IEA Bioenergy Task 37

Country report Sweden

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iea Energy Technology Network

Energiforsk

IEA Bioenergy

Biogas Plant Inventory 2014

Substrate/Plant type	Number of plants	Production * (GWh/year)
Sewage sludge	139 (+2)	679 (+7)
Biowaste**	35 (+12)	717 (+137)
Agriculture**	37 (-2)	44 (-33)
Industrial	5 (+/- 0)	123 (+6)
Landfills	60 ((+/- 0)	219 (-21)
Thermal gasification	1(+1)	1
Sum	**277 (+13)**	**1 784 (+98)**

** = energy content in the produced biogas independent of the utilisation*

*** = redefinition of 6 agriculture plants as biowaste plants*

Biogas Utilisation 2014

Utilisation	GWh	%
Electricity	58 (+12)	3%
Heat	434 (-87)	24% (-7)
Upgraded, automotive fuel	1,017 (+110)	57% (+3)
Industrial use*	75 (+75)	4% (+4)
Flare	191 (+6)	11%

** = new utilisation category, earlier defined as heat or other*

CNG/CBG/LNG/LBG as automotive fuel, end 2014

- Number of refuelling stations: 155 (excl. 63 non-public), incl. 6 for LNG/LBG
- Number of vehicles: 46,975 cars (1%)*, 2,315 busses (17%)*, 755 trucks (1%)* incl. 50-100 LNG trucks

* = percentage of the national market

- 1,613 GWh (60% renew. on energy basis, 970 GWh, incl. imports)

