Current and future activities concerning biogas plant methane emissions in the EC and IEA Bioenergy Task 37

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iBBA Methane Emissions Workshop
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Overview

- **Summary of GHG savings requirements in the EU (Renewables Directive (2009/28/EC) - RED)**

- **New EU publication – biogas pathways**

- **Emissions data**

- **Sample Life Cycle Assessments of biogas plants**
• Calculation of GHG Impact

Article 19 (1)
Defines the method for calculation, using the methodology given in Annex V.C. Typical and default values for GHG emissions for “cultivation”, “transport” and “processing” steps given in Annex V.D & E

Here, the difference between GHG emissions for biofuels produced from energy crops and those produced from wastes/residues becomes apparent
Some GHG Savings in the RED

- Default GHG savings compared with fossil petrol/diesel (Annex V.A)
  
<table>
<thead>
<tr>
<th>Source</th>
<th>GHG Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas* from municipal organic waste</td>
<td>73%</td>
</tr>
<tr>
<td>Biogas* from wet manure</td>
<td>81%</td>
</tr>
<tr>
<td>Biogas* from dry manure</td>
<td>82%</td>
</tr>
<tr>
<td>Rapeseed biodiesel</td>
<td>38%</td>
</tr>
<tr>
<td>Palm oil biodiesel (CH₄ capture at mill)</td>
<td>56%</td>
</tr>
<tr>
<td>Sugar beet ethanol</td>
<td>52%</td>
</tr>
<tr>
<td>Sugar cane ethanol</td>
<td>71%</td>
</tr>
</tbody>
</table>

(* in the form of compressed biomethane compatible with natural gas)
GHG savings calculation according to the RED

BIOGRACE European project calculation tool,

http://www.biograce.net/content/ghgcalkulationtools/recognisedtool

BioGrace Excel tool

Version 4c for Compliance
State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU (Staff Working Document, SWD (2014)259)


JRC scientific report on the default and input values for GHG emissions of biomass (Report EUR 26696 EN, 2014)

http://iet.jrc.ec.europa.eu/bf-ca/publications
New EU Biogas Pathways

1. An energy crop: maize silage;
2. An agricultural waste: feedlot manure;
3. Municipal organic and agro-industrial waste: biowastes. (and co-digestion)

These combine with two means of digestate management:
- open tank storage;
- closed tank storage (gas tight).

Also combined with two end-uses for the biogas:
- biogas for power and heat production;
- biogas upgrading to biomethane (without combustion of the off-gas) (with combustion of the off-gas)
**Digestate methane emissions**

Based on:

- **LHV (maize):** 16.9 MJ/kg (Moisture = 65%)
- **LHV (slurry):** 12 MJ/kg (Moisture = 90%)
- **LHV (Biowaste):** 20.7 MJ/kg (Moisture = 76,3%)

- Temperature of digestate: ca. 20°C
- Residual methane potential:
  - maize = 30 l CH₄ / kg VS
  - manure = 35 l CH₄ / kg VS
  - biowaste = 44 l CH₄ / kg VS

- Methane losses
  - maize = 0.44 g CH₄ / MJ biogas
  - manure = 2.0 g CH₄ / MJ biogas
  - biowaste = 0.49 g CH₄ / MJ biogas
Biomethane production emissions

• **Upgrading with venting of the off-gas** includes pressure swing absorption, pressure water scrubbing, membranes and organic physical scrubbing. The methane lost in the off-gas is considered to be emitted to the atmosphere.

• **Upgrading with oxidation of the off-gas** includes pressure swing absorption if the water is recycled, organic physical scrubbing, chemical scrubbing and cryogenic. In this case, the off-gases are considered to be flared with a high efficiency.
Upgrading emissions

Biogas lost in the process is considered to be:
- 3–10 % PSA;
- 1–2 % water scrubbing;
- 2–4 % organic physical scrubbing;
- 0.1 % chemical scrubbing;
- 1–15 % membranes
- <1 % cryogenic

(Biogas Handbook data)

3 % of the methane is emitted for upgrading with venting of the off-gas

0% of the methane is emitted for upgrading with oxidation of the off-gas
Electricity generation (CHP engine)

Emissions reported to be from 0.44% to 2.43%

JRC average value taken to be 1.7%

Gross electrical efficiency of the CHP engine considered to be 36% in sample calculations.

