

This is one of 12 case studies presented in the report "Biogas from manure, and waste products – Swedish case studies"  
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## The biogas plant in Boden

Facts/unique: thermophilic (55°C) co-digestion of sewage sludge and food wastes.  
First in Sweden to deal with methane leaks during upgrading.



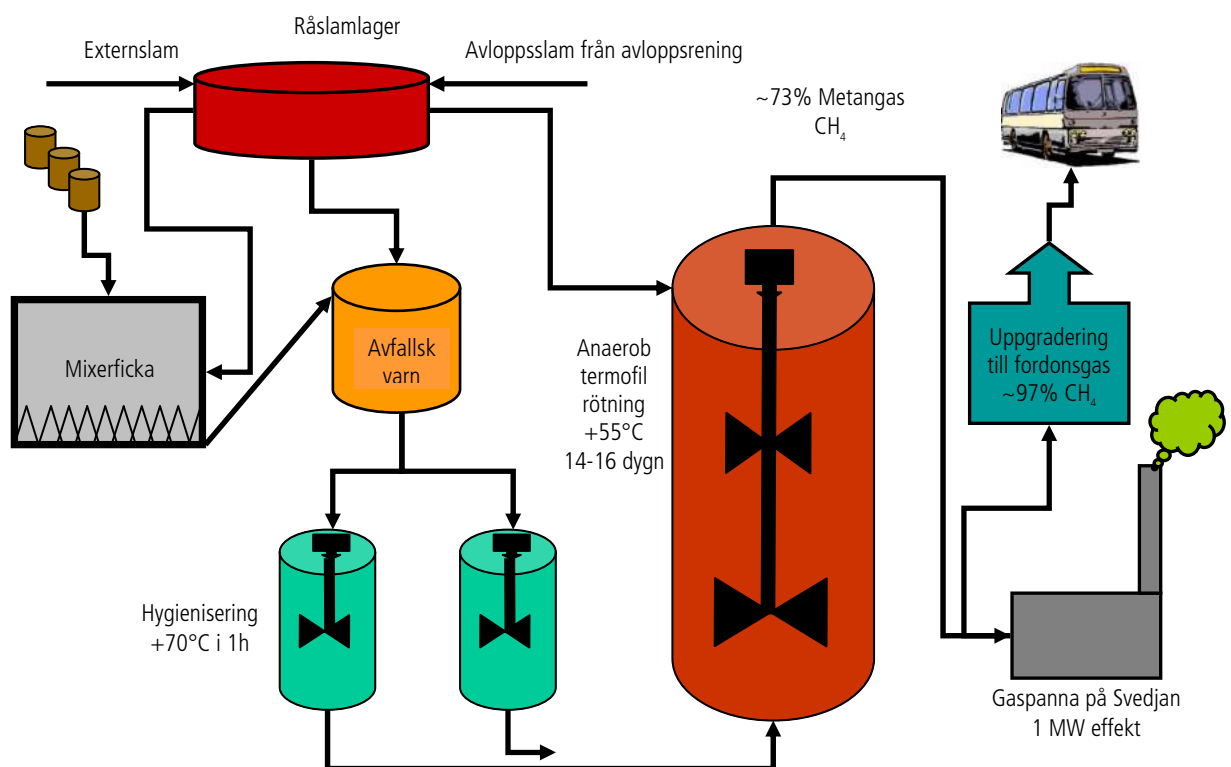
**Figure 1** The biogas plant at Svedjan, Boden

The biogas plant in Boden, which started operating in 2003, can be seen as one result of the focus placed on environmental questions by the local authority since the early 1990's. The biogas produced by the sewage treatment plant at Svedjan was first used only for heating. Biogas production increased when the plant began co-digesting sludge with food wastes. The objective was to make more efficient use of the energy in the biogas. Plans to use the biogas as a vehicle fuel were finally realised within the framework of the KLIMP program. In the spring of 2007, Sweden's and the world's most northerly upgrading plant and filling station for biogas was ready to begin operation.

More methane can be extracted by co-digesting sludge and source-sorted household waste, than when sludge is digested alone. In turn, this results in a greater production of biogas, which supplies Boden's filling station with environmentally-friendly fuel. It is important from a strategic point of view that biogas as a vehicle fuel is also produced in northern Sweden. Together with Östersund and Skellefteå, Boden has led the way by establishing the first upgrading plants north of Uppsala. More local authorities in northern Sweden are now ready to follow Boden's example.

