

IEA Bioenergy Task 37 Energy from Biogas

Denmark Country Report

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Biogas Production

Produced raw biogas in Denmark

Source: Energistatistik 2013, quoted by Danish Energy Agency

OBS: Newer Energy Statistics data from 2014 and 2015 are not yet published .

Substrate/Plant type	Number of plants	Production (GWh/year)
Sewage sludge	57	250
Biowaste	-	-
Agriculture	67	861
Industrial	5	51
Landfills	25	56
Total	154	1218

Brutto energy consumption in Denmark = 763 PJ, of which RES represent 26,7%
Biogas provided 1,1% of the actual energy consumption in Denmark (2013) .

Biogas Upgrading

Biogas upgrading plants (fed into grid)	Upgrading capacity in m ³ /h STP	Gas filling stations	Gas driven cars
6	18 Mill Nm3	8	81

- There are economic incentives, thus great interest, during the last two years, for the up-grading/grid injection of the the produced biogas, both at new and at older AD plants. The political interest for using upgraded biogas as vehicle fuel is increasing as well, especially concerning application for public transportation (city buses) and heavy duty vehicles (trucks).
- The first Danish biogas upgrading plant was established in Fredericia, in 2011. Five more biogas upgrading plants were connected in the past two years to the national gas grid, with a total capacity of about 18 million Nm3 upgraded bio-natural gas.
- 10 new biogas-upgrading projects are about to be implemented the next two years. Up to 60 million Nm3 bio-natural gas will end up in the distribution or the transmission network, either by direct connection or by compression. Many other projects are in the design phase.
- There are 7 biogas filling stations in Denmark, and their number is increasing
- **XX** CNG cars are in operation in Denmark.

Biogas upgrading

Source: EnergiNet.Dk



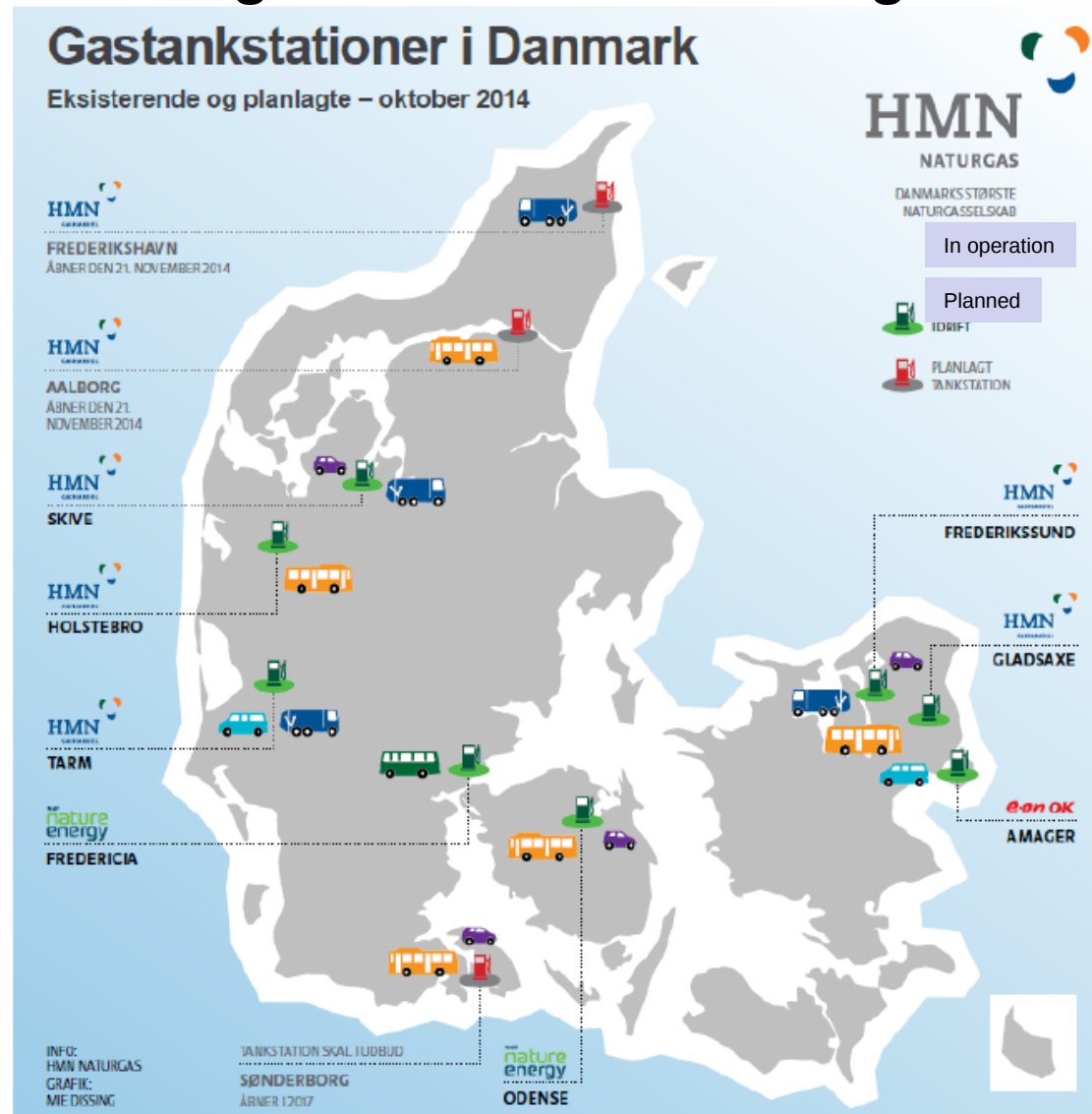
Bio-natural gas plant at Horsens Biogas connected to DONG Energy's gas distribution network in East Jutland. The upgrading facility is the container with the three columns in the centre of the photo. Commissioned in October 2014. Photo: Jørgen Weber.

