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Maabjerg BioEnergy – a biogas project with numerous advantages



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The county of Ringkøbing in the North of Jutland is one of Denmark's most important agricultural areas. Indeed, farming and food production in the county accounts for an annual turnover of 550 million Euro and employment of 11,400 people.

Figure 1. The area where the project Maabjerg BioEnergy is taking place.



Unfortunately, from the same area water is discharged directly into a number of large wetlands consisting of sandy and highly permeable soil, which the EU has designated habitat areas. Altogether this causes a problem with surplus nutrients (phosphorous and nitrogen, in particular) which get washed out to creeks and the underground water. Particularly in order to adhere to recent legislation concerning utilisation of nitrogen, it is necessary for the farmers to increase the availability and exploitation of the nitrogen.

The establishment of the Maabjerg BioEnergy plant offers a solution to this problem, since manure from the participating farms is separated into two parts:

- A wet fraction, which is returned to the farmers, with a high content of easily accessible nitrogen (75% of total) and a low content of phosphorus (25% of total).
- A dry fraction, with a high content of phosphorus and a low content of nitrogen. This fraction can be exported from the area or used as bio fuel.

Maabjerg BioEnergy Ltd. is owned by five entities:

- Holstebro Struer Farmers' Association
- Holstebro Fur Farmers' Association
- Vestforsyning, a municipality-owned company supplying electricity, heat and water and treating waste water
- Elsam, one of Denmark's main producers of electricity and heat and owner of the local CHP plant of Holstebro, Maabjergværket
- Nomi, a local waste company

With the EU Water Framework Directive adopted in October 2000, the European member countries have obliged themselves to ensure "good status" for all waters, surface waters and ground water by 2015. According to the directive this means that the environmental condition in the waters deviates only slightly from the uninfluenced state of reference.

The local issue of preventing water pollution in the town Holstebro may thus be similar to problems in many areas in the rest of the EU.

Further benefits of biogas plants for the society include:

- Cheap greenhouse gas reduction (0 to 6 Euro/tons CO₂)
- Utilisation of organic waste from industries and waste water
- Efficient redistribution of nutrients
- Organic fertiliser free of pathogens and weed seeds and with declared nutrient content
- Smell from slurry reduced as the slurry is turned into a thinner liquid, which disperses quicker into soil

Biomass resources

Maabjerg BioEnergy will utilise a wide variety of biomass sources in the biogas plant:

- Manure from pigs, cattle, mink and poultry (85% of the amount of biomass)
- Industrial waste from dairies and slaughter houses (9%)
- Waste water (4%)
- Energy crops (2%)

The area's livestock farmers represent a combined total of 27,000 so-called animal units, corresponding to 800,000 pigs. In total, around 450,000 tons of biomass will be digested at the biogas plant.

Digested slurry

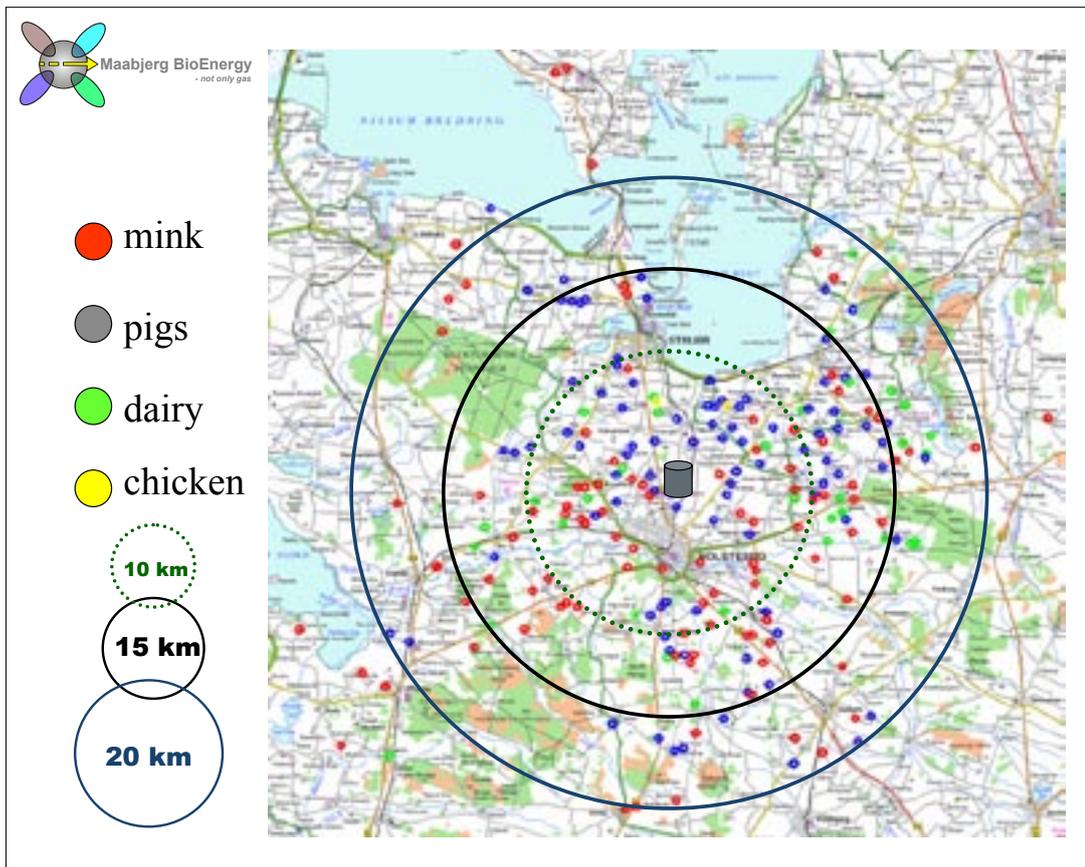
The digested slurry will, as mentioned, be separated into two fractions; a wet fraction consisting of around 390,000 t/year and a dry fraction consisting of around 60,000 t/year (30% dry matter).