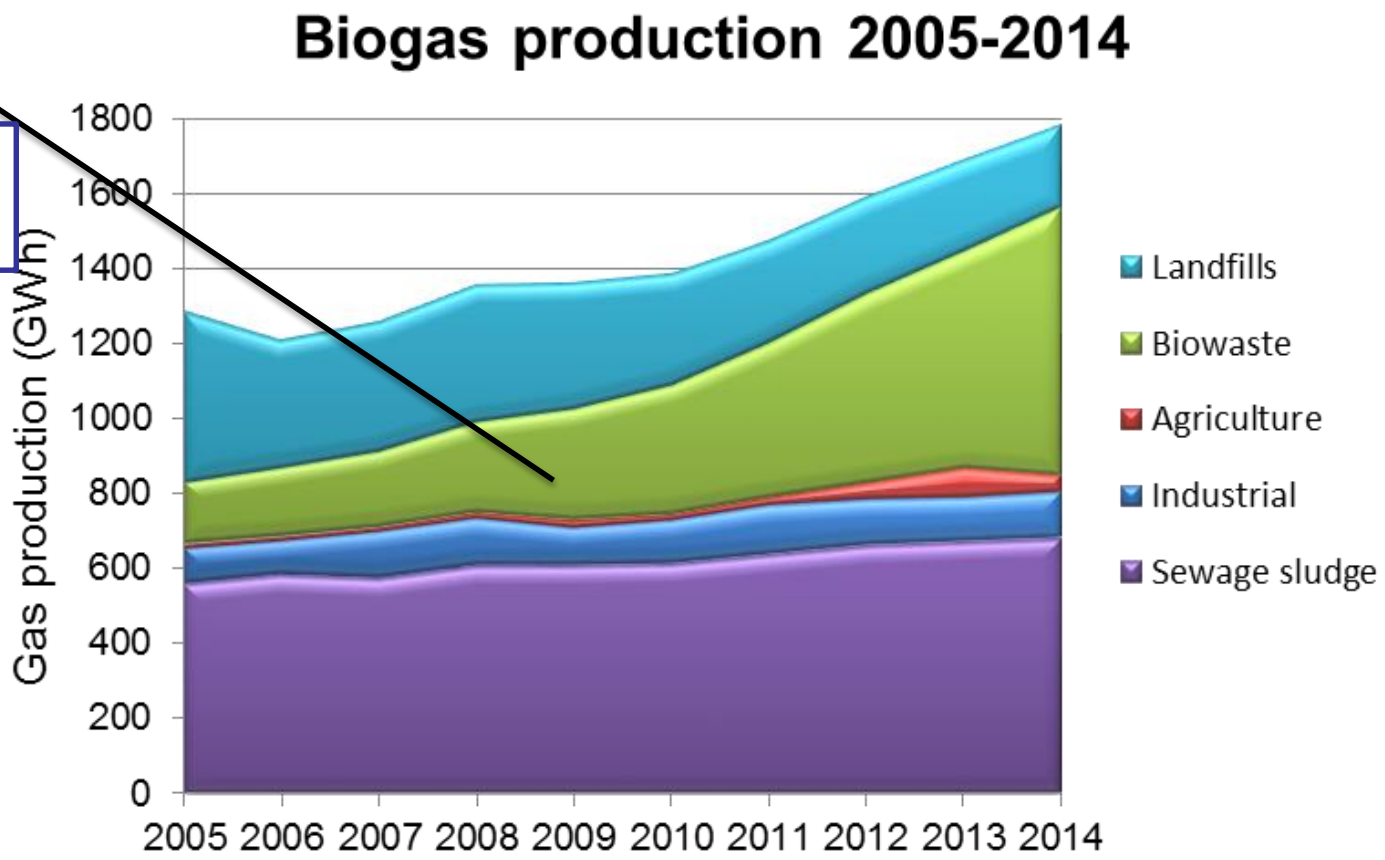
Biogas upgrading 2014

- 59 biogas upgrading plants in operation: 41 Water scrubbers, 6 PSA, 12 Amine scrubbers.
- 2 membrane units and 1 cryogenic upgrading unit taken into operation 2014-2015, but not enough production data to get into the statistics
- Biomethane production 2014: 1,117 GWh/year (286 GWh injected into the grid)
- LBG production: 1 plant produced 41 GWh during 2014
- No power to gas installations exist in Sweden

A complete list of all upgrading plants will be available in late November (?) at http://www.iea-biogas.net

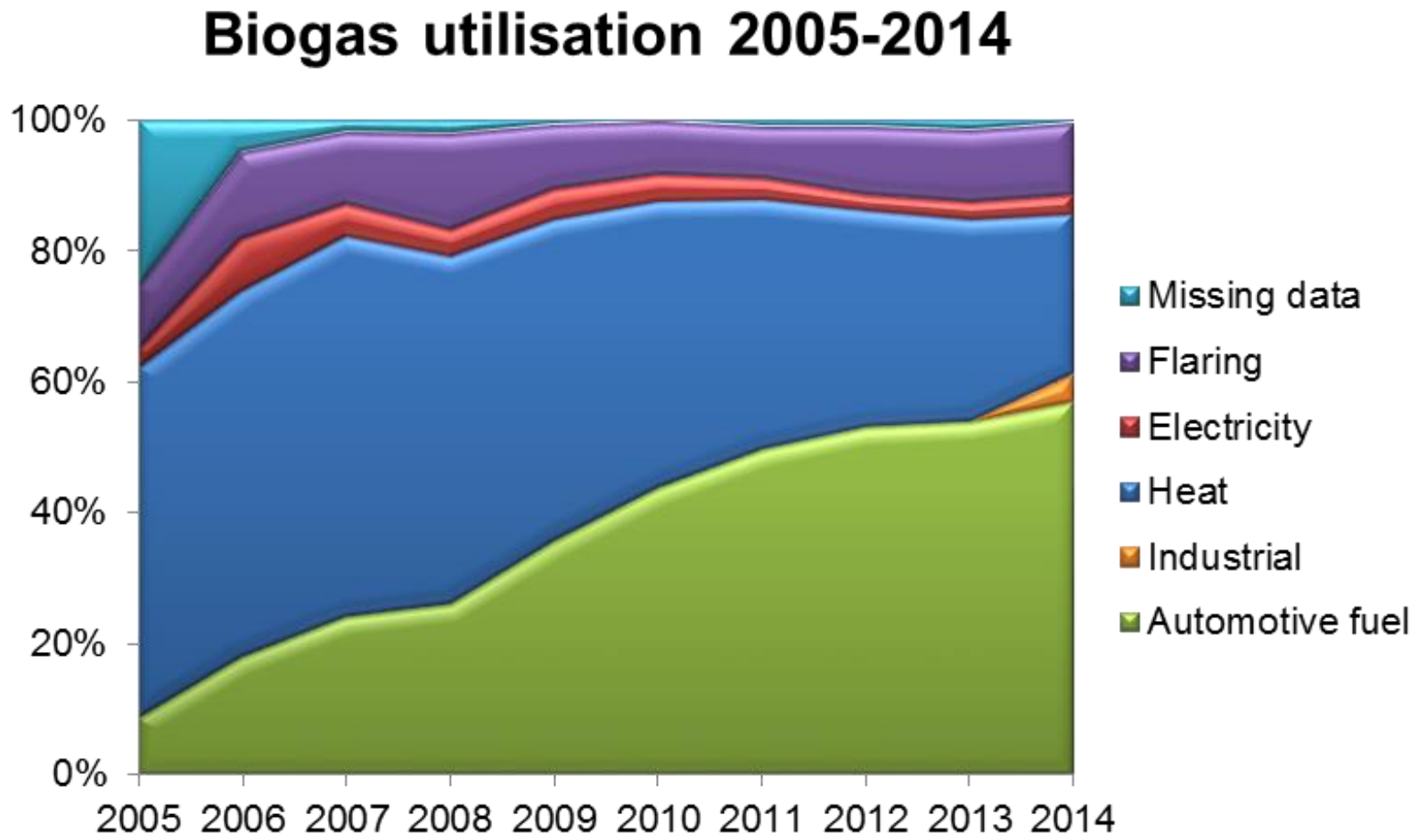
Biogas trends (1)

