG 2012
- New system
- New requirements on efficiency and ecology
- 340 new plants a year

EEG 2016
- New

Marion Wiesheu 08.02.2016
What does apply to all renewable energy Acts?

• **The EEG regulates**
  - Priority connection to the grid
  - Priority transmission of electricity
  - Purchase of the electricity

• A consistent fee for this electricity paid by the grid operators for a 20-year period.

• There is a size graduation in EEG that prevents that large plants get too high feed-in tariffs. The larger the plant, the smaller the feed-in tariffs.

• There is a continuous reduction of the feed-in tariffs for new plants.
  (Degression in EEG 14: 0.5 % each quarter)
# Overview: Feed-in tariff – EEG 2009

<table>
<thead>
<tr>
<th>Bonus Type</th>
<th>&lt;=150 kW</th>
<th>&lt;=500 kW</th>
<th>&lt;= 5 MW</th>
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</thead>
<tbody>
<tr>
<td>1. Basic feed-in tariff</td>
<td>16 Yen (11.67 Cent)</td>
<td>12 Yen (9.18 Cent)</td>
<td>11 Yen (8.25 Cent)</td>
</tr>
<tr>
<td>2. Bonus for emission reduction</td>
<td>1 Yen (1.0 Cent)</td>
<td>1 Yen (1.0 Cent)</td>
<td></td>
</tr>
<tr>
<td>3. Bonus for energy crops</td>
<td>9 Yen (7 Cent)</td>
<td>9 Yen (7 Cent)</td>
<td>5 Yen (4 Cent)</td>
</tr>
<tr>
<td>4. Bonus for residues from landscape management</td>
<td>3 Yen (2 Cent)</td>
<td>3 Yen (2 Cent)</td>
<td></td>
</tr>
<tr>
<td>5. Bonus for manure</td>
<td>5 Yen (4 Cent)</td>
<td>1 Yen (1.0 Cent)</td>
<td></td>
</tr>
<tr>
<td>6. Bonus for new techniques</td>
<td>3 Yen (2 Cent)</td>
<td>3 Yen (2 Cent)</td>
<td>3 Yen (2 Cent)</td>
</tr>
<tr>
<td>7. Bonus for using heat</td>
<td>4 Yen (3 Cent)</td>
<td>4 Yen (3 Cent)</td>
<td>4 Yen (32 Cent)</td>
</tr>
</tbody>
</table>

Conversion rate: 133 Yen = 1 Euro
### Overview feed-in tariff – EEG 2014

#### Biomass (Energy crops and Biowaste) § 44

<table>
<thead>
<tr>
<th>Performance classes</th>
<th>Germany</th>
<th>Japan</th>
</tr>
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<tbody>
<tr>
<td>≤ 150 kW</td>
<td>18 Yen (13,66 ct/kWh)</td>
<td>39 Yen</td>
</tr>
<tr>
<td>≤ 500 kW</td>
<td>16 Yen (11,78 ct/kWh)</td>
<td>39 Yen</td>
</tr>
<tr>
<td>≤ 5,000 kW</td>
<td>14 Yen (10,55 ct/kWh)</td>
<td>39 Yen</td>
</tr>
<tr>
<td>≤ 20,000 kW</td>
<td>8 Yen (5,85 ct/kWh)</td>
<td>39 Yen</td>
</tr>
</tbody>
</table>

Performance classes Germany Japan

<table>
<thead>
<tr>
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Conversion rate: 133 Yen = 1 Euro

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08.02.2016
The costs for electricity from biogas are difficult to determine because they depend on many different factors:

- The size of the plant:
  - Investment costs 75 kW plant: About 1 million Yen per kW inst. el. power
  - Investment costs 1 000 kW plant: About 400 000 Yen per kW inst. el. power

- The feedstock:
  - Energy crops ➔ rather expensive
  - Solid and liquid manure and agricultural byproducts ➔ rather cheap
  - Waste ➔ Costs vary

- Regional realities on the ground:
  - Safety requirements, approval, connection to the grid, etc.