The farms connected to the biogas plant are placed with an average distance of approximately 15 km. Analysis has shown that a combination of transport of slurry in trucks and in pipes is the cheapest solution. On the way to the biogas plant, the manure is collected in tanks at pumping stations and is pumped from here to the biogas plant. On the way back the digested wet fraction is redistributed and pumped back to where it is most needed. The final pipeline system may entail over 200 km double pipelines.

Apart from being a more economical solution than a transport solution based on trucks alone, the combined transport by truck and pipelines has the advantage of minimising the transport on roads, thereby minimising the environmental problems from road transport (noise, emissions to the air, traffic accidents, odour etc).

The dry fraction may be exported or used as bio fuel. Burning the dry fraction in the nearby CHP plant will be the most economical solution, assuming no taxes must be paid. This is due to the fact that the nutrient value of the dry fraction is low compared to the costs of transport.

Figure 2. Main reasons for selecting the area for the project are: high density of pigs, mink and cattle; increasing restriction on emissions of phosphorous and nitrogen; threatened business interests if no action is taken; and strong political support.



Biogas production

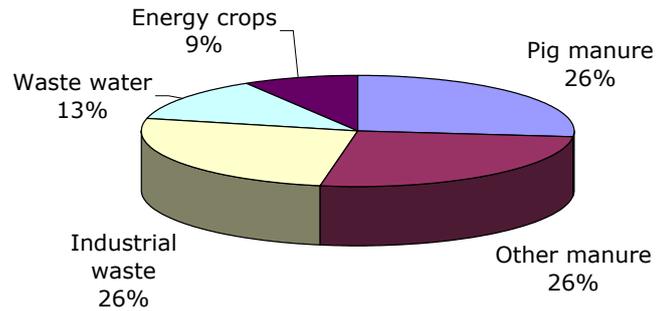


Figure 3. Biogas production from the Maabjerg BioEnergy plant. More than 50% of the biogas produced will originate from manure. Around 26% will originate from industrial waste, primarily from slaughterhouses and dairies.

tation. When burned, the phosphorus remains in the ashes, while the nitrogen is released. The ashes will be used by a company producing fertilizers. In this way the phosphorus will be used where needed, as opposed to posing a threat for the water environment.

Biogas

The total biogas yield from the biogas plant is expected to be around 16 mio m³, equivalent of approximately 100 GWh. Although industrial waste only accounts for 9% of the biomass used in the biogas plant, it contributes with 26% of the biogas

produced. Figure 1 illustrates how the various biomass fractions contribute to the biogas yield.

Maabjergværket

Maabjergværket is the local CHP plant of Holstebro. The plant has a capacity of 28 MW electricity and 68 MJ/s heat. The energy at the plant is currently produced from:

- Municipal waste (1,760 TJ or 63%),
- Straw (427 TJ or 15%)
- Wood chips (344 TJ or 12%)
- Other bio fuels, i.e. wood pellets 66TJ (3%)
- Natural gas 206 TJ (7%)

There are two boilers for the burning of waste and one for the burning of biomass. The natural gas is used at the over-heaters of the boilers.

