IEA Bioenergy Task 37

**BIOGAS IN THE SOCIETY**
Information from IEA BIOENERGY TASK 37 Energy from biogas and landfill gas

# OPTIMISED DIGESTION OF ENERGY CROPS AND AGRICULTURAL WASTES IN A LOCAL BIOGAS PLANT IN REIDLING, AUSTRIA

## SUMMARY

The Rohkraft biogas plant, situated on a pig breeding farm in Reidling, Lower Austria, was started in December 2003. Main purpose, next to the treatment of the available pig manure, was the organisation of an alternative source of income due to the price decline in the pig breeding. The produced biogas is burned in two combined heat and power engines (CHP). The produced electricity is supplied into the national power grid and the heat is used to provide a local heat supply for the neighbouring village.

**FACTS**

- Treatment of manure, agricultural residues and energy crops
- Electricity supply into the national power grid
- Heat supply into a local heat grid

Figure 1:
The "Rohkraft" Biogas plant in Reidling, Austria. From left to right the CHP unit, the covered digestate storage tank, the second digester step with gas cover and a gas storage tank can be seen.

## BACKGROUND

With the reduction of European subsidies in the agricultural sector, the situation of the farmers in Austria became increasingly difficult. In the same time the energy prices increased significantly. Therefore the production of energy from manure and other agricultural residues became economically interesting. To support energy alternatives, in 2002 a national Austrian law concerning the supply of power into the national power grid was passed, guaranteeing fixed rates on the power supply from biogas plants of 12.5 up to 16.5 € cent/kWh, depending on the plant size. At the Reidling site, a pig breeding was existing, with an daily manure output of 15 $m^3$. Additionally, the farm was searching for methods to reduce ammonia emissions from the piggery. Furthermore an alternative income to compensate the declining meat price was looked for. The new political regulations opened the possibility to fulfil both aims and after the new law was passed, the biogas plant was built up immediately. Rates of 14.5 € Cent per kWh electrical- and 2 € Cent per kWh thermal energy are paid to the farm.

**Table 1:** Main process parameters "Rohkraft" biogas plant in Reidling, Austria. Characterising mean operational values in 2004 and 2005.

| | | 2004 | 2005 |
|---|---|---|---|
| Input raw materials (wet) | [$t.d^{-1}$] | 14.19 | 29.9 |
| Input manure + leachates | [$t.d^{-1}$] | 15,0 | 20,0 |
| Input VS (manure included) | [$t.d^{-1}$] | 7.98 | 16.87 |
| Biogas production | [$Nm^3.d^{-1}$] | 5,615 | 11,008 |
| Hydraulic retention time | [d] | 132 | 77 |

## PROJECT

The Rohkraft biogas plant is situated in a typical agricultural area in Lower Austria, next to the small village of Reidling. The digester was started in December 2003 as a two stage continuous stirred tank reactor system, comprising a main digester volume of 2,000 $m^3$, a second digester step of 1,850 $m^3$ and open storage tanks with a volume of 3,800 $m^3$ (Fig. 1). All digesters are built from concrete. The storage of the solid substrates is realised in four clamp silos built from concrete, with a total capacity of 15,000 $m^3$. All leachates of the silages are collected and discharged into the manure storage tank (135 $m^3$). The substrates used are pig manure (30 %) and solid energy crops (70 %) like maize (Fig. 2) and residues from vegetable processing. Except for the pig manure, which is from the own pig breeding, all substrates are delivered from regional farmers. The same farmers use the digestate of the plant as fertilizer on their agricultural areas. The feed dosage is executed automatically 24 times per day. All input weights are recorded. The mean process temperature is 39 °C. The removal of $H_2S$ from the biogas is achieved by air dosage into the digester gas phase. Water vapour is removed by means of a water trap. Biogas quantity and -quality are analysed online, based on infrared- (flow rate, $CH_4$ and $CO_2$) and electrochemical cells ($O_2$ and $H_2S$). The biogas is used to generate electrical current and heat in two combined heat and power units (CHP) with an electrical capacity of 500 kW and a thermal capacity of 517 kW each (GE Jenbacher, Austria). Electrical current is fed into the national grid and heat is mainly used for a local heat supply in the neighbouring village of Reidling.