## The biogas plant and substrate

The biogas facility at Svedjan co-digests sewage sludge from eleven sewage treatment plants run by the local authority and c. 1200 individual septic tanks with source-sorted food waste from households, restaurants and shops. The food waste is chopped and mixed with the sludge in a 'pulper'. The mixture is pasteurized at 70°C for one hour before it is pumped into the reactor, which has a volume of 1300 m<sup>3</sup>. The process is thermophilic, with a temperature of 55°C and a retention time of between 14 and 16 days.

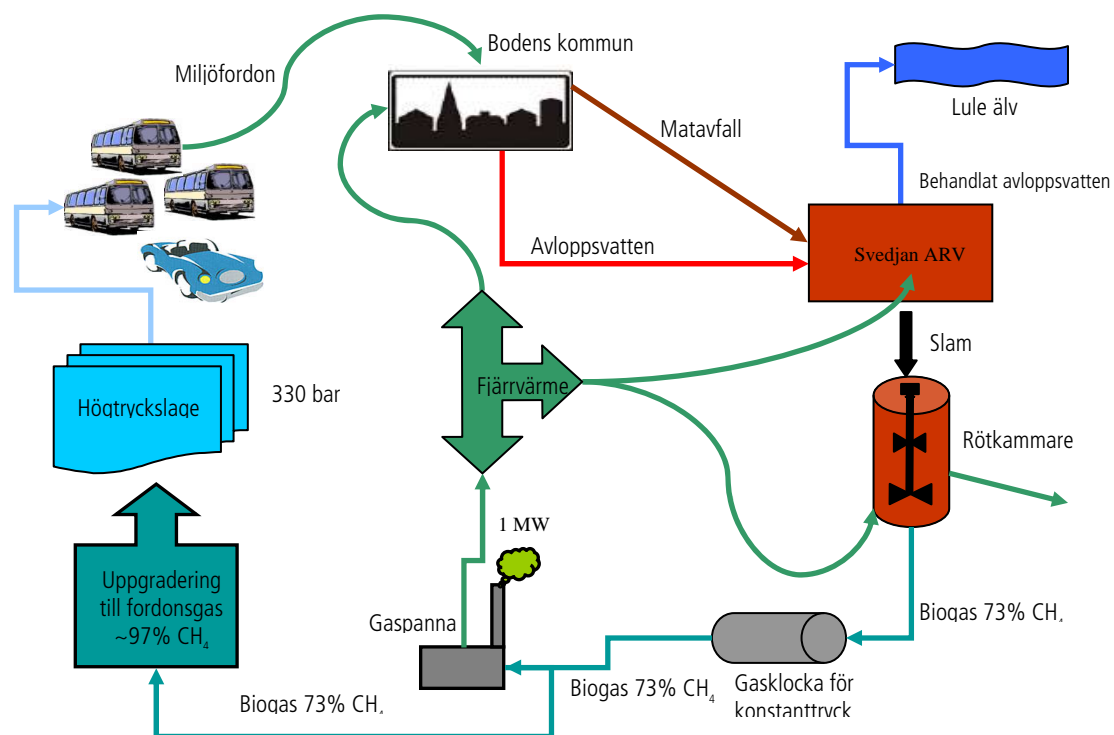


**Figure 2** Diagram of the biogas plant in Boden

## Upgrading and use of the biogas

Some of the biogas was previously combusted in a boiler to heat the plant buildings. The excess heat (c. 3000 MWh) was distributed through the district heating

network in Boden. Since the upgrading plant (of the water wash type) started operation, some of the biogas is now converted to vehicle fuel. The upgrading plant at Boden was the first in the country to deal with leaks, which amount to c.3% of the methane produced. The leaks are made harmless by catalytic combustion. The excess energy is used to heat buildings. This new technology reduces methane leakage to c. 0.1%. In step with increasing demand, the plant can produce c. 600,000 Nm<sup>3</sup> of vehicle gas annually, which replaces roughly 0.7 million litres of petrol.



**Figure 3** Biogas and vehicle fuel are produced from sewage sludge in Boden

### Distribution of the biogas

High pressure compressors, gas storage tanks and filling equipment are located c. 500 m from the sewage treatment plant. The gas is transported under a pressure of 10 bars in a pipe 250 mm in diameter. The gas is stored in containers at three different pressures in the proportions 1:2:3, with the high pressure containers (330 bars) as the smallest storage. The liquid volume is c. 26 m<sup>3</sup> which implies a gas volume of c. 6000 Nm<sup>3</sup>. The dispenser at the filling station has two different mouthpieces, one for quick filling of heavy vehicles and one for cars. Another dispenser is also planned. There is also a possibility to fill up from two containers.