Placing the biogas plant next to the local CHP plant makes it possible to exploit a number of synergies. One advantage is that it will be possible to sell the dry fraction as biofuel (approximately 187 TJ) to the CHP plant with minimal transport costs. The dry fraction is planned to replace imported wood chips in the existing biomass boiler.

Another advantage is the possibility to sell biogas to the CHP plant. The biogas will replace natural gas at the CHP plant. The biogas sold to the CHP plant will amount to approx. 137 TJ. The remaining biogas will

be used in three gas engines of 5.7 MW at the biogas plant, producing electricity to the grid and heat to the biogas plant and also to the district heating network.

Benefits to the society

The Maabjerg BioEnergy plant will provide environmental benefits and benefits related to employment in the area around Maabjerg. Farming and food production related to the farms connected to the Maabjerg BioEnergy plant accounts for an annual turnover of 42 million Euros corresponding to an employment of 863 man-years.

Increasing environmental demands from the side of the authorities will make it necessary to reduce production at the farms in the area, unless action is taken. As the area in question is a remote, rural area with few job alternatives, the loss of jobs is a high concern. Table 1 illustrates the alternatives.

With future environmental demands it will be necessary to reduce the number of animals at the farms, thereby reducing the annual turnover with 17.5 million Euros and the employment with 364 man-years - equivalent to an employment reduction of 42%.

With the Maabjerg BioEnergy plant it may be possible to increase the production leading to an increase in the annual turnover of 6.7 million euro and an increase in employment of 129 man-years - equivalent to an employment increase of 15%. Another option is to further reduce the emissions of phosphor and nitrogen to the water environment and keep the animal production constant. The establishment of the Maabjerg BioEnergy plant will furthermore result in substantial benefits for the environment as illustrated in table 2.

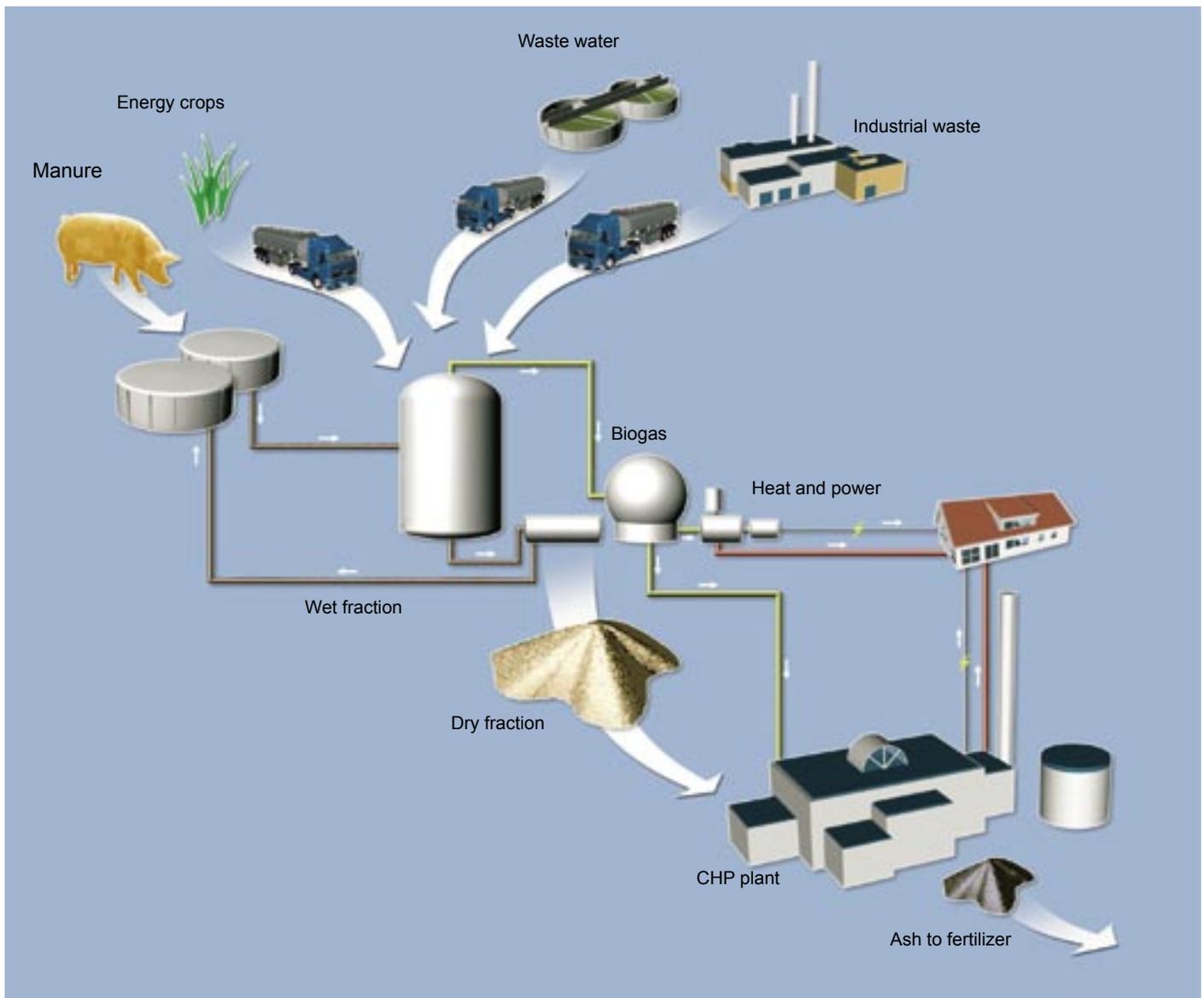
As can be seen, the future situation with environmental demands in effect