If the mature and incipient projects will be accomplished:

- **150-180 mill Nm³ (nominal capacity) bio-natural gas will be grid-injected**
- **Equivalent to 5% of the gas, in the Danish gas system, originating from liquid manure, organic wastes and other biomass**

Green plants are existing upgrading plants connected to the gas network. Red shaded plants indicate project maturation of upgrading plants, which may be realised within the next two years. The map is based on information received from network companies. As such, some maturation projects may not be shown on the map, and it is also uncertain whether all projects will be realised.

Filling stations in DK with gas



Existing and planned gas-filling stations. Source: HMN Naturgas

Biogas Trends

Large and X-large scale of the new plants:

- Treatment capacity of 200,000 – 900,000 t biomass /year/plant
- Biogas production of 6 – 64 mill. Nm³ biogas /year/plant

Gas up-grading / grid injection:

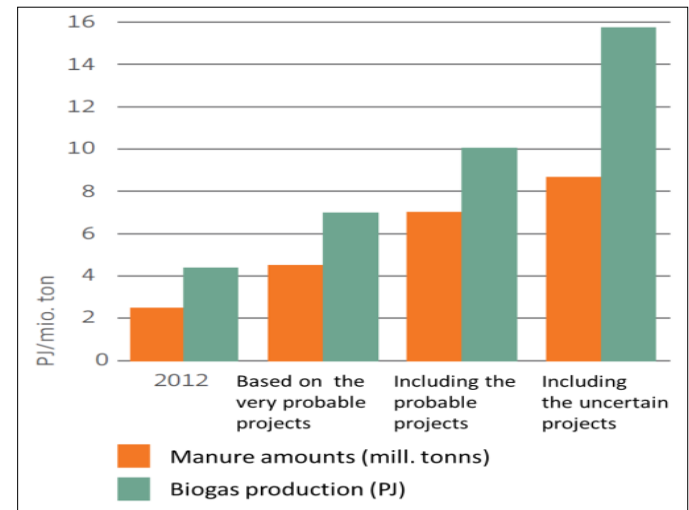
- 75% of the new biogas production upgraded /grid injected
- 20% used for CHP (at the AD plant, or sold)
- 5% used for production process (own process, or sold)
- Many older plants installing gas up-grading

New AD co-substrates

- Deep litter
- Straw

No energy crops

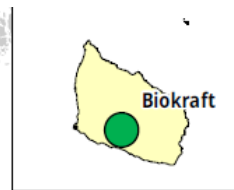
- Max. 27% until 2016
- Max 12% 2016-2020
- Lower after 2020



Projection of manure based biogas deployment, up to 2020.

