BIOGAS IN SOCIETY
A Case Story

GÖSSER BREWERY

THE ROLE OF BIOGAS IN GREENING THE BREWING INDUSTRY

IEA Bioenergy Task 37

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MISSION AND VISION

In 2015, the Austrian company BDI set up an anaerobic digestion unit at the site of one of the biggest breweries in Austria, the Gösser Brewery close to Leoben (figure 1). This facility has a yearly production of approximately 100 Million litres of beer. The Gösser Brewery, which is part of the Heineken Group, decided to establish a decarbonised beer production facility as their contribution to greening of the brewing industry.

During the brewing process several organic residues are generated, which can be used as feedstock for an anaerobic digestion process. Each hectolitre of beer (100 litres) produces approximately 20 kg of brewers' spent grains. Furthermore, residual yeast, hot and cold break (a protein rich fraction from the brewing process), filter cake and waste water are residues which occur during the brewing process. Anaerobic treatment of waste water is currently realised on-site for most breweries. Different technologies are employed including for Upflow Anaerobic Sludge Blanket (UASB) and Expanded Granular Sludge Blanket (EGSB).

Brewers' spent grains contain by far the biggest energy yield of the residues. During anaerobic digestion approximately 75 Nm³ CH_4 can be produced from each tonne of brewers' spent grains. Biogas can be used in a Combined Heat and Power (CHP) facility for electricity and thermal energy or in a boiler for thermal energy only (Table 1). In terms of the energy demand of a brewery, typically biogas from anaerobic digestion of the residues from brewing, storage and bottling processes when used in a CHP facility can cover between 50 and 60% of the electrical energy demand of the brewery and 60% of the thermal energy demand within the brewing process. Utilisation of biogas in a boiler should cover 100% of the heat demand in the form of saturated steam. Thus, the utilisation of biogas leads to the replacement of natural gas.

TECHNICAL DATA

Two stage mesophilic anaerobic digestion

The biogas plant consists of a two-stage mesophilic anaerobic digestion system (figure 2). The first stage is a biological acidification step (also called a hydrolysis step). During this first process, polymers such as starch, cellulose, proteins, and fats are hydrolysed to sugars, amino acids and short chain fatty acids. These readily degradable compounds are subsequently converted to acetic acid, propionic acid and butyric acid during acidogenesis. The pH of this reactor is acidic typically below 6.5. A gaseous stream is produced dominated by CO_2 and H_2.

The organic substrate, the brewers' spent grains, is fed to this first digester, which has a volume of 450 m³. After the biological acidification step the volatile fatty acids dominated by acetic acid are pumped to the main methane reactor digester with a volume of 2560 m³. Both digesters are set up as continuous stirred-tank reactor (CSTR) systems. A third reactor (a post reactor) subsequent to the methane reactor has a volume of 3680 m³; this allows for digestate storage.

Desulphurisation of biogas

To avoid process inhibition and to guarantee a stable and fast degradation process the biogas plant uses two strategies for desulphurisation of the biogas. Firstly, iron hydroxide is added to the main digesters to bind H_2S in the liquid during the anaerobic digestion process. The second step of H_2S removal is a microbiological process. For this microbiological desulphurisation a small amount of air is injected in the head space of the main and post digester. Depending on the surplus of O_2 effected by this injection, H_2S is oxidised either to S_2 or H_2SO4.

Figure 1: Gösser brewery (close to Leoben)

Figure 2: Biogas facility at Gösser brewery

Gas utilisation

Before utilisation of the desulphurised biogas, the gas is dried and compressed. Two different strategies can be pursued at the plant (Table 1). On the one hand biogas can be used in the boiler of the brewery for the production of heat as saturated steam at about 140 °C. On the other hand, a CHP unit is additionally installed to produce electricity and heat at a temperature in excess of 90 °C (without utilisation of the off-gas heat). The produced electricity is fed into the grid in accordance with the national feed-in rate "Ökostromgesetz".

Digestate

The treatment of digestate is limited due to odour emissions as the brewery is located in a residential area. Already in the planning and approval phase the neighbourhood of the brewery was involved in the discussions with respect to potential odour emissions. Thus, no additional digestate treatment is installed at the site. Currently, after storing the digestate in a covered post digester, the digestate is transported to the surrounding farmers and applied as fertiliser on arable land.

LESSONS LEARNED

The implementation of an anaerobic digestion plant for organic residues in a brewery is feasible and has been realized at the Gösser brewery in Austria. The Gösser brewery developed the concept of a "Green Brewery" with an ambition to produce beer with 100% renewable energy. Within the concept of a "Green Brewery" the Gösser brewery together with the company BDI, realised a biogas plant for the treatment of organic residues from the brewing process. The biogas plant is located at the brewery and is feed with brewers' spent grains. The biogas from the anaerobic digestion process is transported to the brewery for utilization in the boiler of the brewery to substitute natural gas. Residual biogas is combusted in a CHP for electricity and heat production.

Thus, the biogas services heat demand at different temperature levels. In the boiler saturated steam is produced and in the CHP, heat for lower levels of thermal energy. Additional to the anaerobic digestion of solid wastes from the brewing process, waste water is treated anaerobically in a UASB reactor. This unit was installed many years ago. The Gösser brewery covers 100 % of energy demand from renewable energy. Beside the anaerobic digestion units, heat from a neighbouring wood processing industry and a solar thermal system is used; 40 % of the heat demand is covered by the wood processing industry, 5–10 % from the anaerobic waste water treatment plant and the residual 50 % from the biogas plant. Additionally, the brewery optimised energy reduction demand in each single step of the beer production process. The Gösser brewery is a very good example of combining renewable energy technologies to produce process heat and electricity. Another hurdle is the management and utilization of digestate. The brewery is in a built up area surrounded by residents (figure 1). To avoid disquiet within the neighbourhood during the approval process, the local residents were consulted. The end resut of this consultation led to minimum handling of digestate at the brewery site to limit odour emissions. The digestate is transported to surrounding farmers and applied as fertiliser on arable land.

Table 1: Inputs and outputs of biogas plant at brewery Gösser

Input		Output	
Brewers spent grains	13,621 t/a	Biogas produced	2.3 million m³/a
		Biogas to brewery (boiler)	3.3 million kWh/a
		Electricity (from CHP)	3.4 million kWh/a
		Heat (from CHP)	2.2 million kWh/a

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