On average, the costs of electricity produced from biogas in Germany are 17-28 yen / kWh. Conversion rate: 133 Yen = 1 Euro
Development of costs in Germany (2013-2030)
Why can we not reduce the costs?

What makes the plants cheaper?
• The basic technique for biogas production has become cheaper.
• The efficiency of the plants has been increased through greater efficiency of CHP and higher gas yields.

What makes the plants still expensive?
• Requirements for safety and environmental protection have increased.
• The production of energy crops becomes more expensive.
• Even waste materials become more and more expensive in Germany.
The discussion about the costs of biogas production have become more important since 2012 in Germany.

In future biogas needs a justification for the high costs.

What can bioenergy provide what others can not?

Flexibility instead of baseload.
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- Conclusion
Key objectives of the policy in the EEG 2014

- Reduction of costs
- No additional energy crops
- Direct selling and flexibility
## Overview: Feed-in tariff – EEG 2014

### Biomass
*(Energy crops and Biowaste)*  
§ 44

<table>
<thead>
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<td>≤ 5,000 kW</td>
<td>14 Yen (10.55 ct/kWh)</td>
<td>39 Yen</td>
</tr>
<tr>
<td>≤ 20,000 kW</td>
<td>8 Yen (5.85 ct/kWh)</td>
<td>39 Yen</td>
</tr>
</tbody>
</table>

### Household waste
§ 45

<table>
<thead>
<tr>
<th>Performance classes</th>
<th>Germany</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
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<td>20 Yen (15.26 ct/kWh)</td>
<td>39 Yen</td>
</tr>
<tr>
<td>≤ 20,000 kW</td>
<td>18 Yen (13.38 ct/kWh)</td>
<td>39 Yen</td>
</tr>
</tbody>
</table>

### Manure
§ 46

<table>
<thead>
<tr>
<th>Performance classes</th>
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<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 75 kW</td>
<td>32 Yen (23.73 ct/kWh)</td>
<td>39 Yen</td>
</tr>
</tbody>
</table>

**Conversion rate:** 133 Yen = 1 Euro
Individual requirements biomass-feed-in tariff (§ 44)

It is the parent feed in tariff.

No individual requirements on the size of the plant or the feedstock.

All biodegradable substrates can be used, except sewage sludge.

New plants in 2015: Not more than 2 plants have gone into operation.
Individual requirements for small manure plants (§ 46)

Requirements:

• Electricity generation on the site of the biogas plant.

• Installed electric capacity: maximum 75 kW

• Use of 80% manure on an annual average.

• Manure: Liquid and solid manure of pigs and cattle, horse manure, goat and sheep manure.

• Poultry manure is not creditable to the 80%.

• The remaining 20% are arbitrary.
Evaluation of small manure plants

What is good?

• There is still much manure available.

• There is no competition with land used for agricultural goods.

• Other advantages:
  ➔ Reduction of greenhouse gas emissions
    Methane emissions are captured and by the power generation in the CHP the methane is converted to less climate-relevant CO2.
  ➔ Reduction of odors
  ➔ Producing of high-quality fertilizer
    Separated solid digested is used in some cases as bedding for cows. However, this must be discussed with the veterinary and the digested has to be sanitized.
Evaluation of small manure plants

What is bad?

- These plants are limited to 75 kW installed electric capacity. There are farmers or associations of farmers which could generate more than 75 kW, purely from manure.

- The continuous reduction of the feed-in tariff for new plants must be abolished, otherwise the feed-in tariff in future is too small for new plants.

New plants in 2015: About 60 new plants

→ This feed-in tariff is working very well and we are satisfied.
Individual requirements of household waste plants (§ 45)

Requirements:

• At least 90% of the following substances must be used:
  • garden and park waste
  • Household biowaste
  • Market waste (expired food)

• The remaining 10% are arbitrary.

• Immediate post-rotting of solid digestate and no combustion.

→ Unfortunately only certain waste materials are accepted in this class of feed-in tariffs.

