ENERGY CROP DIGESTION PLANT STREM

SUN – CROPS – BIO-ENERGY

SUMMARY

The Energy Crop Digestion Plant in Strem, Austria (Fig. 1), is a further milestone in the eco-energy initiative of the Guessing region in the South-Eastern part of Austria, district Burgenland. Strem was the first Austrian Biogas plant based solely on solid energy crop substrates. The produced biogas is converted into power and heat and the energy is sold to the public power grid and the local district heating network.

Fig.1: The Strem Biogas plant in the Guessing Region (Burgenland, Austria). From right to left the final storage lagoon, the bunker silo in the background, the substrate hopper, the first and the second digester

INTRODUCTION

In the Güssing region, the expansion of the European Union has resulted in major structural changes within the agricultural sector. Many agricultural enterprises converted from full acquisition to supplementary income, resulted in grassland and acres that was not cultivated any longer and fell into fallow land. Thus sufficient agricultural land for energy crop production was available in the closest periphery of the biogas plant. The plants – grass, clover, maize and sunflowers – can be produced by environmentally careful agricultural management with a minimum transportation required.
The Austrian renewable-energy granting scheme gave the opportunity to sell the produced biogas as converted electricity into the power grid. For the 500 kWel biogas plant, an energy supply price of 14,5 cent/kWh is guaranteed for 13 years.

Fig. 2: The plant operator, monitoring the quality of regional growing rye-grass

Table 1: Process parameters of the Strem biogas plant as measured in 2005 – 2006 (96 % availability of full contracted CHP operation)

Input energy crops maize whole crop silage:	5,940 t/year
Input energy crops grass silage:	2,181 t/year
Input energy crops clover silage:	1,374 t/year
Biogas production:	1.88 Mio m^3/year
Production of electrical energy:	4,153 MWh/year
Production of thermal energy:	4,220 MWh/year
Own electrical consumption:	61 MWh/year
Own thermal consumption:	701 MWh/year
Sale of electrical energy:	4,153 MWh/year
Sale of thermal energy:	1,697 MWh/year

PROJECT

The main challenge was to design a new generation of biogas plant that can be operated continuously, using exclusively solid energy crops without the addition of slurry, manure or fresh water. The used substrates grass- and maize silage (Fig. 2) are harvested (cut and chaffed) from nearly 300 ha and compacted into the clamp silos (Fig. 3). The runoff and drainage from the silos are collected and supplied to the fermentation process. The storage volume of the 4 driving silos amounts to 15,000 m^2 on a total area of 4,300 m^2.
The used energy crops are metered into the main fermenter using a special designed hopper. The hopper was designed and assembled by the general contractor Thöni Energietechnik and can store a two days stock of substrate. Due to its exact metering system, including a full automatic balance, the energy crops can be brought in continuously (every 30 minutes). An automatic conveyer system and a spiral discharge the crops below the liquid surface. By this means approximately 25 t/d or 11.000 t/a solid substrates are fed in the main digester (Tab. 1).

Fig. 3: 11,000 t of energy crops are harvested per year and stored and ensiled in 4 bunker silos

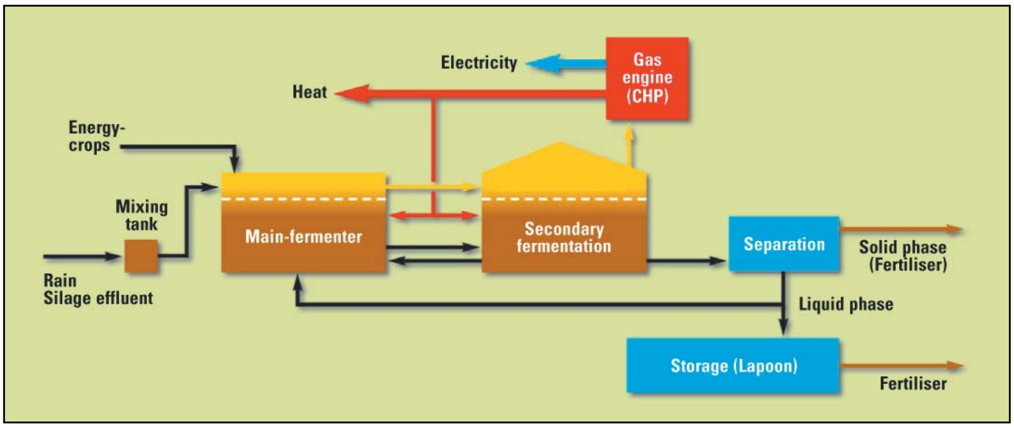

Fig. 4: Flow scheme of the Strem biogas plant showing the separation of the digestate. A part of it is used as process liquid in the main digester for dilution purpose

Figure 4 shows an overview on the whole Energy Crop digestion plant Strem.

