

# MAABJERG BIOGAS PLANT

## OPERATION OF A VERY LARGE SCALE BIOGAS PLANT IN DENMARK

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### MISSION AND VISION

The Maabjerg BioEnergy biogas plant, one of world’s largest, was designed primarily to treat animal slurries and eventually to form part of a biorefinery concept ([www.maabjergenergyconcept.eu](http://www.maabjergenergyconcept.eu)). The biogas plant itself was taken into operation in January 2012 and is operating at full capacity.

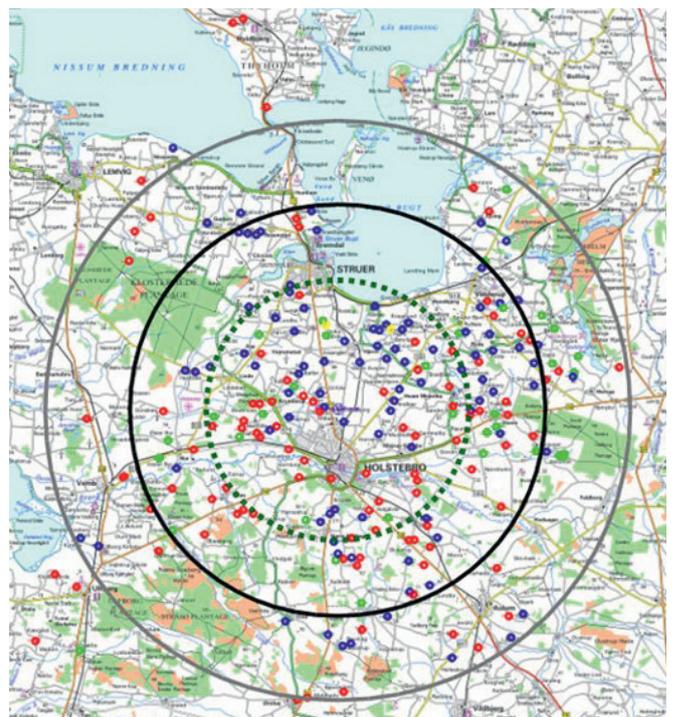
The biogas plant was born as an environmental project aiming to reduce runoff of nutrients into groundwater, rivers and bays, while contributing to develop the local farming economy and preserving employment. The aim was furthermore to support environmentally friendly energy production by exploiting biomass resources for the benefit of the local community. Farmers, represented by the Holstebro-Struer Farmers Association and the Holstebro Fur Breeders Association, in collaboration with the neighbouring utility companies Vestforsyning and Struer Forsyning, joined forces to establish Maabjerg BioEnergy. Maabjerg BioEnergy which is a key part of the future concept of creating a biorefinery centered around production of 2<sup>nd</sup> generation bioethanol from straw.



**Figure 1:** General view of Maabjerg BioEnergy Plant, (Photo: Maabjerg BioEnergy)

### INPUT AND OUTPUT

Maabjerg BioEnergy is a plant of unprecedented scale that processes up to 800,000 tons of biomass yearly, of which about 500,000 tons are liquid and solid manure, supplied by the local farming community as shown by Figure 2. Along with manure, the plant co-digests wastewater sludge, dairy waste and food waste, producing 18 million Nm<sup>3</sup> biogas for use in district heating and electricity generation, as well as digestate for use as fertilizer and fibres, as shown in Table 1 and Table 2.



**Figure 2:** The area of animal slurry collection around the biogas plant, with the average radius of 20 km. Source: Maabjerg BioEnergy

## BIOGAS IN SOCIETY

A Case Story from IEA BIOENERGY TASK 37 “Energy from Biogas”

**Table 1: INPUT**

<b>Green line</b>	<b>tons/year</b>
Animal slurry	460.000
Animal manure	20.000
Dairy waste	120.000
Potato pulp	15.000
Yeast cream	15.000
Abattoir waste	10.000
<b>Total green line</b>	<b>640.000</b>
<b>Industry line</b>	<b>tons/year</b>
Wastewater sludge	75.000
Flotation sludge	10.000
<b>Total industry line</b>	<b>85.000</b>
<b>Total input</b>	<b>725.000</b>

**Table 2: OUTPUT**

<b>Green line</b>	<b>tons/year</b>
Liquid fertilizer (digestate)	550.000
Fertilizer fibres	40.000
<b>Industry line</b>	<b>tons/year</b>
Sludge (30 % TS)	10.000
<b>Biogas utilisation</b>	<b>m<sup>3</sup>/year</b>
Vinderup Varmeværk (District heating)	7.500.000
Måbjergværket (District heating)	3.500.000
Maabjerg BioEnergy	7.000.000
<b>Total industry line</b>	<b>85.000</b>
<b>Biogas total</b>	<b>18.000.000</b>

Source: Maabjerg BioEnergy

As the Green Line mainly processes animal waste and the Industrial Line processes sewage from households, these two lines are operated separately. This means that it is possible to use digestate from the green line as crop fertilizer without any problems. The digestate from the industrial line is not spread on the soil for crop production, but separated into fibers and liquid. The liquid is returned at the waste water treatment plant and the fibre fraction is sold to a company which either incinerates it for energy generation, or applies the fibres as soil conditioner in forest areas.

