BIOGAS IN SOCIETY
A Case Story

# ORGANIC BIOGAS IMPROVES NUTRIENT SUPPLY

## KROGHSMINDE BIOENERGY I/S, DENMARK

IEA Bioenergy Task 37

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## ORGANIC BIOGAS IN DENMARK

Organic biogas plants have been under consideration in Denmark for the past 15 years without a real breakthrough, until recently. The first plant was established in 2009 at Bording in West Jutland. This first facility encountering many technical challenges in processing high dry matter content feedstock. In 2015, a further two new organic biogas plants (Kroghsminde Bioenergy I/S and Hans Martin Westergaard Biogas Plant) began operation. These facilities applied an adapted German technology for the treatment of high dry matter biomass; in this case deep litter and grass silage co-digested with animal slurry. Both facilities have shown stable operation. In 2017, a large organic biogas plant treating feedstock from 40 suppliers was brought into operation by Nature Energy Månsson in Brande. In addition to these four facilities several projects are under development, both on farm and at joint co-digestion plants, as organic biogas lines.

## MISSION AND VISION

This organic biogas facility was established at Kroghsminde organic dairy farm in Ølgod. The ovner, Jens Krogh, is a seventh generation farmer (figure 1). The farm produces organic milk from 140 cows, corn and other crops on a 450 hectare farm. All the animals are housed on deep bedding, which, when subsequently digested, is converted into a liquid fertilizer, more amenable for nutrient uptake by crops and easier to apply by the farmer. The produced biogas offers the opportunity to expand the activities and sources of revenue for the farmer and enhances the economic stability of the farm.

As an organic farmer, Jens Krogh wishes to contribute to the national energy strategy of phasing out fossil fuels and reducing the overall greenhouse gas (GHG) emissions from agriculture. Because of the biogas plant, the $CO_2$ emissions of the milk production are assessed as negative, at -0.82 kg $CO_2$/l produced milk. An investment grant from the Ministry of Food, Agriculture and Fisheries in 2012, provided favorable economic conditions to allow investments in organic biogas.

## OPERATION OF THE FACILITY

The feedstock for the digester originates on the farm, which produces large amounts of deep bedding, but also includes for feedstock which is imported from three other organic milk farms and an organic egg farm in the locality. The biofertilizer is sent back to the organic farms in a circular economy system. The digestate/biofertilizer is transported twice a week, according to a specific delivery plan. Biomass transport is expensive, so all the biomass suppliers must be located close to the plant.

The required plant operations are computerized. The daily routine of the facility personnel includes for 20 minutes dedicated to feeding and 30 minutes to supervision of biological stability (temperature, pH) and mechanical operation (pumps and sensors). Other tasks include lubrication (10 minutes per week), oil change (30 minutes every six weeks) and motor inspection every six months.

## BENEFITS OF THE FACILITY

The benefits of the organic biogas facility (Figure 2) include:

- Improved nutrient supply on the farm.
- Higher and constant crop yields. Crop yields are higher, the yields are more stable and the crops are of better quality. Nitrogen is a limiting yield factor on many types of organic farming. The yields of crops have been found to increase 20-30% due to fertilizing with biofertilizer as compared to the undigested dung.
- Creation of new jobs and supplementary income for farmers

**Figure 1:** Farmer Jens Krogh explains the benefits of his organic farm and organic biogas facility

- Contribution to improved climate performance through reduction in GHG emissions and less nitrogen loss to the environment.
- Less dependence on conventional livestock manure through nutrient supply based on recycling of own residual biomass.

## TECHNICAL DATA

The investment cost of the biogas facility was €1.6 million. The facility was supplied by JH-Bioenergy and started operation in 2015. The primary digester has a capacity of 1,200 $m^3$; the post digester has a capacity of 1,880 $m^3$. The facility is thermophilic and operates at 52°C. The biogas is converted to electricity in a 340 kW gas engine producing 3 GWh of electrical energy each year. Transport costs between €2 and €2.6 per $m^3$ of biomass. The biomas feedstock is of the order of 69 t/day, broken down in terms of daily production as in Table 1.

**Table 1: Inputs to the organic biogas facility at Kroghsminde Bioenergy I/S, Denmark**

| Daily Feedstock expressed in t/d | |
|---|---|
| Organic grass silage | 5t/d |
| Corn | 4t/d |
| Organic poultry manure | 1t/d |
| Horse manure | 1t/d |
| Organic silage (horse bean, lupine, barley / ryegrass) | 2t/d |
| Organic deep litter | 9t/d |
| Organic cattle slurry | 48t/d |
| **Total** | **69t/d** |

## LESSONS LEARNED

Organic biogas facilities are a new concept combining organic produce with enhanced biofertilizer, and renewable biogas production from residual and waste biomass in a closed circular economy. Planning the facility proved to be a long process with much paperwork and administration. Farmer Jens Krogh advises one to be prepared to spend time and discuss ideas with many different people including advisors and those with experience of developing their own facilities. Advice is needed on location, on the choice of plant concept, on the business plan and finance. He advises to listen to experienced people with an open mind without allowing your own ambitions and ideas to take from that advice. It is essential to engage with your community seriously at an early stage in the design and planning process.

The biogas site as a workplace must be functional and flexible in relation to being able to store many different types of biomas. Ensure a wide open space and do not plan for deep storage. Partitioning with walls should be optimised to facilitate cover of the biomass. Financial security is important; it is important to secure a good long term price for electricity, so the financial return is not entirely dependent on prices that one does not have influence on. The investment grant was crucial for Farmer Jens Krogh, not only for reducing the investment itself, but was also important for the creditors and their risk.

A final lesson is to be aware that there is a lower ammonium-N content in digestate from deep bedding (below 50%) as compared with 75-85% in digestate from livestock manure. Organic digestate from deep litter has a high first-year nitrogen effect.

**Figure 2:** Panorama photo of the organic biogas plant and farm buldings

## THE FUTURE

Large amounts of deep bedding are feed for this biogas facility. This necessitates larger digester volumes and longer retention times. A plant extension and replacement of the gas engine with a bigger one is under consideration. In the longer term, corn silage is intended to be phased out. The farmer's advantage lies in having a liquid biofertilizer improving grass yields. Thus more grass in the crop rotation is proposed; this will make the farm more independent from outside biomass suppliers and grain harvesters. Larger plants, receiving biomass feedstock from several farms are more financially sustainable due to economies of scale. However the costs and environmental impact of increased transport is a great challenge. To solve this, biomass separation will be required.

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