



IEA Bioenergy
Technology Collaboration Programme

Renewable CO₂ from food waste based Biogas – a case story from Switzerland

Case Story

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Background an Overview

Food waste is a perfect feedstock for biomethane production. Every day, the Recycling Energie AG in Nesselbach, Switzerland processes 300 tons of food waste from restaurants, hospitals and residential facilities and turns this into biogas. App. 800 m³/h of the raw biogas is then upgraded and fed as natural gas substitute into the gas grid. The annually injected biomethane equals an energy equivalent of 35 GWh/a.

The upgrading of the biogas produces an offgas, which contains mainly the renewable CO₂ and a residual proportion of methane, the so called methane slip. In general such waste gas streams are - depending on valid regulation - either combusted to reduce methane emissions or they are discharged into the environment. Since March 2023 in Nesselbach the offgas is treated further to turn the CO₂ into a commercial product. The CO₂ cleaning and liquefaction plant is one of only a few plants in Europe to provide biogenic CO₂ in a food grade quality. CO₂ is an important base product for the chemical and food industries. Large quantities of biogenic and therefore renewable and emission neutral CO₂ are needed to substitute fossil CO₂ which is currently the standard within the industries. Beside such applications, so called carbon capture and utilization (CCU) there might be an increasing market for carbon capture and storage (CCS) technologies, where the CO₂ is stored underground.

The CO₂ upgrading and liquification plant is operated by an separate company, the CO₂ Energie AG. The liquefaction plant produces up to 4000 tons of food-grade liquid CO₂ per year. Industrial gases company Messer Schweiz AG collects the CO₂ three times a week by a tanker and sells it to manufacturers - for example producers of dry ice or carbonated drinks. CO₂ Energie AG generates further income for the operation of the plant through the sale of CO₂ compensation certificates, which is done via the Swiss climate protection foundation KliK. The sale of certificates is an essential aspect - the revenue from selling the CO₂ alone is not sufficient to cover production costs.

The technical process

The biogas treatment plant feeds the CO₂ filtered out of the raw gas into the new liquefaction plant (see Figure 1). There it is cleaned, filtered and dehydrated. In the following step it is cooled down to around minus 20 degrees Celsius, where it liquefies.

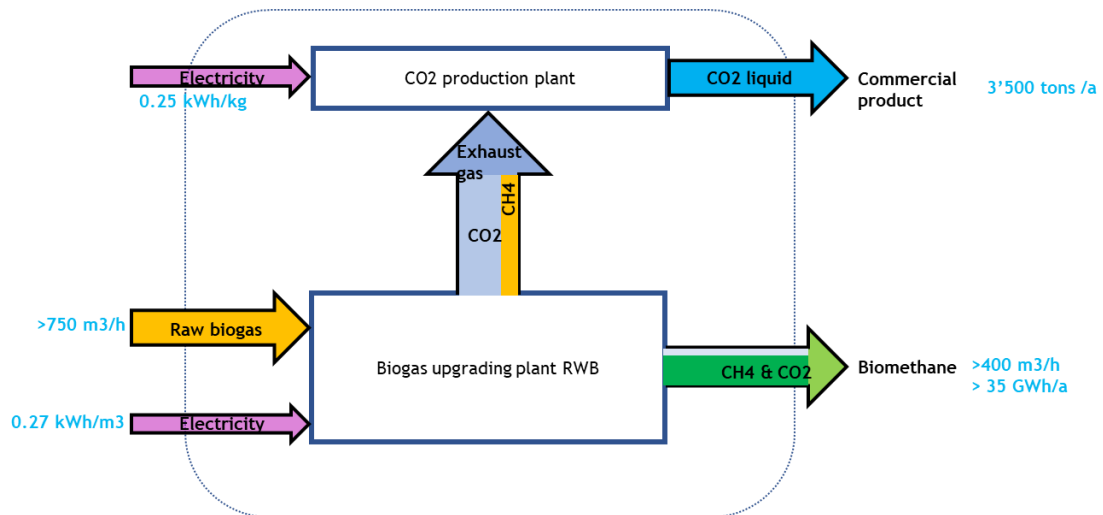


Figure 1: Structure of the Biomethane processing with integrated CO₂ liquefaction

Before loading the quality of the liquid CO₂ is tested. The monitoring and control of the food grade quality of the liquid CO₂ requires rather expensive equipment.