30 000 ton 2005 –
307 000 ton 2013



Food waste collection in 190 of Sweden's 290 municipalities

Biogas trends (2)



Biogas trends (3)

Biogas potential until 2030

Three scenarios with good, moderate or poor development of financial support system, technology and the price of fossil fuels.

1–3 TWh in scenario 3 (poor development)
5–8 TWh in scenario 2 (moderate development)
5–10 TWh in scenario 1 (good development)

Source = Dahlgren S (2013) “Realiserbar biogaspotential i Sverige 2030 genom rötning och förgasning”, WSP

Digestate handling 2014

Plant type	Digestate (Mtonnes wet)	Fertiliser usage	certified
Sewage sludge	674	19% (-5)	>50%
Biowaste	1,378	99%	~64%
Agriculture	278	100%	-

Financial support system

The support system in Sweden is mainly focused on increasing the usage of biomethane as vehicle fuel. The existing support systems are:

- No carbon dioxide or energy tax on biogas until the end of 2015 (extension 2020 pending EU approval). Corresponding to around 708 SEK/MWh (76 €) compared to petrol and 570 SEK/MWh (61 €) compared to diesel
- 40% reduction of income tax for use of company NGVs until end 2019 (10kSEK cap)
- Investment grants for marketing of new technologies and new solutions for biogas during 2010-2016. Maximum 45% or 25 MSEK (~3M€) of investment cost
- Climate investment grant for municipalities: Total budget 1,925 MSEK (~200 M€) until the end of 2018. Similar to KLIMP!
- A joint electricity certificate market between Norway and Sweden. The producer gets one certificate for every MWh electricity produced from renewable resources and electricity consumers must buy certificates in relation to their total use. Price span 2014-2015 140-190 SEK/MWh (~15-20 €)
- 0,2 SEK/kWh (~ € 0,02/kWh) for manure based biogas production to reduce methane emissions from manure. Total budget 355 MSEK (10 years)

National strategies

- Government 2020 goals for renewables already reached
  - 50% of the total energy utilisation
  - 10% goal in transports
- Vision to have a fossil free transportation sector by 2050.
  - Still awaiting government strategy to meet these goals

- The gas industry's biomethane vision is 100% in NGV market by 2030, and 100% in the national grid by 2050
  - National strategy to be launched in December!

Performance and economic data

Median cost estimate (average cost estimate) from nine Swedish biogas plants. Unit: SEK/kWh, 1 € = 9.3 SEK

Crude biogas	Upgrading	Distribution in grid	Distribution by road	Refuelling	Total
0.54 (0.86)	0.31 (0.32)	0.06 (0.08)	0.12 (0.15)	0.04 (0.07)	0.97 (1.35)

Average price of CNG in Sweden Oct 2015:
1.24 SEK/kWh (2012: 1.41 SEK/kWh)

Source: SGC report 296 available for free download at www.sgc.se

Obstacles for the biogas development

- Long term conditions from the government and EU is missing (1-5 years planning horizon…)
- Substrate competition
- Suggestion of new very tough regulations on digestate as fertiliser (limits on content of heavy metals
- Unclear situation regarding import/export of biogas (mass balance limitations)
- Uncertainties concerning ILUC

Biogas Research Center

Resource-efficient biogas solutions

Strategic multi-criteria assessment of biogas solutions

Jonas Ammenberg & Roozbeh Feiz, Environmental Technology and Management, Linköping University

Many different 'biogas solutions'