New plants in 2015: About 10 new plants
Common requirements for all feed-in tariffs

For the first time, in EEG 2014, the extension of biomass plant installation is limited:

- No more than 100 MW of capacity from biomass per 12 months is allowed to be installed in addition to the existing installed electrical capacity.

- Normally the feed-in tariff for new plants is reduced by 0.5 % per quarter starting from the 1st of January 2016.

- In case there are more than 100 MW built within 12 months, the feed-in tariff will be even more reduced, namely by 1.27% per quarter for new plants.

⇒ Policy says:” If there will be built too many new plants, the feed-in tariff is too costly and the electricity will be too expensive.

This year the 100 MW cap has not been exploited.
Common requirements for all feed-in tariffs

„Double overbuilt“ compulsory for new plants

• New plants with an inst. electric capacity of over 100 kW will receive the feed-in tariff only for 50 % of their installed capacity.
  ➔ Does an operator want to produce 100 kW of electricity on average, he has to install 200 kW of capacity at the plant.

• The plants must be able to produce flexible power.
  ➔ Flexibility premium / Flexibility surcharge

Flexibility and direct selling as a core task in EEG 2014
Conclusion on EEG 2014

The EEG 2014 has a significantly simpler feed-in tariff structure than the EEGs before.

There are less requirements!

• **But:** The feed-in tariffs were decreased and therefore only few new plants are built.
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Connection to the grid in EEG

- Renewable energies have priority access to the grid.
- The plant operator makes a request for connection to the grid.
- The operator of the grid has to find a proper connection point.
  - suitable voltage level
  - shortest distance
  - most economical
- The operator of the biogas plant has to pay the costs up to the point of connection.
- The costs for the expansion of the public grid has to be borne by the grid operator.

⇒ The grid operator must expand and optimize the grid!
Restricted connection to the grid

**Photovoltaics and wind energy are fed into the grid fluctuating - there may be disruptions to the grid.**

- Therefore, since 2009 biogas plants with more than 100 kW installed capacity are required to be able to reduce the amount of electricity fed into the grid.

- This biogas plants must have a system for metering the produced electricity and be able to reduce the feeding-in of this electricity remote-controlled.

- This reduction in feed-in electricity is compensated, regardless of the size of the plant.
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Why do we need flexibility in biogas plants

- Baseload loses value with increasing share of renewable energies.
- Flexible power plants must compensate the valleys of the sun and wind.

⇒ Need for bioenergy and natural gas plants
Forms of direct selling

Direct selling = the electricity is not supplied to the grid operator but sold to an electricity trader.

**Three different forms of direct selling:**
1. The biogas operator does not change his operating.
2. The electricity trader can control the biogas plant remotely.
3. The electricity trader and the biogas plant operator agree on a fixed schedule.
How can I combine direct selling and feed-in tariffs of the EEG?

When the produced electricity was conducted through a public grid!

→ Market premium, Flexibility premium
Market premium

The operator of the biogas plant can combine direct selling with the feed-in tariff of EEG = Market premium model

- The biogas plant adheres to the requirements of the EEG and will be paid after the statutes of the EEG but the electricity will be sold to an electricity trader.

In future, the biogas plant has two sources of income:

- Market premium will be paid by the grid operator.

- Revenue of direct selling will be paid by the electricity trader.
Market premium = Feed-in tariff – monthly market value on the electricity exchange

The plant operator has to get the monthly market value from his electricity trader
Direct selling and market premium can be used by other renewable energies!

Flexibility premium is only for biogas plants!
Flexibility premium

If biogas plants can store the gas and provide additional capacity for electricity production they can apply to the flexibility premium / flexibility surcharge in addition to the market premium.

- A flexibility premium will be paid for extra capacity:
  For example: A biogas plant is operating with an average of 100 kW, 200 kW are installed at the plant and there is a big gas storage, so the plant can get the flexibility premium for its ability to produce more electricity in case it is needed.