In the near future, the biogas from the Svedjan plant will support 6 buses, 3 heavy vehicles and 150 local authority- or privately-owned cars.

## **Digestion residues**

The digestion residue (c. 1600 tons per year) is used to produce filling material and soil conditioner. In the future, a range of different products may be developed (e.g. forest pellets) based on the digestion residue. The residue is de-watered by centrifugation to a dry weight of c. 30%. The residue is stored in silos and transported by truck (c. 30 tons for each transport).

## **Financing**

The investment costs for stage 1 (the digester and the pre-treatment facility for food wastes) were 26.8 million SEK. Of this, LIP contributed 10.4 million SEK. The total investment cost for stage 2 (the upgrading plant and filling station) was 19.5 million SEK. Of this, KLIMP contributed a little more than 8.3 million SEK. The net investment was therefore 27.6 million SEK, which means that the annual capital cost is c. 2.5 million SEK. Both investments are economically viable for the following four reasons:

- A. the amount of sludge produced by sewage treatment has halved, which means that transport costs have decreased by c. 0.5 million SEK per year.
- B. The local authority can treat food wastes in their own facility. The cost is calculated at c. 200 SEK per ton, which can be compared with the cost of composting, which is calculated at 700 SEK per ton. The savings are estimated at 1 million SEK per year.
- C. The net income from the sale of vehicle gas, when full production is reached in a few years, will be c. 3.5 million SEK per year. This calculation assumes that the biogas is not used to heat the plant.
- D. The plant has the capacity to accept and treat 1000 tons of food waste from other sources, which will give an income of c. 0.5 million SEK per year.

In total, the savings will be of the order of 3 million SEK per year, which means that the investment will be repaid within a 10-year period.

## **Lessons learned**

Construction has largely gone according to plans. However, stage 1 was delayed for a little more than a year because the legal decision to approve construction was appealed. In the planning and construction phases, it is important to carefully select the substrates that the plant will treat. Problems can occur with the quality of the food waste, either because of mistakes in source-sorting or during transport. The concept can therefore be recommended for future biogas producers, providing that the quality of the food waste can be guaranteed. The upgrading plant is working especially satisfactorily.

## Benefits for the environment and society

Emissions of carbon dioxide from the Boden area have decreased by a little more than 1400 tons per year as a result of the development of biogas. The filling station for biogas is easily accessible and the local authority encourages the purchase of biogas-driven cars. For example, local inhabitants have been offered 800 Nm<sup>3</sup> of free gas in 2008 if they invest in a biogas car.

The establishment of more filling stations in the northern counties is strategically important for the development of biogas in Sweden as a whole. Apart from the existing public filling stations at Boden and Östersund, Skellefteå will soon open a biogas station, and Sundsvall will follow within a few years. The Swedish Environmental Protection Agency has approved grants to the gas supply company 'Fordonsgas' to open filling stations for vehicle gas in a number of towns along the coast of northern Sweden.

Construction of the biogas plant at Boden has reduced the amount of organic waste that was earlier deposited in landfills by c. 5000 tons per year. Anaerobic digestion has reduced the volume of sludge, which in turn has decreased the number of truck journeys by c. 700 per year. New technology is used to deal with methane leaks at the upgrading plant, which means that emissions of this greenhouse gas to the atmosphere are now negligible. Construction of the plant created employment, and one new position was created to run the plant.

### Facts 1. Basic data on the biogas plant

Start year (biogas production):	2003
Digester volume	1 300 m <sup>3</sup>
Process temperature:	55 °C
Start year (upgrading):	2007
Upgrading method:	Water wash
Total investment costs:	46.3 million SEK

### Facts 2. Yearly input & outputs

Substrate:	
Source-sorted food wastes	1 200 tons
Sewage sludge	24 000 tons (960 tons dry weight)
Biogas:	
From sewage sludge	2500 MWh
From food wastes	3 000 MWh
To local heating	3 500 MWh
Distributed through heating network	1 600 MWh

Upgraded biogas	400 MWh
Digestion residue:	
Filler material in construction	1 000 tons
Soil conditioner	600 tons

#### Contacts

	<a href="http://www.boden.se">www.boden.se</a> Ove Andersson Telephone: +46 921 621 78 E-mail: <a href="mailto:ove.andersson@boden.se">ove.andersson@boden.se</a>
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#### Suppliers

Biogas plant:	Läckeby Water AB <a href="http://www.lackebywater.se">www.lackebywater.se</a>
Upgrading plant, storage tanks and filling station:	YIT Vatten och miljöteknik AB <a href="http://www.yit.fi">www.yit.fi</a>