will moderately improve the environmental conditions regarding emissions of nitrogen and phosphorus to air and ground water, whereas the situation will be significantly improved if the Maabjerg BioEnergy plant is installed. The Maabjerg BioEnergy plant will furthermore result in a reduced emission of 57,000 tons of CO₂ equivalents per year. The reduced emissions of CO₂ after replacement of natural gas with biogas at the CHP plant will be of benefit to the CHP plant, which has recently been granted a limited quota of CO₂ allowed to be emitted by the plant.

Status

To make it economically feasible to build and operate the Maabjerg BioEnergy plant, it will be necessary to avoid taxes related to burning of waste. Furthermore, to maintain or even increase production at the farms it will be necessary for the farmers to be credited with the amount of ni-

Figure 4. Maabjerg BioEnergy biogas plant. The plant receives biomass from different sources, which is transported both by truck and by pipelines. Output from the plant consists of the wet and the dry fraction of the fermented slurry, biogas as well as heat and electricity. (Illustration by Mikkel Jensen, Penalthuset).



trogen that will be burnt and emitted to the air rather than returned to the farms as a nutrient.

In June 2005, the Danish Government decided to promote the use of fibre

fraction for energy production. This decision was based on detailed analyses and assessments of the environmental and socio-economic perspectives for implementation of environmentally friendly projects, like the Maabjerg

BioEnergy Project. The detailed changes of environmental legislation, tax exemption rules etc. will be prepared in the autumn of 2005.

Maabjerg BioEnergy is part of a large integrated EU Concerto project called ECOSTILER, which will receive funding from the 6th framework programme of the EC. Maabjerg BioEnergy is expected to receive 4.2 million Euro of the total 10.2 million Euros. The project consortium consists of three main projects: Maabjerg BioEnergy in Denmark, one project in the Netherlands and another in the UK. In total, 14 partners and 5 observer communities are involved in the project. The consortium is currently about to sign the final contract with the EU after having completed the negotiations.

	Animal units	Reduced turnover (Mil. Euro)	Employment (Man-years)
Present situation	25,000	0	863
Future situation with environmental demands	15,000	17.5	499
Situation with the Maabjerg BioEnergy plant	29,000	-6.7	992

Table 1. Benefits for society.

Emissions (Tons/year)	Surplus nitrogen	Surplus phosphorus	Emission of nitrogen to air	Reduced emission of CO ₂ to air
Present situation	1,460	400	290	0
Future situation with environmental demands	1,300	90	180	0
Situation with the Maabjerg Bio-Energy plant	1,020	-100*	90	57,000**

Table 2. Environmental benefits of the BioEnergy plant.

* The deficit of phosphorus of 100 tons/year is no problem to the farmers, as currently a large surplus of phosphorus is stored in the soil as a result of years of over-fertilization.

** The dry fraction will replace woodchips at the CHP plant. It is assumed that the woodchips will replace natural gas another place in the Danish energy system.

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