Figure 2:
Delivered grains (e.g. maize) are cracked directly before ensiling in the silage clamp silos.

After one year of operation, a second process line was set up, characterised by the dosage of substrates directly into the second digester and a second combined heat and power unit with the same capacity as the first one. These modifications resulted after two months of adaptation in a total electrical capacity of 1 MW and a thermal capacity of 1,034 kW. Due to the upgrading, the

**Table 2:** Process parameters of the "Rohkraft" biogas plant in Reidling, Austria as measured in 2005 (8030 hours of annual CHP operation)

| | |
|---|---|
| Input energy crops: | 11,000 t/year |
| Input manure + leachates: | 7,300 t/year |
| Biogas production: | 4.02 Mio $m^3$/year |
| Production of electrical energy: | 8,030 MWh/year |
| Production of thermal energy: | 8,223 MWh/year |
| Own electrical consumption: | 562 MWh/year |
| Own thermal consumption: | 50 MWh/year |
| Thermal consumption pig breeding: | 1,000 MWh/year |
| Sale of electrical energy: | 8,030 MWh/year |
| Sale of thermal energy: | 1,600 MWh/year |

hydraulic retention time was reduced from 132 days to 77 days. The mean organic loading on the other hand increased to 4.4 kg VS/m³ reactor volume and day. Some more changes in the process associated with the upgrading are shown in table 1. More performance data are presented in table 2, the course of productivity and power generation can be seen in figure 3.

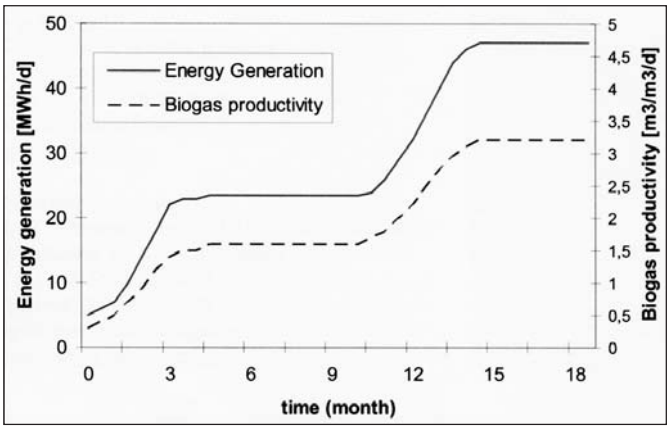


Figure 3: Energy generation and digester biogas productivity (m³ per m³ digester volume and day) in the "Rohkraft" –Energy Crop digestion plant in Reidling during 2004/2005.

## RESULTS

As it can be seen in figure 3, the capacity of the Reidling Biogas plant was increasing continuously in the first two years of operation. Due to a supportive process control and continuous on-site analytical measurements (Fig. 4), a reliable long term plant operation and more than 98 % of the theoretical capacity of the heat and power unit could be achieved. In 2005 the sale of electrical energy amounted to 7,468 MWh per year, the sale of thermal energy to 1,600 MWh/year. The sale of thermal energy is increasing continuously, because more and more people from the neighbouring village decide to join the local heat grid. The energy generation costs in the first years resulted in 6 – 8 € cent per kWh, so the benefit was about 6 – 7 € Cent per kWh produced.

## CONCLUSIONS

The Reidling biogas plant impressively shows that the co-digestion of manure, residuals of food processing and energy crops in continuous stirred reactor systems is an effective and reliable way for the production of biogas. Especially in agricultural areas such systems are very attractive, since the local production of energy is a promising source of income for the farmers. On the other hand, the use of energy crops makes the energy generation costs strongly dependent on the market price of the agricultural crop materials. The experiences of the first years show, that it is possible to achieve a high degree of efficiency, due to a good process control which is comparable to industrial processing. For the economic success it is important to use both electricity and heat, like it is demonstrated in the described plant.

Figure 4:
The "Rohkraft" biogas plant runs its own analytical laboratory. A new titration method for the analysis of volatile fatty acids is being presented actually.

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## CONTACTS

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