IEA Bioenergy Task 37

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

NUTRIENT RECOVERY FROM DIGESTATE AND BIOGAS UTILISATION BY UP-GRADING AND GRID INJECTION

INWIL SWITZERLAND

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SUMMARY

The SwissFarmerPower Biogas plant in Inwil (SFPI), Switzerland started operation in 2008 with the purpose of reducing eutrophication in an area with a large livestock industry. The plant consists of a thermophilic plug flow digester (KOMPOGAS) and two mesophilic continuously stirred tank reactor (CSTR) digesters. The plant receives mainly pig manure from 80 farmers and different kinds of organic waste from the regional food industry as well as biowaste from the source separated collection of municipal solid waste (MSW) which is treated in the thermophilic digester. The solid output is matured under aerobic conditions, whereas the liquid output is treated by ultrafiltration and reverse osmosis to obtain a concentrated liquid fertilizer and clean water.

FACTS

- Treatment of manure, biowaste and industrial biogenic waste
- Total biogas production corresponding to 3.4 Mio m^3/year
- Biomethane injection into the gas grid replacing 19 GWh natural gas annually

Photo 1: General view of the SwissFarmerPower plant: reception hall, storage tanks for liquid substrates, digesters, post-digester with gas holder, storage tank for liquid fertilizer (from left to right) (Photo: SFPI)

BACKGROUND

The SFPI biogas plant was built in 2008 as a measure to reduce the increasing eutrophication (high concentrations of nutrient release to water courses) of the rural area with the highest density of pigs, and thus an excess of nutrients, close to the city of Lucerne in the heart of Switzerland. The goals of the project were on one hand to recover nutrients from biogas plant digestate and produce a liquid fertilizer concentrate by means of a series of membrane processes, and on the other to produce up-graded biogas for injection into the local gas grid.

Table 1: SFPI biogas plant – inputs and outputs

Input	**Tonnes/year**
Pig manure	30,000
Industrial waste	15,000
Biowaste	16,000
Total	61,000
Output	
Solid digester output	13,000
Liquid fertilizer	10,000
Permeate	> 30,000
Total	53,000

Through the application of an ultrafiltration process followed by reverse osmosis the volume of liquid nutrient rich digestate could be reduced by approximately 75 %. This leads to a big reduction of manure transportation from the nutrient rich region to farming regions with a demand for nutrients, due to the fact that the liquid digestate has been concentrated.
Furthermore the emission of greenhouse gases such as CO_2 and NH_3 could be reduced. The main reason for this is the fact that the reverse osmosis step demands a slightly acidic pH which means that instead of ammonia (NH_3), ammonium (NH_4^+) is present and consequently emissions of ammonia during application on agricultural land are reduced.

PROJECT DESCRIPTION

SwissFarmerPower Inwil AG is a company owned jointly by regional power utility companies, local farmers and manure producers as well as a supplier of agricultural commodities and marketer of agricultural products (fenaco). The plant handles 30,000 tonnes/year of animal manure and 31,000 tons/year of other waste materials, mainly from different food industries (e.g. waste fat, vegetable waste, whey, coffee residues) and biowaste. The biogas plant has two digestion lines: two conventional stirred tank reactors (1350 m3 each, residence time 25–30 days, 36°C, 6.0 % dry solid), fed through a holding tank, and a thermophilic plug-flow digester (Kompogas). The total plant capacity is approximately 61,000 tonnes/year.

Photo 2: Ultrafiltration unit (Photo: SFPI)

The annual production of solid digestate is around 13,000 tons. This digestate is further treated in a post-composting process to achieve a high quality product.
The liquid digestate is further treated in a series of steps, starting with solid-liquid separation in a centrifuge, followed by ultrafiltration and finally reverse osmosis. Before reverse osmosis, the pH is lowered towards 6 to increase ammonia recovery. This treatment has two advantages compared to the spreading of untreated digestate, first, the fertilizing effect of nitrogen is increased, and second, the release of the greenhouse gas ammonia is significantly reduced.
Around 10,000 tons of nutrient-rich concentrate is produced annually. To store this concentrate a storage capacity of 6,000 m3 is available at the plant site.

Most of the nutrient-rich concentrate is transported to regions in Switzerland with a high nutrient demand resulting from arable agricultural activities including corn and wheat production.

Photo 3: Digestate transporter vehicle (Photo SFPI)

Over 30,000 tons of permeate are recovered from the reverse osmosis. This permeate has the quality of drinking water and is used for cleaning purposes at the plant.
The gross energy production from the plant, in the form of biogas (with about 60 % methane), is approximately 19 GWh/year. Right from the start of the project biogas up-grading to the quality of natural gas was undertaken. The capacity of the up-grading installation is 3.4 Mio m^3 biogas per year with a methane content of 55–65%

Photo 4: Biogas up-grading equipment (Photo SFPI)

Biogas up-grading is performed with the following steps: First, sulphur is removed biologically inside the digester by injection of air, then by an active carbon filter.

Second, the carbon dioxide is removed in a pressure-swing-absorption process. The fast-cycle PSA technology of the Canadian company XEBEC Adsorption Inc. was delivered by the Swiss representative Acrona Systems Ltd. The PSA process consists of a series of columns filled with molecular sieves to remove the carbon dioxide from the raw biogas.
Following up-grading the biomethane is then introduced into the local low-pressure gas grid.
The advantage of this biogas valorization concept is that there is no excess heat which has to be transported with consequent heat losses in a district heating system and even lack of heat demand during warm periods of the year. Furthermore, biomethane can be used equally in summer and winter and displaces natural gas which is a fossil fuel.

RESULTS

The operation of the SwissFarmerPower plant has reduced CO_2-emissions by approximately 3,500 tons by replacing 19 GWh natural gas per year. The biomethane is mainly used to produce heat for industrial processes. Some of the biomethane is used as vehicle fuel.

CONCLUSIONS

Co-digestion of pig manure and organic waste has contributed to solve a substantial environmental problem in the area of Lucerne. The biogas installation has also made it possible to reduce the local emissions of CO_2 considerably by replacing fossil fuels for heating and for transporting the manure. Furthermore, ammonia emissions are reduced during the transformation of the pig manure to the concentrated fertilizer.

Photo 5: View to the digesters and storage-tanks (Photo: SFPI)

CONTACTS

SwissFarmerPower Inwil AG
Philip Gassner

Im Feld
CH-6034 Inwil

tel +41 41 449 51 00
fax +41 41 449 51 01
e-mail: info@sfpinwil.ch
www.sfpinwil.ch

engeli engineering
Hans Engeli

tel +41 44 858 30 20
e-mail: info@engeli-eng.ch