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

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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***






EU Renewables Directive 2009/28/EC

- **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)**

Biogas* from municipal organic waste	***73%***
Biogas* from wet manure	***81%***
Biogas* from dry manure	***82%***
Rapeseed biodiesel	***38%***
Palm oil biodiesel (CH_4 capture at mill)	***56%***
Sugar beet ethanol	***52%***
Sugar cane ethanol	***71%***

(* 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/ghgcalculationtools/recognisedtool

	BioGrace Excel tool	
	Version 4c for Compliance	

New EU publications

August 2014

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)

http://ec.europa.eu/energy/renewables/bioenergy/doc/2014_biomass_state_of_play_.pdf

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 CH_4 / kg VS
  manure = 35 l CH_4 / kg VS
  biowaste = 44 l CH_4 / 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)

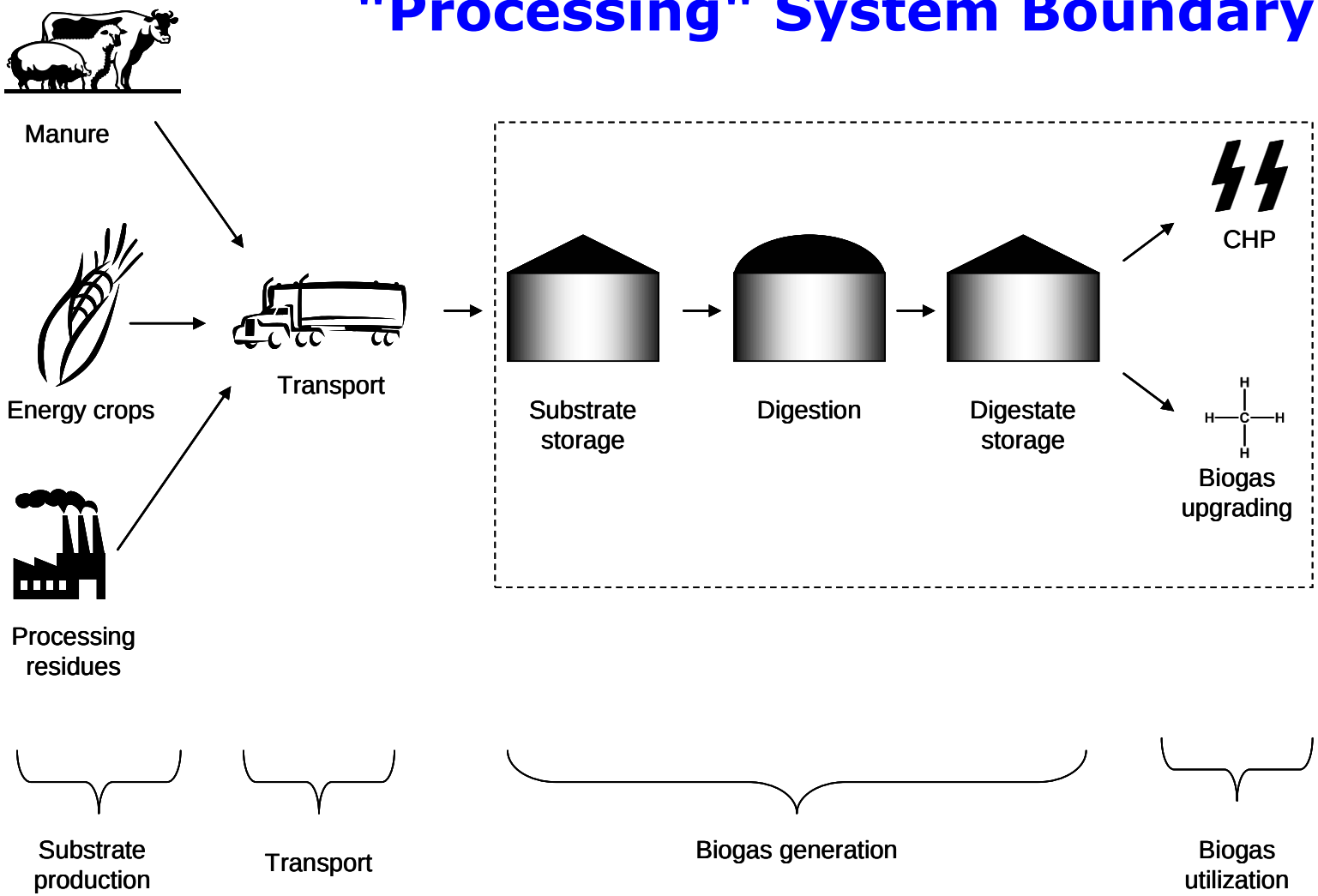
Methane emissions from biogas-producing facilities within the agricultural sector, Eng. Life Sci., 10 (2010) 595–599