Main and second digesters

The fermentation takes place in cylindrical tanks, manufactured from reinforced concrete. The capacity of each of the two digesters is 1,500 m^3. Sufficient thermal isolation and an integrated heating system ensure optimal thermophilic conditions (49.5 °C). Due to the high organic solid concentration of the discharged energy crops, a certain dilution is required to guarantee sufficient mixing and the best contact conditions between substrate and micro-organisms. Therefore, a certain portion of the liquid fraction of digestion residue is used for dilution purposes. The digester content is stirred using two horizontal arranged paddles. Their rugged construction allows to stir solid substrates and due to their innovative design the stirrers prevent the generation of bottom- and surface layers and support the release of the produced biogas. The paddle stirrers are running with a low frequency and are equipped with an automatic central lubrication system. Each of them only requires 5.5 kW electricity because of their control by frequency converters.
The second digester is equipped with a 300 m^3 double membrane gas holder that allows to buffer small differences in gas production.

Fermentation end product

The supernatant of the second digester – the raw fermentation end-product, is further processed at the Strem plant. Because of the neccessity of internal recirculation, the supernatant is separated into a liquid and solid fraction using a screw extrusion press. 30 % of the extracted liquid are re-fed into the main digester. The rest is stored in lagoons and spread out on the fields as valuable fertilizer. The solid part is used as fertilizer for special cultures, but optionally may be further processed in the future.

Biogas

The produced Biogas is utilized in combined heat and power generators. The CHP units have an output of 500 kW/h electric energy and 535 kW/h thermal heat. The electricity is supplied into the grid and the thermal energy is integrated into the local heating

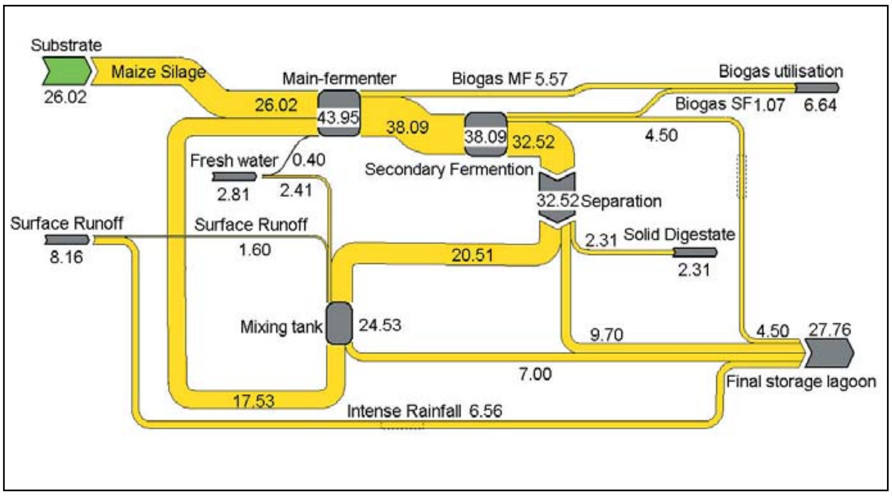

Fig. 5: Mass flow diagram of a typical operation day, when maize whole crop silage is used as single substrate. Data given in t/d.

system of Strem. As there are two CHP engines, even during regular maintenance the full contracted energy can be supplied. This leads to an availability of the system of higher than 96 %. The heat is supplied into the local district heating system operating a wood combustion plant.
The combination of biomass combustion and biomass fermentation as demonstrated in Strem, is an outstanding example for decentralized regional energy production. The biogas plant Strem is however more than a regional demonstration project: The plant is part of an Austrian-wide research network and is therefore an important contribution for the improvement of an efficient energy production from agricultural products.
The main research targets were to improve the technical and economical efficiency of the whole Energy Crop digestion system and to figure out to optimum point of operation for a certain substrate portfolio. For plants, which are operating on solid energy crops, that have to be bought on the market, the substrate costs are the biggest influence on the economy.
The mass and energy flows of the Strem plant have been monitored for more than two years of operation and put into a data base to calculate a daily based mass flow analysis. This tool helps to figure out the changes in efficiency under different operating conditions. These are the change of substrate composition or the amount of dilution liquid added. The key parameter is the minimization of the energy left in the digestate. These data can be derived from the analysis of the digestate's residual methane potential. The results can be highlighted in SANKEY mass flow diagrams (Fig. 5), providing a fast impression of enhancement opportunities.

CONCLUSION

The Energy Crop digestion plant in Strem demonstrates how the production of renewable energy can be integrated into a sustainable solution for a rural area. The production of energy crops revive the agriculture in the Güssing region on its way to energy self sufficiency. The research activities in Strem will help to push forward the green energy production into higher efficiency and lower production costs. Goal is to evolve the biogas production from energy crops to a serious industrial way of primary energy supply.

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