### COMBINED ROAD TRANSPORT AND DOUBLE PIPELINE FOR BIOMASS HANDLING

Transport of the large amounts of manure yearly is a major challenge for Maabjerg BioEnergy. Calculations show that if transport is carried out entirely by road, there will be a need for 50 – 70 deliveries each day to the plant. For this reason, Maabjerg BioEnergy chose a combination of road transport and a piping system. The piping system branches out from the plant and has a number of collection tanks (nodes) where the farmers can deliver their slurry. From the nodes, the collected slurry is pumped to the biogas plant. The pipeline system consists of double pipes, one used to

transfer the raw slurry to the biogas plant and the second one for sanitized digestate, which is transferred to digestate tanks located at the nodes. This means that the farmers deliver the slurry and pick up the digestate at the same location. The double pipeline system connects the biogas plant with the farmer’s community to the west, and another one with Arla Foods, in Holsterbro. Maabjerg BioEnergy and Holstebro Central Waste Water Treatment Plant are connected to a transfer station located 16 km east of the city. An additional transfer station, south of the city, is planned, but not yet built.

Currently (June 2014), the agricultural sector receives annually 550,000 m<sup>3</sup> of digestate, as environmentally friendly fertilizer from the green line, and the wastewater treatment plant receives in return about 80,000 m<sup>3</sup> digested material from the industry line. Furthermore, Maabjerg BioEnergy sells annually some 40,000 tons of fibre from animal slurry, to be burned for heat production, at the Måbjergværket (Central heating plant) or to be used for fertilizer, with a rich content of carbon and phosphorus. In addition, DDH (Hedeselskabet) receives 8,200 tons of fibre from the sludge line.

### REDUCING ODOUR EMISSION

Another important challenge for the biogas plant is odour control during biomass transport and handling. To deal with this, a comprehensive strategy was developed and implemented. The biogas plant is equipped to receive liquid and solid products from all types of vehicles in closed halls. The polluted air from the plant passes through an odour removal system. The slurry pipeline prevents not only odour nuisance, but also the inconvenience of extensive heavy truck traffic on the roads leading to the plant. In addition, digestion of slurry substantially reduces the odour associated with raw slurry. Consequently, utilisation of digested slurry as fertilizer leads to a significant reduction of odour after spreading on fields compared to utilization of raw slurry.

### ENVIRONMENTALLY FRIENDLY ENERGY PRODUCTION

Slurry from a large number of farms and a variety of suitable wastes are co-digested to produce biogas for heat and power generation (Table 3). Maabjerg BioEnergy is able to cover the demand for district heating in 5000 homes and power consumption of 12,000 homes.

**Table 3: NET ENERGY IN MWh (megawatt-hours)**

	Heat	Electricity	Total
<b>Biogas</b>	58.200	49.100	107.300
<b>Fibre</b>	15.100	6.900	22.000
<b>Total</b>	73.300	56.000	

Source: Maabjerg BioEnergy

Biogas production displaces 50,000 tons of CO<sub>2</sub> from energy production and through reduced greenhouse gas emissions directly on farms in the form of reduced emissions of methane, as shown in Table 4. It is estimated that emissions associated with leakage of N and P are reduced by approximately 300 tons a year (Table 5) when digestate is applied as fertilizer instead of raw slurry. This value may vary depending on which feedstock materials are co-digested with animal slurries.

**Table 4: Annual CO<sub>2</sub> savings (tons)**

Energy conversion	21.600
Agriculture	31.500
<b>Total</b>	<b>53.100</b>

**Table 5: Overview of investment costs and socio-economic benefits**

<b>Investment costs (million DKK)</b>	
Biogas plant	329
Pipelines, logistics	65
Miscellaneous	43
Total	437
EU financial aid	25
<b>Net investment</b>	<b>412</b>

**Estimated climate, environmental and socio-economic benefits:**

Reduced CO <sub>2</sub> emissions	50.000 tons CO <sub>2</sub> /year
Reduced N and P leakage	about 300 tons/year
Jobs protected (agriculture and food industry)	300
Socio-economic value	1 billion DKK over 20 years