IEA Bioenergy Task 37 (2013)

Methane emissions in biogas production, Dumont et al. Biogas Handbook, Chapter 11 (2013)

IEA Bioenergy Task 37

"Processing" System Boundary



Source: Dumont et al. Biogas Handbook Chapter 11 (2013) Woodhead Publishing

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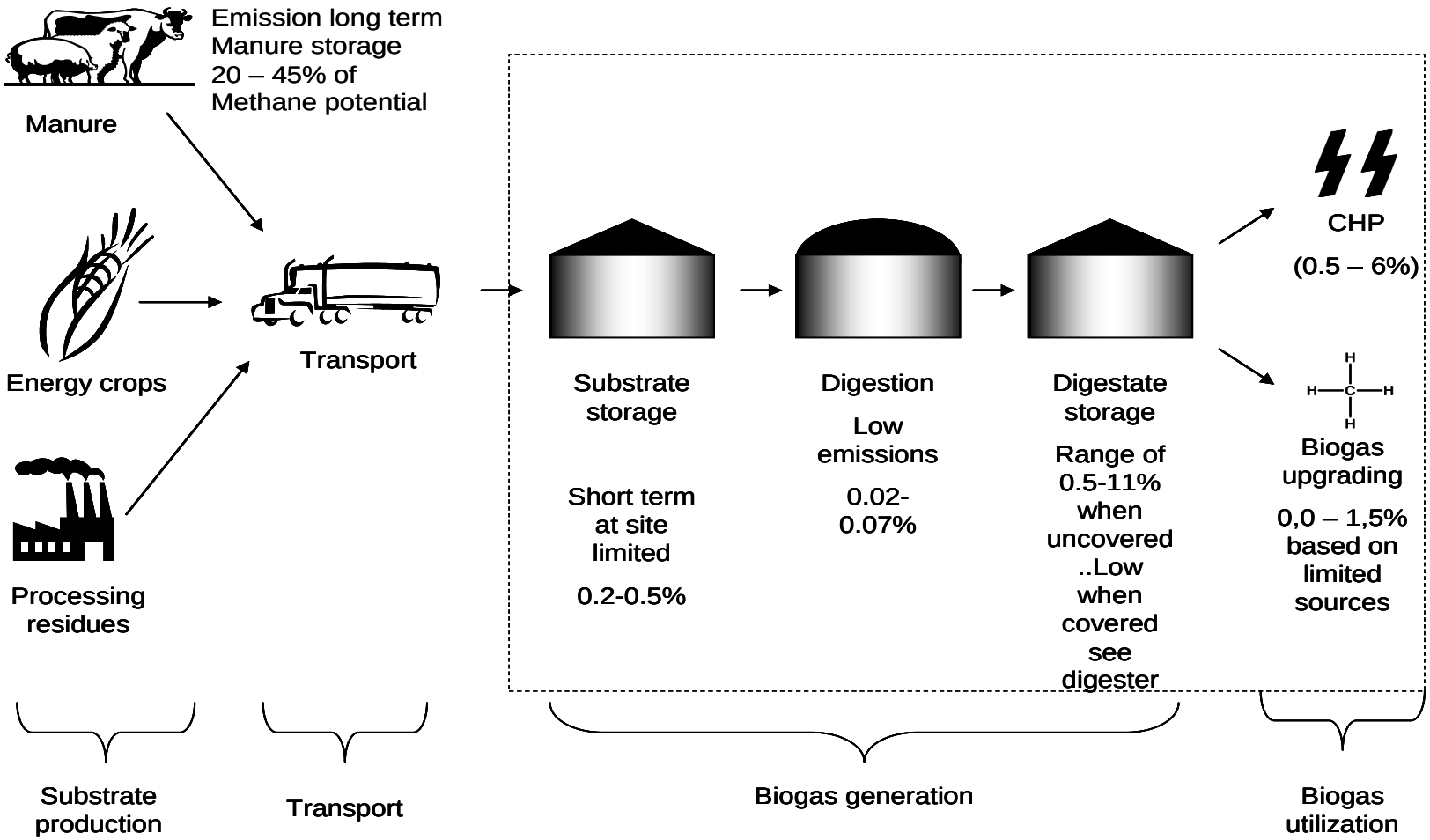
Biogas Handbook – Chapter 11