- The last two years have shown that the increased support, given for the use of biogas for electricity production and for upgrading by the Energy Agreement in November 2013, is working.
- It is expected that the biogas production could be more than doubled during the coming years, if the present development trend continues, from 4.3 PJ, to around 10 PJ.
- It is also estimated that the current framework conditions will not be sufficient for a continuous expansion, and that some of the existing barriers need to be diminished or even removed.

Biogas trends



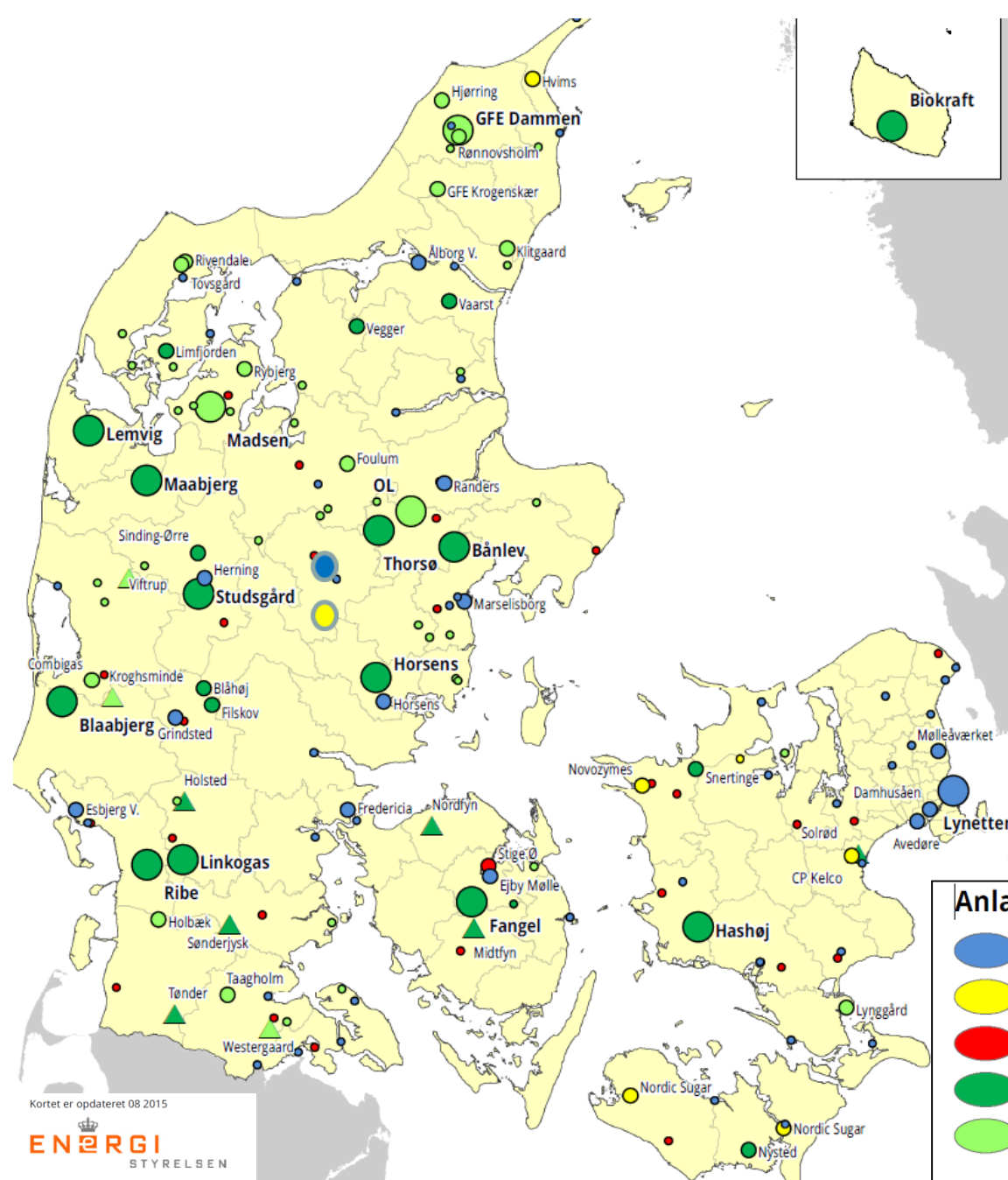
The present situation

Source: Danish Energy Agency, 2015

The Energy Agreement from Nov. 2013 is working!

Many new biogas plants:

- 2014 – 2015: 9 new AD plants established
- Several about to be finalised in 2015-2016
- About 50 other projects in the pipeline



Kortet er opdateret 08 2015

ENERGI
STYRELSEN

Anlægstype

- WWTP
- Industry
- Landfill
- Central biogas plants
- Farm biogas

Anlægsproduktion

(TJ/år)

- 0 - 20 (ikke navngivet i kortet)
- 21 - 100
- 101 - 400
- Under opførsel

Biogas Utilisation

Utilization of biogas in Denmark

Source: Danish Energy Authority (Data from 2013)

NB: The Energy Statistics 2014 – 2015 not published yet.

Utilisation type	GWh	%
Electricity	1400 (2013)	79
Heat	250 (2013)	20
Up-grading	?	
Vehicle fuel	n.d.	n.d.
Flare	-	>1%

Danish Energy Agency /Biogas Task Force estimates that, in the short term (up to 2020) direct use of biogas for CHP and industrial processes will be more advantageous socio-economically. This is mainly due to the cost of upgrading. Establishment of local biogas networks, connecting several biogas plants will facilitate sales to local customers.

In the long term (after 2035), the system advantages of carrying biogas in the natural gas network will be so great that selling to this network will be the best socio-economic solution.

Digestate handling