The plant was built by HZI (Hitachi Zosen INOVA), it was commissioned at the beginning of 2023. The project did start with a first feasibility study in 2019, construction was started in 2022. The investment was around 3 Million CHF (3,5 Mill. USD). The plant requires an area of app. 80 m². It is estimated that personal for supervision and operation with 20 h/week is required. Maintenance and operation will require an estimated downtime of 2 weeks per year.

The first year of operation did show that the required quality specification can be achieved and the process complied with the economic targets. The operation of the complex technology and the interaction with the upgrading process requires experience. The early operation phase and the optimization caused some down times. The energy demand of the process is a substantial part of the overall costs.

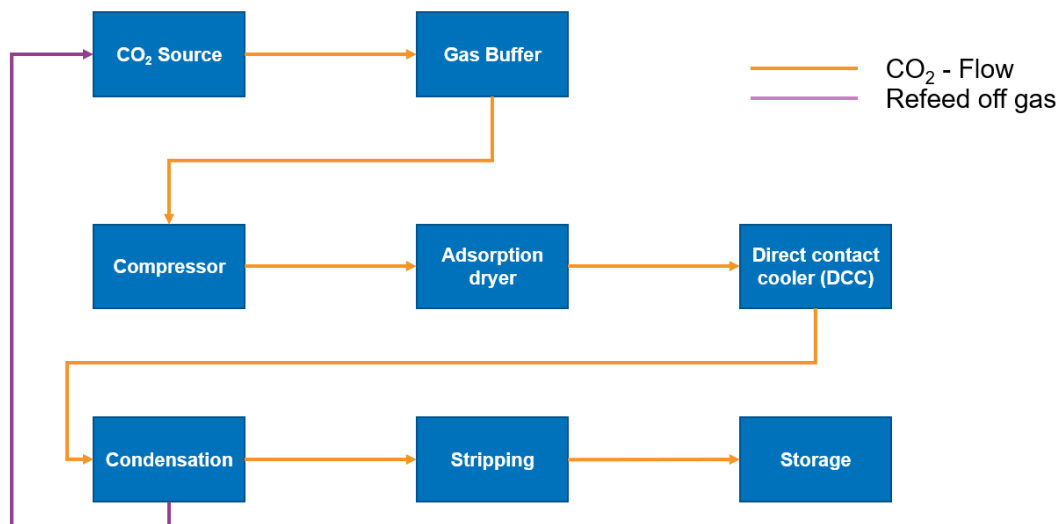


Figure 2: Process flow of CO₂ purification and liquefaction



Figure 3: Impressions CO₂ Plant in Nesselbach

Outlook

Biogenic CO₂ will be increasingly required in the future as substitute for fossil CO₂, as source for CO₂ for Carbon Capture and Storage and as renewable carbon source for GHG neutral carbon based liquid fuels. The purification of the CO₂ rich off-gas from biomethane processing plants is a good option to provide renewable CO₂. The process is available and the plant in Nesselbach is an example for the practicability of the process. It was proved that this process can be hooked onto existing biomethane plants. Liquefaction is of great importance for transportability. Increasing numbers of plants will improve the operational availability of the plants and likely reduce further the costs. However, at the moment the market for renewable CO₂ does not allow economic operation without support schemes. If the further development of use or storage of biogenic CO₂ is wanted, framework conditions need to be set to support such a development.

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IEA Bioenergy Task 37 “Energy from Biogas”
<http://task37.ieabioenergy.com>

Further Information
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