Farm-scale biomethane liquefaction

The markets for liquefied biomethane are promising because there is a growing demand for renewable fuels, both in heavy road and marine transportation and in the industry. Liquefied biomethane can be used flexibly as a liquid or gas, depending on the end-use. In the future, liquefied biomethane may also be used on farms, for example, as fuel for tractors or as an alternative to fuel oil in drying processes.

The main advantage of liquefied biomethane is related to its transportation and storage capabilities, especially in areas where natural gas pipelines do not exist. Relative to the energy content, when liquefied, biomethane requires significantly less volume for storage and transportation compared to its gaseous form. At normal atmospheric pressure, the energy density of liquefied biomethane (6000 kWh/m^3) is 600 times higher than that of gaseous biomethane (10 kWh/m^3). Higher energy density allows biomethane to be distributed over a broader area, which in turn expands its market opportunities.

Centria University of Applied Sciences has developed a farm-scale biomethane liquefaction unit in an ERDF-funded "Decentralized biogas production and liquefaction in Finland (HABITUS)" project (1/2020-6/2023). The design of the unit takes into account biogas plants producing around 10-25 Nm^3 of raw biogas per hour, which corresponds to the typical size of biogas plant on Finnish farms. The minimum production limits of biomethane liquefaction units currently on the market are well above this scale.

In the liquefaction process, biomethane is cooled with liquid nitrogen to a temperature low enough to liquefy the methane. The process is carefully controlled to prevent the conversion of methane into a solid state. Liquid nitrogen serves as the refrigerant, which is purchased as a gas. It is important that the purity of the biomethane to be liquefied meets the end-user requirements, as the liquefaction unit does not purify or separate carbon dioxide from biomethane.

The pilot tests on the liquefaction unit during the project were carried out with commercially purchased pure gas. The aim of the piloting was to verify the operation of the unit and to determine the process efficiency. The liquefaction unit operated as planned, requiring no changes to its operation principles. During the pilots, it was found that the consumption of liquid nitrogen is 3.2 kilograms per unit of liquefied biomethane at the selected pressure and temperature levels. The unit is close to commercial readiness, and further development will focus on e.g., process optimization.

Biomethane liquefaction unit. Source: Centria UAS

KEY WORDS

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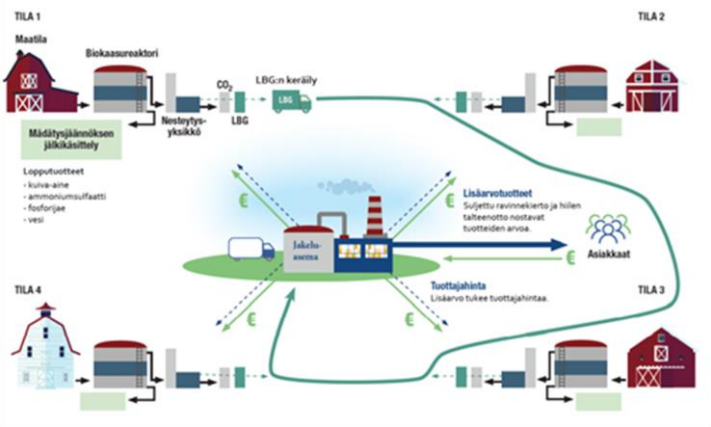
ADDITIONAL INFORMATION

Based on the economic evaluations conducted in the HABITUS project, liquefaction of biomethane using the developed unit could be suitable in a cooperative biogas production model. This model involves several farms where biogas production takes place. The cooperative buys raw biogas and upgrades it using its own purification and liquefaction units, which are located separately on each farm. The nitrogen required for liquefaction is purchased centrally and distributed to the farms. The liquefied biomethane is collected from the farms and transported to a centralized distribution point to be delivered for customers.

The purchase price of nitrogen is the most predominant cost factor for biomethane liquefaction, making it the primary driver for the cooperative model. In addition to nitrogen cost, the cooperative gains advantages in the marketing and sale of the liquefied biomethane. Another benefit of the cooperative is in its security of supply, as the cooperative can provide a stable supply of biomethane even in the event of one biogas plant being out of operation.



The cooperative model. Source: HABITUS project, Centria UAS

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ABOUT BRANCHES

BRANCHES is a H2020 "Coordination Support Action" project, that brings together 12 partners from 5 different countries. The overall objective of **BRANCHES** is to foster knowledge transfer and innovation in rural areas (agriculture and forestry), enhancing the viability and competitiveness of biomass supply chains and promoting innovative technologies, rural bioeconomy solutions and sustainable agricultural and forest management.

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THE PARTNERSHIP

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