- Digestate from agricultural plants are used as fertiliser and applied according to the same rules as animal manure and slurries.
- Co-digestion of sewage sludge from WWTP with manure is only limited due to quality restrictions on waste material that can be applied on land.

Financial Support Systems for Biogas

Improved financial support for the biogas sector was adopted and approved by the EC at the end of 2013. The support cannot be overlapped (e.g. cannot be received by the same plant for both investment costs and for operation costs).

The main elements are:

- 0.056 EUR/kWh for biogas used in a CHP unit or injected into the grid (115 DKK/GJ).
- 0.037 EUR/kWh for direct usage for transport or industrial purposes (75 DKK/GJ)

These tariffs include natural gas price compensation of maximum 0.012 EUR/GJ (26 DKK/GJ) and temporary support of 0.005 EUR/GJ (10 DKK/GJ) up to 2016: after this, the support will decrease by 2DKK/year, up to 2019.

It is also possible to apply for investment grants for plants digesting mainly manure. 19 new biogas projects received governmental grants 2013 with a total value of 268 MDKK (36 MEUR).

Support for upgraded biogas supplied to the natural gas network in the calendar year 2013 is 111.6 DKK per GJ. The support is payable to both upgraded biogas supplied to the natural gas grid and to purified biogas entering a town gas grid. This support is provided with effect from 1 December 2013.

In the energy agreement, new support frames for biogas to transport, process and other applications were also proposed.

Support for biogas after 2020:

Some of the surcharges are tapered off, and the support indexed only partially. There is no expiration date on the surcharges in Danish law, but according to the EC, the aid approval is only valid for 10 years. For subsidies for electricity and upgrading until 2023. Thereafter, the aid will be renegotiated to the EC, which could involve changes. The given subsidies for electricity cannot be granted also to the heat generation, accompanying power generation.