Source: Dumont et al. Biogas Handbook Chapter 11 (2013) Woodhead Publishing

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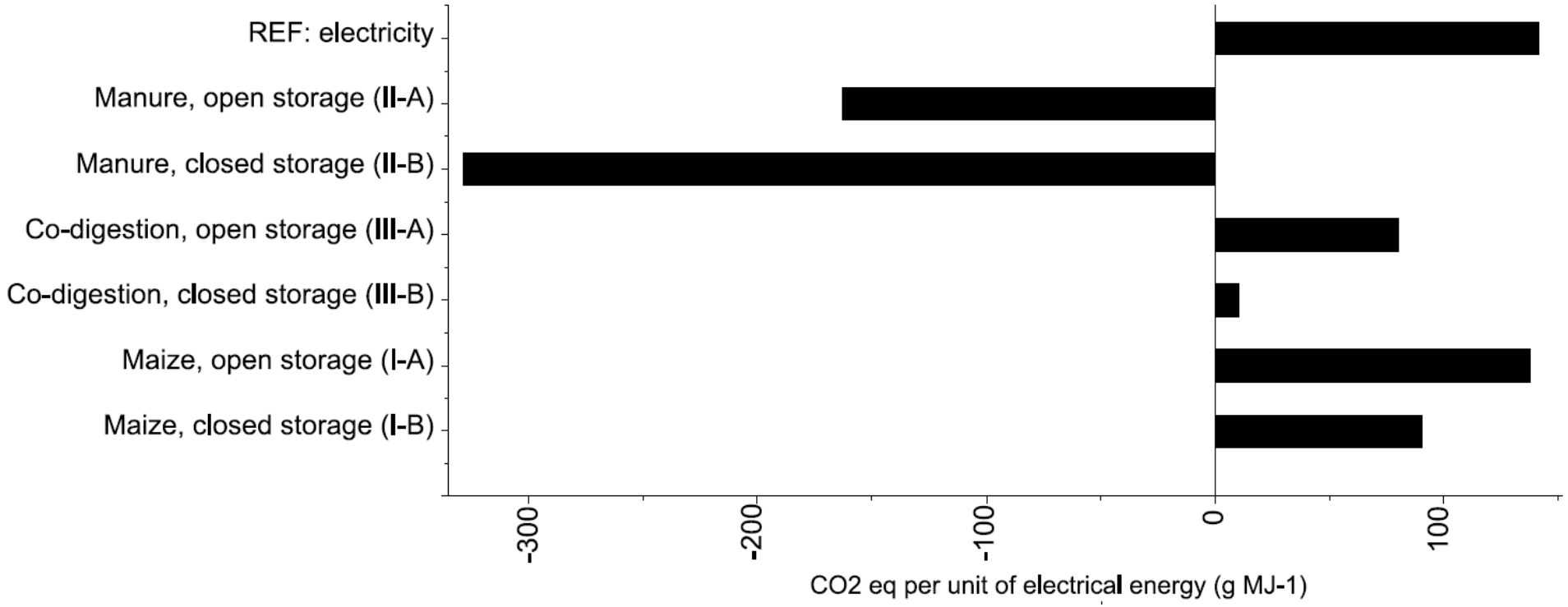
Biogas Handbook – Chapter 11 – emissions

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

Dumont et al. Biogas Handbook Chapter 11 (2013) from original work by Liebetrau et al. (2011)