- Complex 'sector':
  - ✓ many involved actors/sectors & links to several socio-technical systems,
  - ✓ dynamics and variance regarding feedstock,
  - ✓ production in different contexts with diverging purposes,
  - ✓ several technological options both regarding the production and use of the products,
  - ✓ positive and negative interaction with the surrounding systems – synergy effects.
- Often additional values than production of a fuel, e.g.;
  - ✓ waste and waste water treatment
  - ✓ climate mitigation
  - ✓ nutrient recycling and soil fertility improvement
  - ✓ biodiversity
  - ✓ improved water quality (e.g. farming ascidians in the Baltic Sea)
  - ✓ manure management
- Important to take these synergy effects (or externalities) into account

Broad systems studies are essential

BRC focuses on **implementation** of **resource efficient** biogas solutions:

- *Implementation;* requires different kinds of feasibility and incentives - knowledge about important drivers and barriers is essential.
- *Resource efficiency*; maximize the outputs (or added values) from a certain resource or system, but have minimal negative impacts;
  - ✓ E.g. amounts and values of the products and functions provided; economic effects; management of natural resources and impact on essential societal needs; environmental impacts; energy system aspects, etc.
- Strategic, broad and systematic Multi-Criteria Assessments (MCA) to:
  - Collect, select and structure relevant information
  - Highlight critical drivers, barriers and opportunities
  - Show strengths and weaknesses regarding resource efficiency;
    - For biogas producers
    - For the society
  - Compare with competing alternatives
  - Provide an overview and facilitate informed decision making

Essential points

- Broad, long-term, system studies of resource efficiency
- Take synergy effects (externalities) into account
- Compare with competing alternatives;
  - There is a risk of a too internal biofuel/biogas focus, discussing problems and looking for options to become more efficient
  - E.g. if the methane emissions from biogas production are included, than declare the corresponding emissions for natural gas production and distribution as well
  - Sustainability criteria for biofuels!? – how are the fossil fuels coming out if they are also assessed using the same criteria (criteria in RED or from MCA-method)
- Cannot wait for 'THE OPTIMAL' renewable solution and then phase out fossil fuels;
  - "Are not electric vehicles the most efficient …?" "Well, they can be, but …"

Preliminary results – examples from a biogas feedstock study

Key area	Indicator	Ley	Straw	Blue mussels (farmed)	Stickleback fish (case-specific)
Biomethane yield and suitability for anaerobic digestion	Biomethane yield	Satisfactory (Good) ***	Satisfactory (Poor) ***	Satisfactory (Good) ***	Good ***
	Suitability for anaerobic digestion	Good (Satisfactory) ***	Satisfactory ***	Satisfactory **	Good (Satisfactory) ***
Nutrient content and suitability for biofertilizers	Nutrient content	Satisfactory ***	Very poor ***	Poor **	Very Good ***
	Suitability for biofertilizers	Very Good ***	Very Good ***	Poor (Satisfactory) **	Good ***
Accessibility	Geographical and physical accessibility	Good ***	Satisfactory ***	Poor (Satisfactory) **	Satisfactory (Very Poor-Very Good) *
Amount of biomethane	Amount of biomethane	Very Good ***	Very Good ***	Poor *	Good **
Amount and value of biofertilizers	Amount of nutrients	Very good ***	Very good **	Good (Satisfactory, Very good) *	Satisfactory *
Technological feasibility	Technological feasibility	Good ***	Good (Satisfactory) ***	Satisfactory (Poor) **	Satisfactory (Good) ***

Preliminary results – examples from a biogas feedstock study

Key area	Indicator	Ley	Straw	Blue mussel (farming)	Stickleback fish (case-specific)
Profitability	Profitability	Satisfactory (Poor-Good) **	Poor (Satisfactory) **	Poor **	Satisfactory (Poor) **
Control and competition	Control and competing interests	Satisfactory (Poor-Good) **	Good (Satisfactory) **	Good (Satisfactory) **	Poor ***
Institutional support and societal acceptance	Level of support and reasonability	Satisfactory (Poor-Good) ***	Satisfactory (Good) **	Good (Satisfactory) ***	Very Poor ***
	Planning horizon & administrative implications	Good ***	Not Assessed *	Good **	Poor (Very Poor) ***
	Public opinion	Satisfactory **	Satisfactory **	Satisfactory (Poor/Good) **	Satisfactory ***
Environmental and energy performance	Non-renewable energy balance	Satisfactory **	Satisfactory **	Very poor **	Good ***
	Local/regional environmental impact	Good **	Satisfactory **	Good **	Very Good ***
	Indirect land-use change	Satisfactory *	Very Good *	Good **	Very Good **

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