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The future potential for liquefied biogas, LBG

Liquefied biogas (LBG) is a renewable energy carrier with strong potential for heavy transport and maritime applications, particularly in areas where electrification is difficult or insufficient. This information brief summarizes a preliminary study that has mapped the technical, economic, and market conditions for establishing LBG production in the Nordic region, with a focus on northern Sweden and Finland (the Aurora area). It also describes existing and planned facilities, technology providers, and market opportunities.

THE BIOGAS PROCESS AND LBG

Biogas, which consists of approximately 60% methane, is upgraded to biomethane (>97% methane) and liquefied into LBG. This process also generates by-products such as carbon dioxide and digestate, which have various applications, for example in agriculture and industry. LBG has three times the energy density of compressed biogas (CBG), enabling storage and transport over longer distances — a key advantage in regions without gas grid infrastructure, such as Sweden, Norway, and Finland.

MARKET SITUATION AND DEMAND IN THE NORDIC REGION

Denmark is the Nordic leader in biogas production, followed by Sweden and Finland. Sweden produced 2.3 TWh of biogas in 2023 but consumed 4.1 TWh, resulting in a need for imports. Demand for biogas is expected to increase significantly, especially for LBG in heavy transport and maritime sectors. Sweden currently has around 34 LBG refuelling stations, and the goal is for 8,000 heavy trucks to run on LBG by 2030, corresponding to a demand of 6 TWh of LBG. Finland produced approximately 1 TWh and consumed 846 GWh of biogas in 2023. Finland's target is at least 4 TWh of domestic biogas production by 2030, with a strong focus on locally sourced feedstocks. Norway produced 0.7 TWh of biogas in 2023.

BIOGAS PLANTS IN THE AURORA REGION

The Aurora region includes northern Sweden, Finland, and Norway, with 59 biogas plants producing a total of 323 GWh of biogas. This corresponds to approximately 33 million litres of gasoline. The majority are small-scale agricultural and sewage sludge facilities, along with a few larger industrial plants. Only a limited number have liquefaction capacity, highlighting the potential for expanding LBG production in the region.

TECHNOLOGIES FOR BIOGAS LIQUEFACTIO

There are two main technologies for LBG production:
A) Cryogenic upgrading with simultaneous liquefaction
B) Separate upgrading followed by liquefaction

These two technologies are illustrated in Figure 1, where option A is typically used for newly built biogas plants, while option B is common for existing plants that are being expanded. Liquefaction processes are based on various cooling technologies, and the final liquefied methane reaches a temperature of –162 °C. Each technology has its own advantages