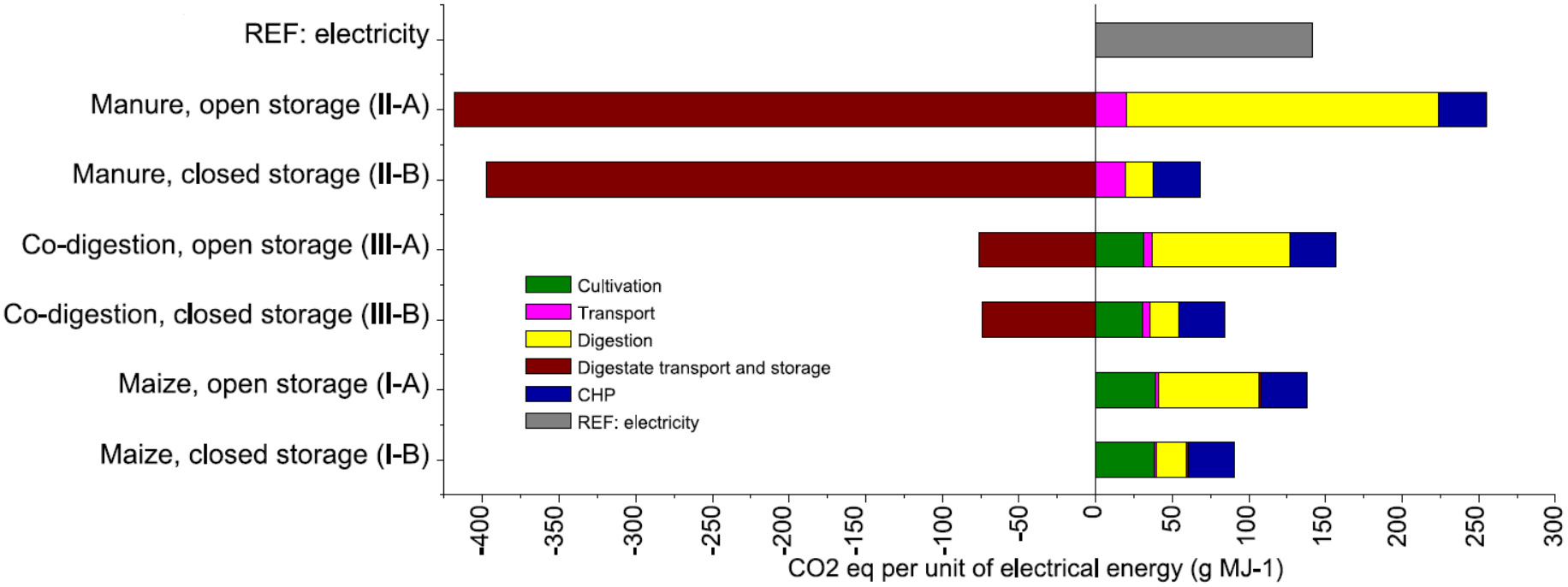
LCA of biogas plants



Effect of open and closed digestate storage

Source: (JRC) Boulamanti et al. Biomass & Bioenergy, 53 (2013) 149-161

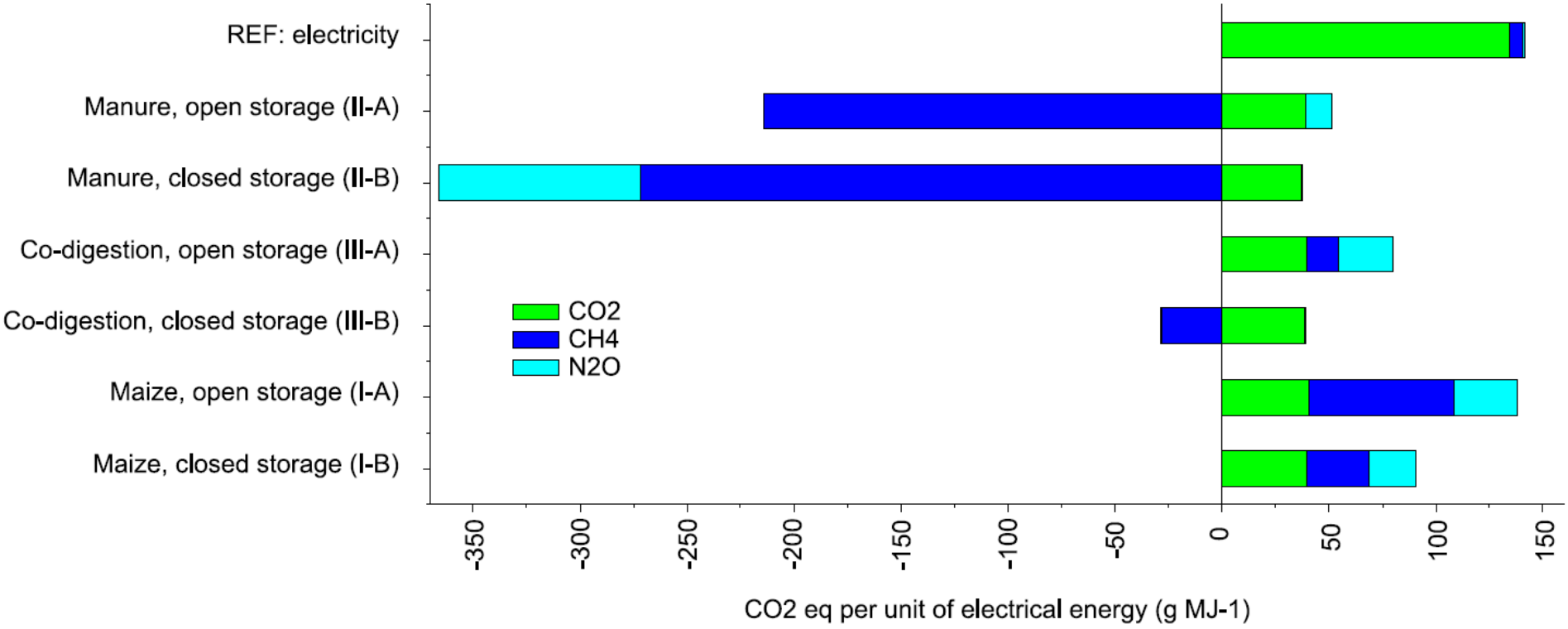
LCA of biogas plants



Contributions of different process components for GWP