National Strategies

The main frame for the actual and future development of biogas in Denmark is the Energy Agreement from 2012.

- **The "Green Growth"** initiative formed the basis for a political agreement made in 2009, which includes the objective that **50% of the livestock manure is to be used for green energy in 2020**. This requires a significant acceleration of the current development in biogas deployment.
- In March 2012, the Danish Government entered into a broad **ENERGY AGREEMENT** for 2012–2020. The agreement includes several elements and calls for a significant enhancement of the share of renewables in the Danish energy supply. **The aim is to have 35% of energy supply renewable by 2020, and to make Denmark fossil fuels free by 2050.**
- **Biogas is a key area** of the agreement. The Danish Energy Authority, in its projection from 2012, predicted that it is possible to have **a 4-fold increase (to 16.8 PJ) of the total biogas production by 2020. The certain growth will be a doubling, to around 10 PJ in 2020.** Danish politicians have indicated that biogas in Denmark should not be developed based on energy crops, and have therefore introduced **limitations for the share of energy crops** used for biogas production. In exchange, there is now **growing interest in co-digesting animal slurry with deep litter and straw** in the production of biogas in Denmark.
- Most of the new biogas will be **up-graded and injected into the natural gas grid.**

Performance and Economic Data

Source. Danish Energy Agency, Biogas Task Force

Performance Data (if available):

- Electrical efficiency : actual data n.a.
- Total energy efficiency: actual data n.a
- Methane emissions: data n.a.

N.B.: A new EUDP project, aiming measurement of methane emissions from AD plants is expected to provide valuable data about this topic.

Economic Data (if available):

- Investment costs
 - AD plant 170-190 EUR / m3 digester
 - Up-grading: actual data n.a.
- Operating Costs

The costs of producing biogas:

- EUR 17.5 - 19.5 per GJ
- EUR 20.7 – 22.3 per GJ in upgraded form.

NB: The Energy Statistics 2014 – 2015 not published yet.

The legislative framework impacting the Danish biogas sector

EU

- Waste Framework Directive
- By-product Regulation
- RES Directive
- EIA Directive
- Habitats Directive
- Nitrate Directive
- Water Framework Directive

Ministry of the Environment

- Planning Act
- EIA Decree
- Habitat Ordinance
- Environmental Protection Law
- Sludge Ordinance
- Waste Ordinance
- Resource Strategy
- Nature Agency biogas mobile team

Climate, Energy and Building Ministry

- The Renewable Energy Law
- Heat supply and project Ordinance
- Electricity Supply
- Natural gas law
- Climate Plan
- Strategic energy planning
- RE in the process

Ministry of Food

- Support /ha agriculture
- Rural development
- Statutory order for fertilizer and plant cover

Economy-94 and Ministry of Internal Affairs

- Local Proxy Rules

Ministry of Taxation

- Tax Laws

Barriers and Challenges for the Biogas Development

Main barriers

- Insufficient financial incentives to establish and operate a biogas plant
- High cost of producing biogas (typically DKK 130-142 per GJ ; DKK 154-166 per GJ in upgraded form)
- The financial situation of biogas plants is still uncertain, despite the current price supplements; some price supplements are to be phased out and will disappear after 2020, if the price of natural gas evolves as expected.
- Difficult for biogas plants to access suitable biomass feedstock (e.g. slaughterhouse waste)
- Difficult process of selling the gas, and obtaining a lucrative price
- No financial incentives for using biogas for process (under approval)
- Biogas subjected to extensive legislation/regulation => planning process difficult

