IEA Bioenergy Task 37

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

BIOGAS PIPELINE FOR LOCAL HEAT AND POWER PRODUCTION IN A RESIDENTIAL AREA ZEEWOLDE, NL

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SUMMARY

Since 2009, houses and other buildings in Polderwijk, a new housing development in Zeewolde in the Netherlands, have been supplied with renewable heat from a CHP (Combined Heat and Power) plant using biogas as fuel. The project is a collaboration between the municipality, a local energy company and a farm located 5 km from Polderwijk. The municipality set up the project by means of a tender procedure, where the winner was determined by a combination of environmental and economical factors. The system consist of a biogas plant on the farm and two CHP plants that use the biogas; one on the farm and one in the residential area. The heat released on the farm is used for heating the digestion process and the heat released by the CHP in the residential area is used for district heating. The project has succeeded in creating an area with a sustainable and energy efficient heating system. In addition, the system supplies the market with a large amount of green electricity and digestate that is used as fertilizer.

Photo 1: Biogas plant on the farm.

FACTS
Substrates: manure, corn, grass and waste products from the food industry
Digesters: 2*2500 m^3
Digester type: CSTR (Continuously Stirred Tank Reactor)
Retention time: 50 days

BACKGROUND

The municipality of Zeewolde is located on the Flevoland polder in the middle of the Netherlands. In 2002 the municipality began to develop a major new residential area, the Polderwijk, in which there are 3000 residential households, a church, schools and 15,000 m^2 of offices and shops. It was planned that the heat demand of the area should be supplied by district heating, since it is the most cost effective system for the sustainable heating of homes and buildings, provided that renewable heating sources are available nearby.

The municipality commissioned an independent consultancy to carry out a market study. Six companies were requested to submit a proposal for the creation of a climate-neutral district heating system. Four companies submitted an offer. These were based on: co–digestion of manure and organic solids, wood burning, gas combustion, and a collective heat pump with solar water heaters as a source, respectively.

After a review of the four offers on price and environmental benefits (CO_2 reduction), the municipality finally chose the system with co-digestion and associated CHP-plants. This was the offer from the energy company Essent Local Energy Solutions, which would run the project in conjunction with a dairy farm (with about 140 cows) in the area.

In November 2005 the municipality and Essent Local Energy Solutions signed a contract for the realization of the project. In 2007 the dairy farmer started the construction of the digesters and two CHP units, one on his farm and one in the residential area. In the same year the first 300 households were connected to the system. At that time it was still based on natural gas. In late 2008, the digestion installation and the biogas pipeline between the farm and the residential area came into use. Since then the system has run to a large extent on biogas. By the end of 2010 almost 1000 homes were connected to the district heating system.

PROJECT

The project consists of several parts: digesters and a small CHP unit on the farm, a biogas pipeline between the farm and the residential area, a large CHP plant on the edge of the new residential area and a district heating system.

The *biogas plant* on the dairy farm consists of two digesters and one post-digester. The plant has the capacity for treating 30,000 m3 of manure and organic material per year. Approximately one quarter of the biogas generated is used in the CHP plant (250 kW) on the farm. The heat from this CHP plant is used for heating of the mesophilic digester (37°C) and is also used for the heating of the farm and the farm houses. The digester is fed with a little over 50 percent organic manure and additional substrates such as corn, grass and waste products from the food industry. The choice of co-substrates depends on market conditions. With more than 50 percent manure to digest, the resulting digestate can be used and marketed as a fertilizer (according to The Dutch Fertilizer Law).

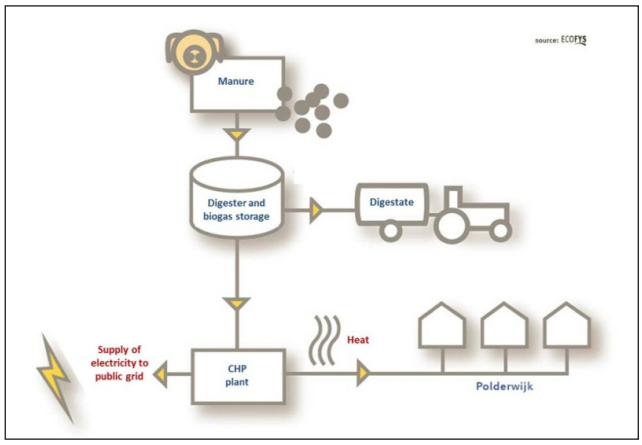

Figure 1. A schematic drawing of the system for biogas production, digestate utilisation, heat and power production and utilisation.

