

BIOWASTE AND SEWAGE SLUDGE RECOVERY: SEPARATE DIGESTION, COMMON GAS UPGRADING AND HEAT SUPPLY

BIOGAS ZÜRICH – AN INNOVATIVE ENERGY CONCEPT

PUBLISHED: APRIL 2014

CONTEXT

The new biogas digester of the company Biogas Zürich AG started operation in July 2013. It is a thermophilic installation for biowaste, built on the former composting site close to the wastewater treatment plant “Werdhölzli” of the city of Zurich, which already had digesters for sewage sludge. The separation of the two waste streams – sewage sludge and biowaste – allows using the digestate of the new plant as fertiliser. In Switzerland sewage sludge must be incinerated. The proximity of the two biogas plants (Figure 1) creates various symbioses, which are fully utilised by Biogas Zürich AG together with ERZ Entsorgung + Recycling Zürich and lead to optimised energy management of both plants. The shares of Biogas Zürich AG are owned by the city of Zurich, Limeco and Erdgas Zürich, which represent at the same time the key partners that procure and treat biowaste, as well as produce and sell biogas.



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Figure 1: Situation plan (© ERZ Entsorgung + Recycling Zürich)

- 1 Biowaste digestion and composting
- 2 Sewage sludge digestion
- 3 Biogas upgrading
- 4 Heat recovery from sewage sludge (under construction)

BIOGAS IN SOCIETY

A Case Story from IEA BIOENERGY TASK 37 "Energy from Biogas"

BIOWASTE DIGESTION

The biogas plant for biowaste digestion (Figure 2) was built in 2012/2013 with the objective to contribute to the sustainable development of the region by environmentally friendly biowaste management which includes renewable energy recovery and production of a high quality fertiliser. The major part of the feedstock is composed of source separated biowaste from households, which are subscribed to the collection service for an annual fee. In addition, there are also green wastes from landscape management and deliveries from private companies, as illustrated in Table 1. The horizontal plug-flow digester with a volume of 1500 m³ (Figure 3) has a capacity to treat 25'000 tons of biowaste per year. The thermophilic temperature in the digester (>52°C) and the retention time of about 14 days guarantees sufficient pathogen reduction (and therefore no necessity for additional hygienisation). As of 2015, the heat requirements for the digester will be covered by the heat recovery from incineration of sewage sludge.¹⁾

The digestate from the biowaste plant is partly used to inoculate the feedstock entering the digester (up to 40 % of entering material); the rest is separated using a screw press. The liquid fraction is pumped to a storage tank before being picked up by farmers for use as ammonium rich fertiliser. The solid fraction is composted, which means that it is subjected to an aerobic treatment for 4 weeks. The mature compost is used in agriculture and horticulture. The net external capital investment for the plant was 25 Million CHF including biogas upgrading.

Figure 2: Biowaste digestion and former composting site (© Biogas Zürich)

Figure 3: Stirring system of the horizontal biowaste digester (taken during construction, © Biogas Zürich)

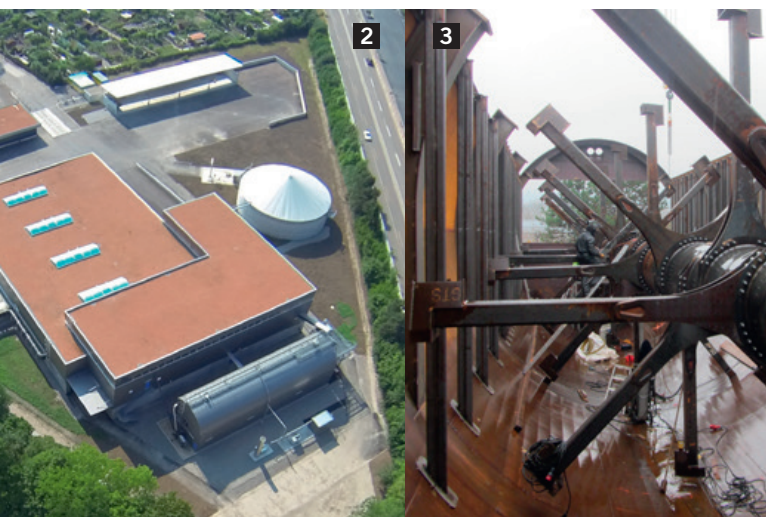


Table 1: Input and output of the biowaste digester
(TS = Total Solids; MWh = megawatt hours)

Input	
Source separated bio-waste from households	19,000 tons per year
Green waste from landscape management	2,500 tons per year
Delivery from private companies	3,500 tons per year
Output	
Gross gas	12,180 MWh per year
Digestate	12,000 t/a liquid digestate, 12% TS 10,000 t/a solid digestate, 45% TS

SEWAGE SLUDGE DIGESTION

With 670,000 pe (population equivalent), the waste water treatment plant Zurich Werdhölzli is the biggest in Switzerland. It is composed of a mechanical-, a biological-, a chemical treatment and a filtration unit. The sludges resulting from the mechanical treatment (primary sludge) and the biological treatment (secondary sludge) are subjected to anaerobic digestion in order to generate energy, as well as to reduce the sludge volume and odours. Some organic wastes from grease traps are co-digested with the sewage sludge, increasing the gas productivity of the plant. These wastes are not suitable for the biowaste digester because of their high content of liquids.

There are four main digesters with a total volume of 29,000 m³ (4 x 7,250 m³), running at mesophilic temperature (38°C). Further, there are four post-digesters with a total volume of 14,000 m³.

