IEA Bioenergy Task 37

BIOGAS IN SOCIETY
A Success Story from
IEA BIOENERGY TASK 37
"Energy from Biogas"

LEMVIG BIOGAS

AN EXAMPLE OF SUCCESSFUL CENTRALIZED CO-DIGESTION IN DENMARK

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MISSION AND VISION

Since 1992, Lemvig Biogas (Fig.1) has been the largest thermophilic biogas plant in Denmark, established with the main aim of producing renewable and CO2-neutral biogas (Table 1). Other aims were to convert suitable organic wastes into useful and safe products, including improvement of fertilizer quality of animal manure and slurries, and protection of the aquatic environment. Lemvig Biogas is owned by 69 local farmers in a 100% privately owned cooperative. The biogas plant was built as a "turn-key" plant by the Burmeister & Wain Scandinavian Contractor A/S Company.

Figure 1: General view of Lemvig Biogas Plant (Photo: Lemvig Biogas)

Table 1: KEY FIGURES

Animal manure	500 tons /day
Organic wastes	120 tons/day
Biogas production	10.2 mill.Nm³/year (2012)
Digester capacity	14300 m³
Process temperature	52.5 °C
Sanitation	MGRT 4 hours at 52.5°C
Utilization of biogas	836 kW-el biogas engine
	1560 kW-el biogas engine
Transport vehicle	3x33 m³ tankers
Investment costs	55.2 mill. DKK KK
Government grants	14.2 mill. DKK
Contractor	BWSC
Operation start-up	1992

Slurry from 75 farms and a variety of suitable wastes are co-digested to produce biogas for heat and power generation. The plant is equipped to receive liquid and solid products delivered by all types of vehicles, such as truck-trailers (both rear and side tipping), articulated tip trailers, tankers and slurry trucks, as well as liquid and solid products from ships in batches of 200 to 10,000 tons, at either Lemvig harbour (maximum draught 4 m) or Thyborøn harbour (max. draught 8.5 m).

Lemvig Biogas Plant is approved by the Danish Veterinary and Food Administration, in accordance with the EU regulations in the area. The plant has environmental authorization to process waste including animal by-products (untreated category III), as the biogas plant has its own shredding and pasteurization facility. The biogas plant can provide complete documentation, in line with the existing legislation, concerning application of digestate to agricultural soil. In this way it is avoided any excess application of nutrients with associated environmental impacts such as eutrophication of watercourses. Documentation and statements hereabout are sent to customers on a monthly basis.
The plant co-digests cattle and pig manure and slurries with various biowastes including:

- Fish waste
- Source-separated organic household waste
- Slaughterhouse waste
- Feed waste/residues
- Soft drinks, beer, alcohol
- Pharmaceutical waste products
- Compromised food (biological or chemical)
- All organic matter with a high content of fat, protein or sugar

TECHNICAL SPECIFICATIONS

The plant processes yearly about 226,000 tons of biomass, consisting of 183,000 tons of annual manure and slurries and 43,000 tons suitable industrial waste (maximum 25 % of the total feedstock mixture). The process steps in the plant are shown in Fig.2. Sixty two (62) livestock farms (cattle, pig, poultry and mink) deliver their slurry to be co-digested at 52.5°C with intestinal content and flotation sludge from abattoirs, digestible fatty organic wastes from food and fish processing and from medicinal industries. A minimum guaranteed retention time of 4 hours at 52.5°C ensures efficient sanitation of the digested biomass.

UTILIZATION OF BIOGAS

The produced biogas it converted into electricity and heat by the CHP-unit of the biogas plant. A Jenbacher 316 gas-engine (El-effect: 836 kW, heat effect: 968 kW, El η_{hn} 39,9%, heat η_{hn} 44,4%) runs 100% on raw biogas. In 2013, an additional new Caterpillar biogas-engine (1560 kW-el) was installed. More than 21 million kWh of electricity is generated every year and sold to the local grid. The surplus heat from the gas engine cooling system exceeds 18 million kWh per year and is sold for distributed to more than 1000 households in the area.

UTILISATION OF DIGESTATE AS FERTILISER BRINGS BENEFITS TO FARMERS

The farmers around Lemvig Biogas are interested to use digestate as fertiliser, due to positive experiences and demonstrated farming benefits. Thermophilic digestion provides sanitation of the feedstock mixture equivalent to pasteurization, whereby infectious species like bacteria, viruses and intestinal worms are killed or inactivated. This means less transmission of livestock diseases and thus lower expenditure on medication of farm animals. Weed and plant seeds are also inactivated by the biogas process, so the farmers have less need for weed control and use less chemicals on the crops. The smell of digestate is considerably less than the smell of raw slurries. This considerably reduces odour from digestate application compared with raw slurry; it also contributes to good relations with the neighbours and positive perception of farming activities. Digestate has better balanced nitrogen-phosphorus content and is more homogenous compared with raw slurries. It is easier to stir and spread or inject directly into the soil. The nutrients have higher availability for the crops, resulting in higher up-take rates compared with raw slurries. The transport of raw slurry from the farms to the biogas plant and of digestate from the biogas plant to the farmers' storage tanks in the fields is carried out at the expenses of the biogas plant. This results in lower transportation costs for the farmers. The quality of the slurry and of the digested biomass is analyzed in the laboratory, at the biogas plant (Fig. 3).