Source: (JRC) Boulamanti et al. Biomass & Bioenergy, 53 (2013) 149-161

LCA of biogas plants



Contributions of different GHGs for GWP

Source: (JRC) Boulamanti et al. Biomass & Bioenergy, 53 (2013) 149-161

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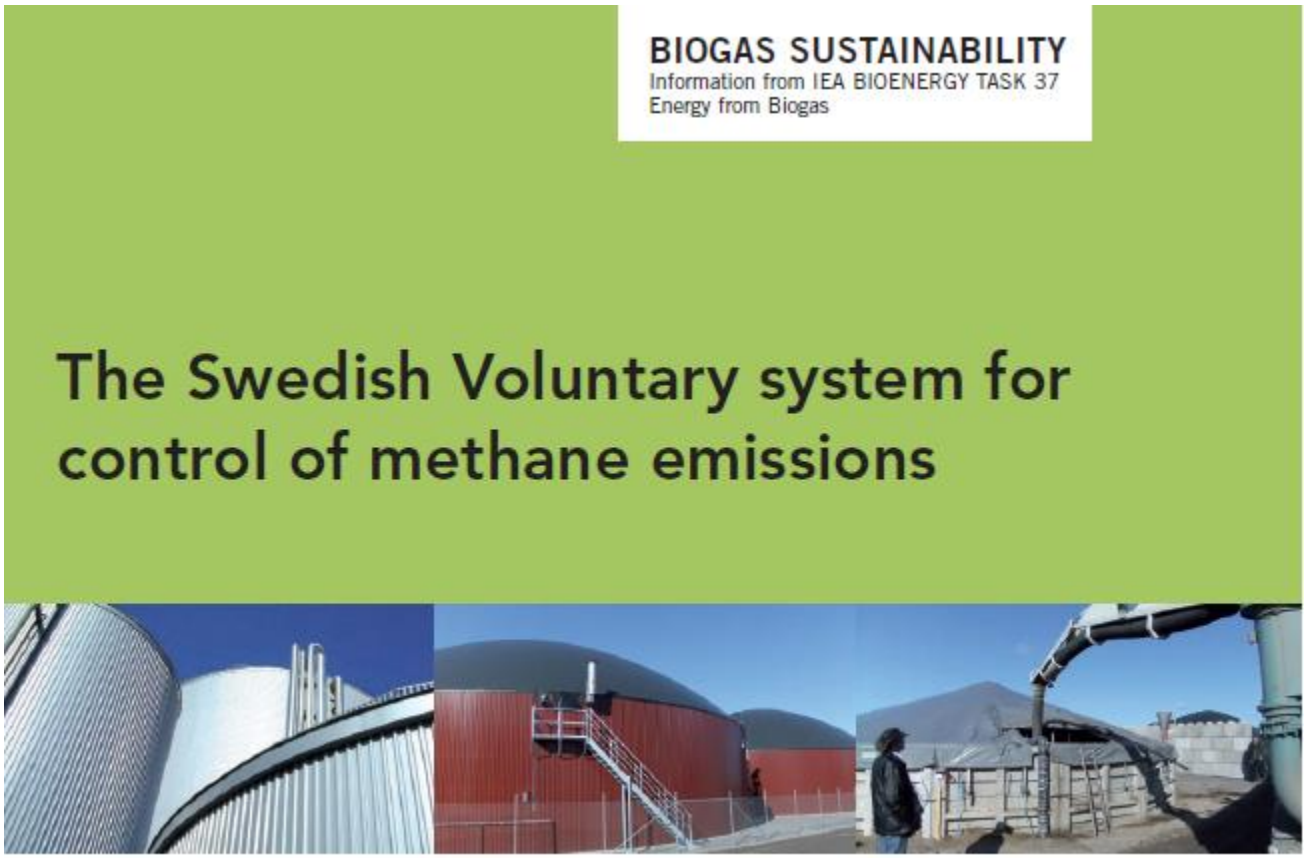
Best practice guide