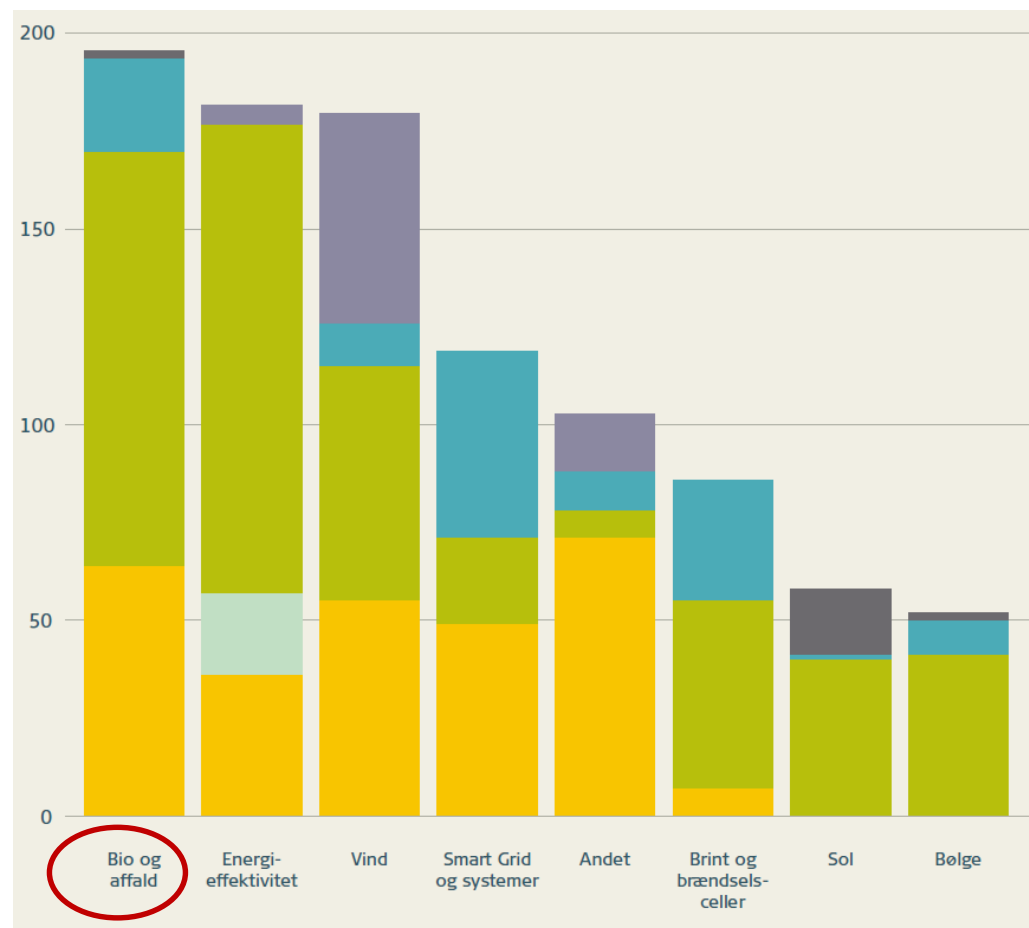
Overall present and future challenges

- Remove financial barriers; Adjust the financial support frames, to better fit present and future biogas deployment objectives
- Find and test new AD co-substrates for animal manure and slurries (e.g. deep litter and straw)
- Integrate the biogas in the national energy supply
- Up-grade the produced biogas and promote sale through the natural gas grid
- Consider direct local sale opportunities as well
- Encourage the use of biogas for transport
- Training, education and information dissemination (plant managers/operators/ farmers/public at large)
- Modernise the national biogas association; create local platforms for project generation.
- Enhance commitment/involvement of policy/decision makers
- Encourage the establishment of local biogas infrastructures
- Simplify project approval procedure

Biogas Research

Actual topics:

- Deep litter and straw as co-substrates for AD of animal slurries. Focus is on economic aspects and pre-treatment as well as AD process optimisation
- GHG emissions from biogas production
- Biogas up-grading /CO₂ removal by new enzymatic process (Demonstration of new technology for biogas upgrading)
- Wind powered electrolytic process , for production of biomethane from hydrogen and CO₂ (Power-to-Gas - BioCat)
- Biogas from enzymatic decomposition of unsorted household wastes (Renescence process)



Public support for energy technology research in 2013 (mill.DKK)