Figure 2: The flow diagram of the plant (Adapted after Lemvig Biogas)

Figure 3: The laboratory (Photo: Lemvig Biogas)

DIGESTATE BANK

Lemvig Biogas has established a so called "digestate bank", helping the redistribution of manure and nutrients in the agricultural area. The slurry suppliers receive back only the amount of digestate they are allowed to spread on their fields (Fig.5), in accordance with the "harmony rules". The remaining digestate is separated and the fractions are sold to crop farmers as an alternative to chemical fertilisers. The fiber fraction, with high phosphorus content is exported to areas outside Lemvig. The buyers of the liquid fraction, high in nitrogen, sign a contract with Lemvig biogas and agree to comply with the legal requirements of maximum load of nitrogen per hectare corresponding to 1.4 LU (Livestock Units) and to have a nutrient utilization efficiency of 87.5 percent.

Figure 4: Digestate containers (Photo: Lemvig Biogas)

Table 2: SALE PRICE FOR BIOGAS
(DKK/m³ biogas with 65% CH_4) Source: Danish biogas Association.

Year	2006	2008	2009	2010	2011
Price	1. 97	2.12	2.21	2.36	2.24

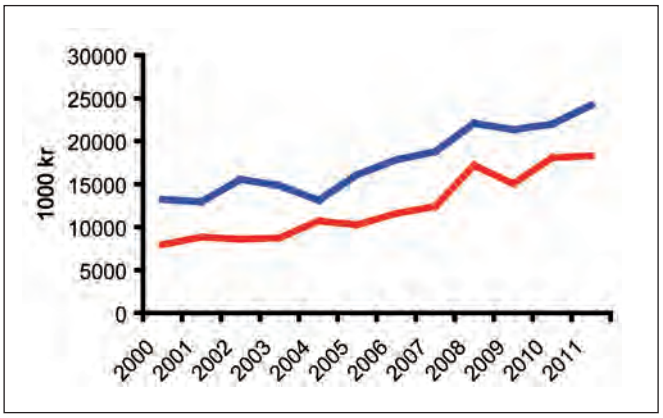

Figure 5: Lemvig Biogas: Total turnover [-] and expenditure [-].
Source: Danish Biogas Association, 2013.

ECONOMIC PERFORMANCE

Lemvig Biogas has a good and stable economic performance comfortably better than break even (Table 2 & Fig. 5). It is considered a reference biogas installation, receiving many visitors weekly from Denmark and from abroad (e.g. Fig. 6).

PLANS FOR THE FUTURE

Since start-up, several reinvestments have improved both the technical and the logistic elements of the biogas plant. In 2008, the digester capacity was doubled, so Lemvig Biogas is more than ever geared to the future.
A local biogas distribution company was recently established to handle increasing output and sale of biogas. This company receives biogas from Lemvig Biogas and for distribution uses a new biogas pipeline to Klinkby.

Figure 6: The visit of HRH Prince Henrik (left), here receiving explanations from the director of Lemvig Biogas, Lars Albæk Kristensen (right). (Photo: Lemvig Biogas)

Synergic combination of large scale centralized co-digestion and organic co-digestion

Organic farmers in the area want their deep litter treated in biogas plants. For this reason, Lemvig Biogas has plans to extend its activity in close synergy with Lemvig Organic Biogas. The organic plant is planned to be built in the immediate vicinity of the existing plant, as shown in Fig. 7. Synergy is expected to occur from the collaboration between the conventional and the organic biogas plants. As examples, the organic biogas plant will use the gas processing and gas storage systems and the same biogas pipeline as the existing plant. The heat supply system for process heat of the existing plant will also supply excess heat to the organic plant. The biogas produced from the two plants will be mixed and delivered to Klinkby and Nissum CHP, both ready to buy the extra biogas.

The control system of the conventional plant, including veterinary control and laboratory facilities, will be adapted to also serve the organic plant. There will be common administration, without a significant increase of time consumption. The existing transport vehicles will serve the two plants, and an extra truck driver will be hired at the organic biogas plant. The concept is in an advanced phase of planning.

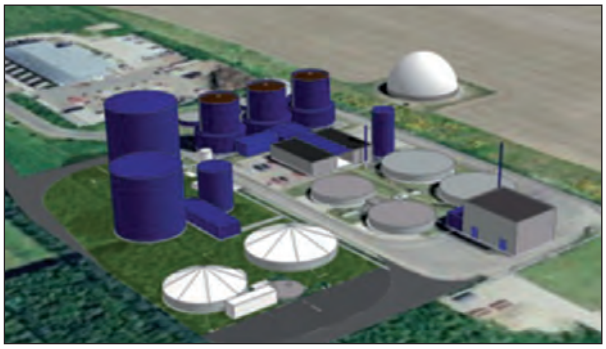

Figure 7: The planned organic biogas plant (at the left)
(Photo: Lemvig Biogas)

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