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)*

IEA Bioenergy Task 37

Country Reports

Annual summary report published each January

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

Task 37 Biogas Country Overview

(Country Reports)

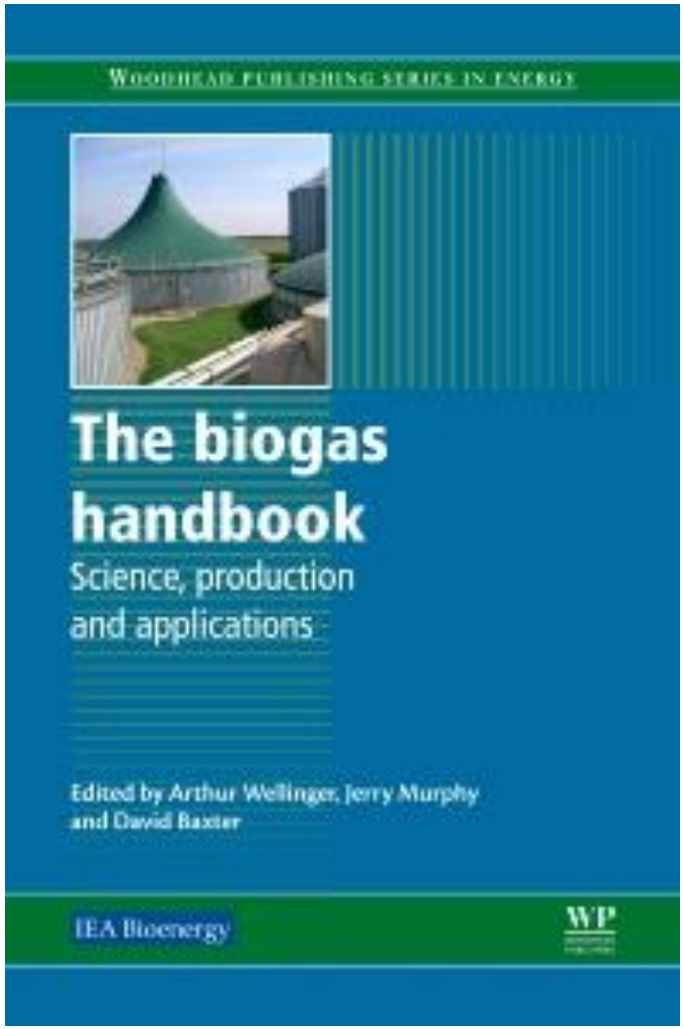
IEA Bioenergy Task 37

The Biogas Handbook
Science, production
And applications

2013

http://www.woodheadpublishing.com/en/book.aspx?bookID=2576

http://store.elsevier.com/product.jsp?locale=en_US&isbn=9780857094988



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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