

This is one of 12 case studies presented in the report "Biogas from manure, and waste products – Swedish case studies"
Download full report at www.gasforeningen.se.

This handbook is published by the Swedish Gas Centre, the Swedish Gas Association and the Swedish Biogas Association and these associations take full responsibility for the contents. The Swedish Environmental Protection Agency and Swentec (Swedish Environmental Technology Council) provided financial support for the production and translation of this handbook.

The biogas plant in Gothenburg

Facts/unique: Upgrading with the Coaab technique and distribution to the gas grid. The upgrading plant is one of the largest in the world.



Figure 1 The upgrading plant at Arendal, Gothenburg

The wastewater treatment plant at Gryaab has been digesting waste water sludge anaerobically since 1990. The two reactors were built to handle the sludge produced from the treatment of wastewater at the Rya plant in Gothenburg. The biogas was originally used to generate electricity and heat. Later, the biogas was distributed through the Gothenburg gas grid. On the initiative of the foundation 'Svensk Metanteknik' (Swedish methane technology), a small upgrading plant was built at Rya in 1992 to convert some of the biogas to vehicle fuel quality. The development of biogas purification technology continued at Gryaab, and in 1994 the first biogas filling station in Sweden for private cars was opened at the plant. Starting in 1996, fatty wastes destined for the reactor at Gryaab could be handled separately. The energy company 'Göteborg Energi' (Gothenburg Energy) soon noted an increased

demand in the region for environmentally-friendly vehicle fuels, and decided to increase the capacity to upgrade biogas. In 2007, a new upgrading plant owned by Göteborg Energi was opened in Arendal, which purifies the gas by chemical absorption.

Although it was a small-scale operation, the Rya plant was, together with Linköping, the first in the country to purify biogas from sludge. The facility to handle fatty wastes was also one of the first of its kind. The new upgrading plant in Arendal is one of the largest in the world. Göteborg Energi is aiming to replace all the natural gas used in Gothenburg with biogas and is continuing to invest resources in projects that promote biogas production in the region. For example, there are plans to produce bio-methane from combustion of biomass waste from the forest industry (e.g. branches, twigs etc. remaining after felling).

The biogas plant and substrate

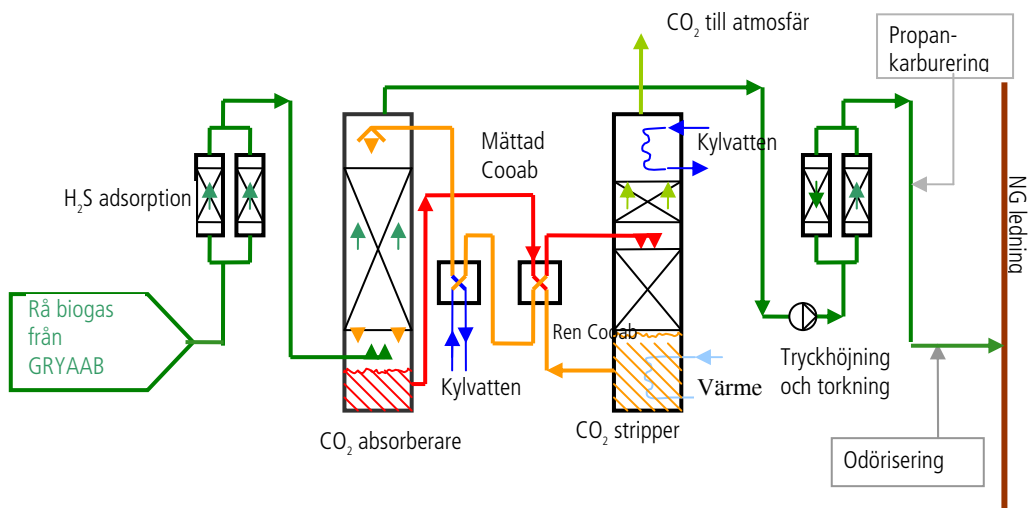


Figure 2 Diagram of the upgrading process with Coaab

The Gryaab plant treats c. 430,000 m³ per year of thickened raw sludge from the wastewater treatment plant at Rya, equivalent to 21,000 tons dry weight. There are two mesophilic (37°C) one-step (continuously-mixed) anaerobic digesters, each with a volume of 11,400 m³. The retention time for the material is c. 20 days. In 1996, the reactors also started to treat sludge from grease separators and other organic substrates such as ground food wastes from restaurants and schools in the Gothenburg region, which has increased the production of biogas. The fatty wastes are received in a separate closed system, from where the organic material is pumped directly into the reactor without mixing with the other substrates.