Recent JRC study and Commission "Staff Working Document" can be found at: http://ec.europa.eu/energy/renewables/bioenergy/sustainability_criteria_en.htm
Emissions data

IEA Bioenergy Task 38 (2010)
GHG benefits of a biogas plant in Austria, Woess-Gallasch et al. IEA Bioenergy Task 38 case study, 2010/Joanneum Research report ENG-B-05/10

Liebetrau et al. (2011)

IEA Bioenergy Task 37 (2013)
Biogas Handbook – Chapter 11

- Emission long term
  - Manure storage
  - 20 – 45% of Methane potential

- Substrate storage
  - Short term at site limited
  - 0.2-0.5%

- Digestion
  - Low emissions
  - 0.02-0.07%

- Digestate storage
  - Range of 0.5-11% when uncovered
  - Low when covered
  - See digester

- CHP
  - (0.5 – 6%)

- Biogas upgrading
  - 0.0 – 1.5% based on limited sources

<table>
<thead>
<tr>
<th>Part of Process</th>
<th>Component</th>
<th>Min. average methane loss (%)</th>
<th>Max. average methane loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage storage</td>
<td>–</td>
<td>0.00065</td>
<td>0.00065</td>
</tr>
<tr>
<td>Feeding systems</td>
<td>Screw conveyor</td>
<td>0.0079</td>
<td>0.0079</td>
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<tr>
<td></td>
<td>Dosing feeder</td>
<td>0.00029</td>
<td>0.16</td>
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<tr>
<td></td>
<td>Substrate storage tank</td>
<td>0.005</td>
<td>0.311</td>
</tr>
<tr>
<td></td>
<td>Mixing tank</td>
<td>0.013</td>
<td>0.288</td>
</tr>
<tr>
<td>Digester</td>
<td>Foil cover</td>
<td>0.006</td>
<td>0.0244</td>
</tr>
<tr>
<td></td>
<td>Gas-tight cover</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Concrete roof</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Digestate storage tank</td>
<td>Open</td>
<td>0.224</td>
<td>11.22</td>
</tr>
<tr>
<td></td>
<td>Covered</td>
<td>0.638</td>
<td>10.299</td>
</tr>
<tr>
<td>Gas utilisation</td>
<td>CHP</td>
<td>0.44</td>
<td>2.43</td>
</tr>
<tr>
<td></td>
<td>Upgrading</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

LCA of biogas plants

Effect of open and closed digestate storage

LCA of biogas plants

Contributions of different process components for GWP

Contributions of different GHGs for GWP

Best practice guide

The Swedish Voluntary system for control of methane emissions

Anneli Petersson “The Swedish voluntary system for control of methane emissions”, IEA Bioenergy Task 37, May 2012,
http://www.iea-biogas.net/case-studies.html
Current IEA Bioenergy Task 37 Study

Linked to Swedish methane emissions measurement project (2014-2015)

"Methane emissions in biogas plants: measurement, calculation and evaluation"
Bernd Linke at al. (2015)
Country Reports

Annual summary report published each January

http://www.iea-biogas.net/country-reports.html

Task 37 Biogas Country Overview

(Country Reports)
The Biogas Handbook
Science, production
And applications

2013


Recommendations

- Guidelines for the selection and use of "literature" emissions data in LCA studies and environmental assessments of biogas and biomethane installations

- Preparation of best available emissions data from biogas and biomethane installations for use by environmental impact assessors (students, researchers, plant operators, public authorities, etc. etc.)
Thank you for your attention

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