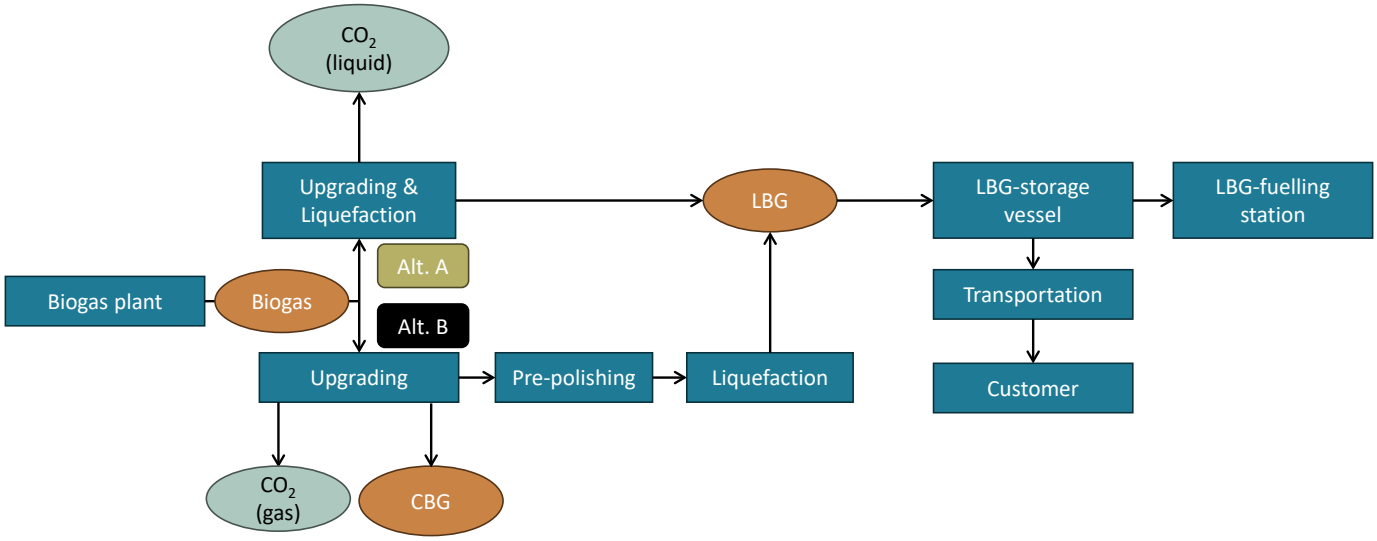


Figure 1. Schematic description of the two main techniques during liquefaction. Alternative A - cryogen upgrading with simultanoues liquefaction. Alternative B - separate upgrading followed by liquefaction.

and drawbacks in terms of energy efficiency, investment cost, and scalability. Cryogenic upgrading enables simultaneous CO_2 separation and recovery. A summary is provided in Table 2.

TECHNOLOGY SUPPLIERS

Several companies supply technological solutions for LBG production, including Air Liquide, Biofrigas, Cryonorm Group, CryoPur, Cryotec, Galileo Technologies, Linde, Nordsol, SIAD Macchine Impianti, Stirling Cryogenics, and Wärtsilä. These are presented in more detail in the report.

PLANT CASES

As of 2025, biogas liquefaction is developing rapidly, particularly in Sweden, and many applications for expansion and new construction of biogas plants—including liquefaction capacity—have been submitted to the Klimatklivet support scheme. In Finland, several larger plants of around 100 GWh are also in the planning or construction phase. Currently, there are 16–20 plants in Sweden, Finland, and Norway that liquefy biogas, with almost all located in the central and southern parts of these countries.

Table 3. Economic analysis of three typical plants of different sizes.

Plant	Production (GWh/year)	Status	Technology provider
Härnösand (HEMAB)	18	Started 2025	Stirling
Östersund	36	Started 2025	Hysytech
Domsjö	100	Not started	Wärtsilä
Götene (Gasum)	133	Started 2025	Wärtsilä
Linköping	150-300	Started 2025	Wärtsilä

The report presents five case studies from Sweden describing investment choices and technical configurations. HEMAB in Härnösand has expanded its existing CBG-production facility using Stirling technology; Biogas i Jämtland Härjedalen is constructing a new plant; and larger facilities such as Domsjö, Götene, and Linköping are investing in Wärtsilä technology and large-scale liquefaction. A brief summary is provided in Table 3.

Table 2. Comparison of different techniques for liquefaction of biogas.

Technology	Advantages	Disadvantages	Energy efficiency (kWh/kg LBG)
Nitrogen expansion process	Robust, easy maintenance, small to medium scale	High energy consumption in single expansion	0,52 – 1,20
N_2-CO_2 expansion process	Lower energy consumption	Higher complexity and cost	0,32 – 0,85
Linde cycle	Simple design	Requires high pressure and multiple cooling stages	0,66 – 1,16
Stirlingprocess	Energy efficient for small-scale plants	Limited scalability	0,43 – 1,45
Rankine cycle with mixed refrigerants	Optimized energy efficiency, large-scale	Expensive and requires precise control	0,32 – 0,85
Cryogenic evaporation with N_2(l)	Simple and safe	Requires continuous supply of N_2(l)	Low, depending on N_2(l)-consumption

MARKET – HEAVY TRANSPORT

On average, a heavy truck driving 700 km per day consumes approximately 600 MWh of LBG per year. LBG/LNG consumption from the transport sector in 2024 amounted to 735 GWh in Sweden and 160 GWh in Finland. Sweden has about 86,000 heavy trucks, and the goal is for 8,000 of them to run on LBG by 2030, corresponding to a demand of 6 TWh of LBG. This is more than the total current biogas consumption in all of Sweden (4.1 TWh). In Finland, the target is to produce at least 4 TWh of biogas annually by 2030, primarily for use in transport, industry, and heat production. The focus is on utilising domestic feedstocks such as manure, waste, and biomass to reduce emissions and strengthen energy security.