Upgrading and use of the biogas

Gryaab's biogas plant produces each year c. 60,000 MWh of raw gas. This is sold to Göteborg Energi, and most is then upgraded to natural gas quality. There is also a

Digestion residue

The 50,000 tons of digested sludge produced annually at the biogas plant is composted. Trucks deliver sludge from the Rya plant to the composting facility 6 or 7 times daily. The sludge is first mixed with sawdust or bark. Rock flour and sand is also added after composting, and the final product is marketed as a soil material for construction. Of the order of 194,000 tons of soil material is produced annually for construction of golf courses and roads etc. and as a cover material in landfills. Gryaab is also working towards the goal of returning some of the sludge to agricultural land.

Financing

The reactors cost 88 million SEK (in 1990). The project was self-financed. The investment costs for the new upgrading plant were 40 million SEK, 9 million SEK of which were covered by a grant from KLIMP. In 1998, Gryaab received a 0.6 million SEK grant from LIP to develop facilities to co-digest sewage sludge with sludge from grease separators and food wastes. The total cost of this investment was 5 million SEK. Other LIP and KLIMP grants have been received, for example, to construct new filling stations. The new upgrading plant will be profitable in the long-term.

Lessons learned

The construction of the reactors went according to plan, and resulted in a significant profit due to reduced costs for sludge disposal. The separate handling of fatty wastes is working well and has decreased the amount of fat transported through the sewage pipe network. The construction of the new upgrading plant has also gone according to plan, although it was delayed a little. A plant that treats combustible gas is covered by many regulations, something which is worth considering for those who are planning similar projects. The purification technique is working quite well, but the plant has suffered some initial technical problems that the operators hope to fix. The plant received a lot of attention during construction. The interest in biogas has increased dramatically since the project started, and the plant has received many visits from both politicians and overseas visitors.

It is important to ensure that the whole chain of production works satisfactorily, from the supply of raw materials to the distribution of the final product. Careful analyses should be carried out of the available raw materials, how much gas can be produced, the size of the market for the final products, and how the biogas will be distributed to the customer. Several different upgrading techniques are available, each with its advantages and disadvantages. The best technique to adopt will depend on the situation and conditions at the plant in question.

Benefits for the environment and society

The environment has benefited from the fact that the large amounts of biogas produced at Gryaab are now converted to vehicle fuel quality. The development of the upgrading plant has decreased emissions of fossil carbon dioxide by nearly 12,000 tons annually. Furthermore, the air quality in the city is improving as more cars are driven on biogas. The demand for biogas as a vehicle fuel is continuously increasing and more filling stations are opening, which improves its availability. The existing natural gas grid in Gothenburg has played an important role in this growth, since the biogas can be distributed together with the natural gas without the need for new pipelines.

The Gryaab plant makes neither a profit nor a loss on the increased biogas production and its sale for upgrading, but it does help to maintain the costs of waste water treatment that are charged to householders at a low level. The amount of sludge resulting from wastewater treatment has decreased considerably since the reactors were installed. The sludge supplied to the following compost process smells much less than when undigested sludge is composted.

Facts 1. Basic data on the biogas plant

Start year (biogas production):	1990
Digester volume:	2 x 11 400 m ³
Process temperature:	37°C
Start year (upgrading):	1992 and 2007
Upgrading method:	PSA and Coaab
Investment costs (reactor):	88 million SEK (1990)
Investment costs (upgrading):	40 million SEK (2007)

Facts 2. Yearly inputs and outputs

Substrate:	
Sludge from grease separators	5 000 tons (c. 250 tons dry weight)
Other organic waste	4 000 tons (c. 200 tons dry weight)
Thickened sludge (wastewater treatment)	430 000 tons (21 000 tons dry weight)
Biogas:	
From the biogas plant	60 000 MWh
Upgraded biogas	60 000 MWh
Digestion residue:	
De-watered sludge	50 000 tons
Soil products	194 000 tons

Contacts

	<p>www.goteborgenergi.se www.gryaab.se</p> <p>Ola Fredriksson, Gryaab Telephone: +46 31 647400 E-mail: ola.fredriksson@gryaab.se</p> <p>Emma Jacobsson, Göteborg Energi AB Telephone: +46 31 62 73 12 E-mail: emma.jacobsson@goteborgenergi.se</p>
--	---

Suppliers

Biogas plant:	<p>Plant: Läckeby Water AB www.lackebywater.se</p> <p>Construction: NCC www.ncc.se</p>
Upgrading plant, Main contractor:	<p>Läckeby Water AB www.lackebywater.se/sv</p>
Upgrading plant, Sub-contractors:	<p>Electricity and instrumentation: Actemium Stenungsund c/o Emil Lundgren AB www.emillundgren.se/stenungsund</p> <p>Construction: Tuve Bygg AB www.tuvebygg.se</p>