Once leaving the digester, the sludge is mechanically dewatered by centrifuges. The withdrawn liquid fraction is treated by a PNAO process (Partial Nitrification and Anaerobic Ammonia Oxidation), in order to reduce the high ammonium concentration of about 700 mg/l NH₄-N by more than 95%. The solid fraction (26 – 32% TS) will be incinerated in an on-site thermal recovery plant, which will be commissioned at the beginning of 2015, producing heat for the digesters and for biogas upgrading.

Table 2: Input and output of the sewage sludge digester

Input	
Sewage sludge	18,000 tons TS / year
Fat from grease traps	5,000 tons / year
Output	
Gross gas	41,400 MWh / year
Digested sludge	10,000 tons TS / year, 3.5 % TS

¹⁾ The heat recovery plant will be operating in 2015. Until then, the heat for the biowaste digestion is provided by the central heat supply station of the wastewater treatment plant.

COMMON GAS UPGRADING

The raw biogas from both digestion plants (biowaste and sludge digesters) is transported by pipeline to an upgrading station with a capacity of 1,400 Nm³/h (Figure 4). By removal of trace gases, H₂S and CO₂, the biogas is transformed into biomethane which is injected into the natural gas grid (Figure 5). The upgrading is achieved by an amine scrubber technology, which guarantees a very low methane slip (≤0.1%) and low electricity demand (0.06 kWh/Nm³), compared to other upgrading technologies. The heat demand of the installation is relatively high (0.62 kWh/Nm³), but the required heat will be furnished by the heat recovery from incineration of sewage sludge (see Figure 6).

As the specific investment costs for upgrading plants decrease drastically with increased capacity, a single upgrading facility for the two biogas plants brings a substantial financial advantage. The chosen biogas transformation system is therefore not only environmentally friendly, but also a financially viable solution. The capital investment for the upgrading plant was approximately 5.3 Million CHF.

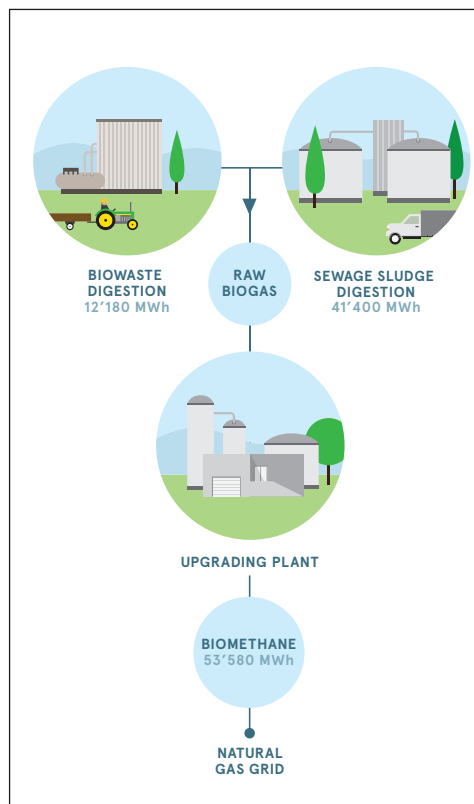


Figure 5: Diagram of the site gas distribution system

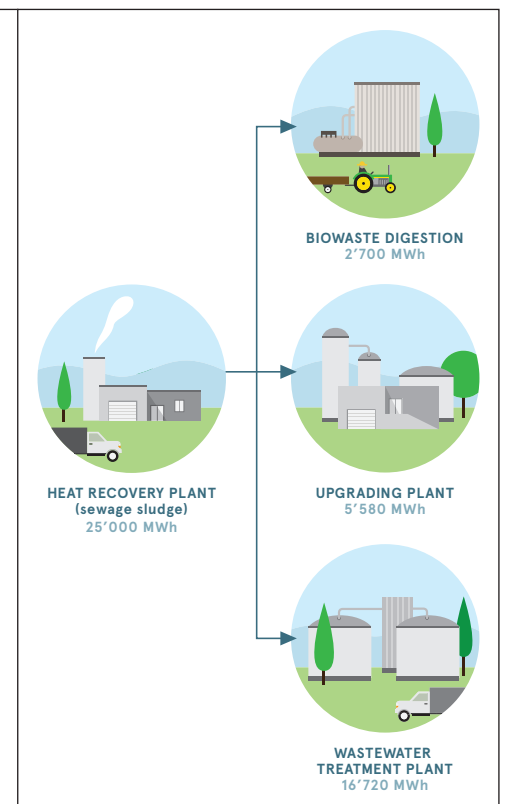


Figure 6: Diagram of the heat distribution system (as of 2015)

biowaste digestion plant and the biogas upgrading plant, as well as the administration buildings. The heat distribution system is illustrated in Figure 6.

HEAT CONCEPT

The heat concept of these installations in Zurich is particularly interesting. The recovery of heat from incineration of sewage sludge will produce 25,000 MWh of useable heat annually, starting in 2015. This will be sufficient to meet the whole heat supply needs of the Werdhölzli wastewater treatment plant, including the sewage sludge digester, the

ON TOP OF IT

To complete the innovative energy concept, Erdgas Zürich AG installed in cooperation with Biogas Zürich AG a photovoltaic facility on top of the storage and composting hall (Figure 7). This allows use of the large space available to produce still more energy. The generated electricity is injected into the grid.



Figure 4: Biogas upgrading plant (© Biogas Zürich)



Figure 7: Photovoltaic facility (© Biogas Zürich)

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