MARKET – MARITIME SECTOR

In the maritime sector, fuel consumption per vessel is generally much higher than in heavy transport and is concentrated in a single port. Wasaline's ferry Aurora Botnia, which can operate on LNG/LBG as well as diesel and also use electricity while in port, has an annual consumption of 25–30 GWh.

Other examples of LNG-powered ferries in the Baltic Sea include Viking Line's Viking Glory and Viking Grace. Together, they consumed 27,197 tonnes of LNG in 2023, corresponding to roughly 367 GWh, in addition to 41,180 tonnes of marine diesel. In Norway, Hurtigruten is working actively with sustainability and aims to build a fully emission-free ferry by 2030, powered by electricity within the Sea Zero project. LBG is highly competitive in price compared with other green fuels, indicating that demand is likely to increase steadily in the coming years.

MARKET – INDUSTRY

In the industrial sector, interest in replacing liquefied natural gas (LNG) with LBG has grown in recent years. This is a relatively straightforward way to improve sustainability, as LBG can directly replace LNG, fully or partially. In 2023, approximately 8.5 TWh of natural gas/LNG was delivered to the Swedish market. Industry is the largest user of natural gas (73%), followed by other sectors (15%), power and heat generation (9%), and residential buildings (3%). Within industry, the steel and metal sectors consume the most (38%), followed by food production (20%), the chemical industry (19%), minerals (12%), pulp and paper (5%), and other industries (6%). In Finland, natural gas is primarily used in industry—especially in the chemical sector—but also for electricity and heat production, as well as in shipping and heavy transport. In 2022, consumption amounted to 11.9 TWh, half of the level in 2021.

Table 4. Economic analysis of three typical plants of different sizes.

Plant size (GWh/year)	Investment cost (€)	CAPEX (€ /year)	OPEX (€ /year)	Capacity (ton/day)
10	2,5 million	293 000	200 000	2
50	7,5 million	879 000	600 000	10
100	12,5 million	1 465 000	1 000 000	20

ECONOMIC ANALYSIS

The production cost of LBG varies with plant size, with economies of scale reducing costs at higher volumes (Table 4). Investment costs for liquefaction facilities are estimated at between EUR 2–12.5 million, depending on capacity (10–100 GWh/year). Operating costs and energy consumption are significant factors. Support mechanisms such as investment grants, tax exemptions, and biotickets (in Finland) are crucial for profitability and competitiveness. The price of LBG is influenced by the TTF natural gas price, the EU Emissions Trading System (EU ETS), and national taxes and subsidies. Comparisons show that with support in place, LBG can become price-competitive, especially for larger facilities.

MARKET OPPORTUNITIES AND CHALLENGES

LBG presents opportunities for export, heavy transport, maritime operations, and industrial users. At the same time, there are risks such as price pressure from the LNG market, political uncertainty regarding subsidies, and the need to expand infrastructure such as refuelling stations. Heavy transport and maritime sectors in particular show strong potential, with LBG offering a competitive alternative to diesel and LNG. Industrial demand is increasing, but weak incentives and uncertain certificate markets pose obstacles. In the maritime sector, LBG is a reliable green fuel, though the market is limited by bunkering availability and regulatory requirements.

SUMMARY

The report shows that there are solid technical and feedstock-related conditions for establishing LBG production in the Nordic region, but that this requires coordinated efforts from industry, policymakers, and local communities. Investments in technology, infrastructure, and market development—together with supportive policy frameworks and long-term contracts—are essential for LBG to become a significant part of the future fossil-free energy system.

REPORT - IN SWEDISH

Read more in the report, published on the project webpage:

Förstudie för produktion av LBG. Saarela, J., Norberg, I. och Lagerlius, J. 2025. https://assets.v3.snowfirehub.com/files/121860/114_forstudie-for-produktion-av-lbg-2025-final.pdf

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