In the *CHP plant* in Polderwijk a gas motor is installed with an electrical capacity of about 1060 kW. It produces about 7 million kWh of electricity annually and the electrical efficiency of the CHP is 41 percent. The thermal capacity is 1270 kW and the heat is released at a temperature of 90°C. In the future, this CHP will be supplemented by another CHP in order to meet the heating needs of the expanding district. Both the CHP unit on the farm and the one in the residential area are owned by the farmer. The farmer sells the electricity produced mainly as 'green power' in the electricity market.

The *biogas pipeline* between the biogas plant and the CHP plant on the outskirts of the residential area has a length of 5600 metres (diameter 250 mm). Because the biogas pipeline runs largely through a rural area, the construction costs were relatively low. The resistance in the gas pipeline is overcome by using a maintenance

free, highly energy-efficient fan. The pressure drop along the complete pipeline is maximum 100 mbar. To prevent condensation in the pipeline the biogas is dried prior to transmission by scrubbing it with chilled water. In addition, the gas is also biologically de-sulphurised inside the digester by adding a small amount of air.
The *district heating system* consists of a heating network of insulated steel pipes and heating units in homes and buildings. These consist of a connection to the central heating system, an ultrasonic heat meter and a heat exchanger for the hot water supply. The supply temperature in the heat network is about 75°C. The return temperature is between 45 and 55°C, depending on the weather.
Two natural gas-fired auxiliary boilers have also been installed at the CHP plant in the residential area. At the start of the project these supplied the heat required. They now function as peak and back-up heating. The pumps in the heating network are equipped with frequency control to reduce energy consumption.

Table 1. Energy production and natural gas consumption for the system in 2010.

Electricity generated from biogas	7,500 MWh
Utilisation of heat from biogas	7,100 MWh
Natural gas consumption	4,735 MWh

RESULTS

The CO_2 emission from heat and electricity consumption is 80% lower than for a conventional new housing development. Electricity produced from biogas covers all electricity consumed and more than 75 % of the heat consumed is produced from biogas. The total carbon dioxide reduction is 5100 tons annually. The extraction of biogas from manure also means less emission of methane, a much stronger greenhouse gas than CO_2. Other environmental benefits are that the fertilizer value of the manure is improved, and the odour nuisance from manure-spreading is reduced.

ORGANISATION

Essent Local Energy Solutions has signed a contract with the farmer for the supply of heat. The price of heat is related to the price of natural gas. For the delivery of heat to the homes and buildings, consumers pay Essent Local Energy Solutions a flat-rate price plus an amount for the delivered heat. For individuals in the Netherlands the principle applies that an alternative heat supply should not cost residents more than an energy supply based on a high-efficiency natural gas boiler. The municipality has no further involvement with the project.

CONCLUSIONS

Completion of this project means that the municipality of Zeewolde has effectively created a residential area that is heated in a durable and energy efficient manner. The existence of energy performance standards gave the opportunity for the market to develop the most creative solution.
By developing a system with two CHP plants instead of one it was possible to install a biogas-pipeline instead of a heat-pipeline between the farm and the residential area. This is a much cheaper option because smaller diameter and simpler pipes can be used, which means that the project then became profitable.
The project has now been adopted in Leeuwarden, a town in the northern Netherlands. A biogas pipeline of about 5.5 km has also been built there, and a dairy farmer delivers the heat to Essent Local Energy Solutions.

Photo 2. Polderwijk, a new residential area using heat from biogas produced at a nearby farm.

CONTACTS

Essent Local Energy Solutions
Mr Klaas de Jong
+ 31 655 156 484
klaas.de.jong@essent.nl

Biogas plant **Polderwijk**