Source: Maabjerg BioEnergy

**ECONOMIC AND SOCIO-ECONOMIC ASPECTS**

Maabjerg BioEnergy is designed predominantly as a heat supply project, with "break-even" finances, which means that any surplus or deficit is adjusted based on the price of heating. All financial agreements in the project are based on the "substitution principle", with a discount of 10%. This also applies to heat consumers. The investment costs of the biogas plant were financed with a long term, very low interest loan guaranteed by Holstebro Municipality. From a socio-economic perspective there are three major benefits of the project. First, agricultural production levels are maintained. Second, imported energy costs are saved and generated electricity can be exported to the grid. The total socio-economic benefit is calculated to be 1 billion DKK over the next 20 years. Finally, a positive public image of the area is achieved and there is an opportunity to market the green-tech know-how. Maabjerg BioEnergy received 5000 international visitors in 2012.

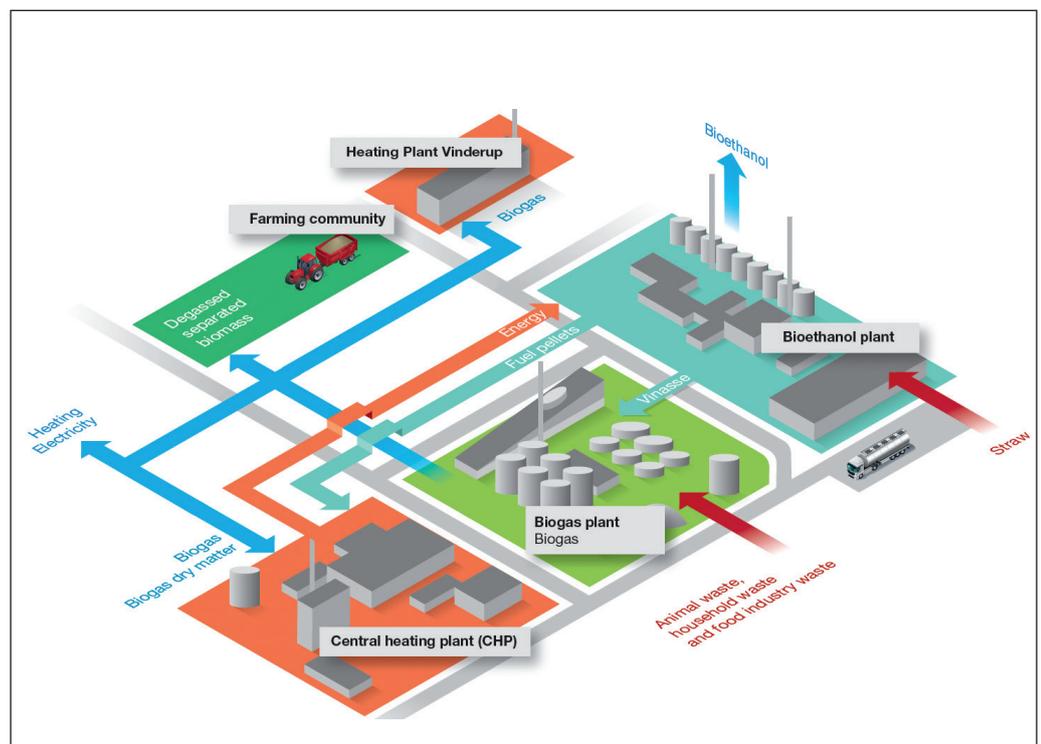
**PLANS FOR THE FUTURE**

The "Maabjerg Energy Concept" (Figure 3) was launched in August 2011 and plans to begin construction of the largest 2nd generation (2G) bioethanol plant in Northern Europe in 2015 with production starting in 2017. Sugary residue from the production of 80 million litres of 2G bioethanol will be used to boost biogas production from 18 million to approximately 50 million cubic meters of biogas. Behind the "Maabjerg Energy Concept" is a group of local utilities, the Danish state-owned DONG Energy and the Danish enzyme producer Novozymes. For more information, please see: [www.maabjergenergyconcept.eu](http://www.maabjergenergyconcept.eu)

**EMPLOYMENT BENEFIT**

The Maabjerg BioEnergy project employs 28 people to run the plant and to drive delivery trucks; this includes the night and weekend shifts. Furthermore, the plant has a positive effect on job preservation in the agriculture and food industries sectors. Without Maabjerg BioEnergy, 300 jobs would have been lost due to strict environmental protection laws.

**Figure 3:** Schematic representation of the Maabjerg Energy Concept, with the biogas plant as an integrated part. Source: Maabjerg BioEnergy



## CONTACTS

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The biogas plant welcomes thousands of visitors each year. For more information about the plant and for booking free visit tours, please contact:

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