- Flexibility premium is an additional premium to market premium.
Market premium und flexibility premium

- Market premium
- Flexibility premium
- Revenue from electricity trader
- More revenue

Additional revenue for direct selling and flexibility premium
Will be paid by the electricity trader
Will be paid by the grid operator
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What we care about.....

![Graph showing Bemessungsleistung MW over years 2004 to 2034 with additional solid biomass and biogas plants, average performance of existing plants, and assumed biomass addition from 2015 onwards.]

© Fachverband Biogas e.V. 2015; Datenbasis DBFZ 2015; Annahme: Zubau Biomasse ab 2015 5 MW
What has happened so far politically?

- **The policy says:**
  - The renewable energies should be expanded and promoted in Germany and a further development of the grid is necessary!
  - Direct selling should be expanded, so that the renewable energies adapt more to the needs of the market.
  - The market premium and flexibility premium should also be expanded.
  - Due to an European guideline renewable energies must determine the feed-in tariffs in future in a competitive way ➔ There will be tenders in future.

- **At the same time, the electricity market will be redesigned with a new act:**
  - Reduction of over-capacity.
  - Putting out of order of old polluting coal-fired plants.
  - Phasing-out of nuclear power plants.

➔ The price of electricity is expected to increase!
The primary aims of the German Biogas Association for the year 2016

- Exploiting the cap of 100 MW additional installed electric capacity every year through new specifications in the new EEG

- New feed-in tariffs for existing biogas plants

- More fermentation of manure in small plants
The bill of EEG Act 2016

1. **System of EEG 2014 is maintained**
   (Feed-in tariffs for biowaste and small manure plants, direct selling, market premium, flexibility premium)

2. **Tenders: Plants with more than 100 kW must participate in tenders**
   (Market premium; flexibility premium)
Tenders
Recent Discussions - (1)

How does a tender work?
• The government should give a certain amount of electricity to the tender, two times a year.

Who can participate?
• Projects for building new plants
• Projects for new feed-in tariffs (existing plants)
• Projects with plans for expansion of biogas plants

When can you participate?
• At least three years before you want to get a feed-in tariff.
What is the approximate process of a tender?

Example: The government opened a tender for 2022 with 150 MW.

Existing biogas plant:

- Biogas plant with 400 kW average power, feed-in tariff ends 2021.
- Operator decision: "We want to keep going on"
- The operator calculates the costs and the desired profit for electricity

\[
= 25 \text{ yen / kWh.}
\]

 Participation in tender in 2019
Tenders
Recent Discussions - (3)

Surcharge for 25 Yen/kWh

→ Feed-in tariff on 01.01.2022 is 25 Yen/kWh,
→ When the plant adhere to requirements of EEG 2016.

The plant operator has 3 years to prepare for the requirements of the EEG 2016.
Special arrangements for small plants

Who does not need to participate in tenders?
• Small manure plants
• Household waste plants
• Plants < 100 kW average power

What we would like to have in addition:
• Plants which are using more then 80 % of environmentally friendly substrates should also not have to participate in tenders
→ Liquid and solid manure, agricultural byproducts, wild plants etc.
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• Facts about biogas production in Germany
• Feed-in tariffs in Germany
• EEG 2014 and the present situation of biogas generation
  • Connection to the grid and restrictions
• Direct selling, market premium and flexibility premium
• Preparation for EEG 2016 and tenders for biogas
• Conclusion
Conclusion

• Biogas has experienced an enormous boost within a very short time in Germany. There was a very fast yearly additional increase of installed electric capacity in a very short time!
  ➜ Therefore there was a reduction of the feed-in tariffs.

• On the other hand, the potential for biogas is still available, especially
  ➜ in the recycling of waste materials and also
  ➜ in the flexibility of producing electricity!

• The generation of electricity from biomass will always be one of the most expensive renewable energies in Germany because of feedstock costs! Therefore, biogas must bring additional benefits and open up additional revenues:
  ➜ Flexible production of electricity
  ➜ By-production of heat
  ➜ Production of a high-quality fertilizer
  ➜ Saving of greenhouse gases
Thank you for your attention