

# BIOGAS BIOFUEL

# LINKÖPING Sweden

*In the transport sector, municipal efforts to reduce local emissions imply carrying out a modal transfer away from private car towards public transport and at the same time limiting the emissions produced by urban public transport and captive fleets of vehicles. Several municipalities have started to investigate the possible energy uses as motor fuel of biogas, a renewable energy source produced from household refuse and/or agricultural waste on landfill or in sewage plants.*

## GENERAL ASPECTS

Linköping is a city with approximately 82,000 inhabitants (132,000 if considering the whole urban area) located to the south-east of Stockholm on the River Stångån. As the capital of the County of Östergötland, the city is a major tertiary centre with many higher education schools and research units. It has also a diversified industrial activity (mechanical engineering, aircraft industry, defence equipment, electronics and micro-electronics, food-processing industry). Its location at the centre of the region and its excellent communication network have made the city into a national and international business centre.



## CONTEXT

46,000 private cars move through the urban area of Linköping every day (29,200 through the city itself) and 8,582,000 persons used public transport in 1997. The centre of the city concentrates most of traffic problems as it is not easy to drive a bus through its narrow streets. The converging point of the public transport network is located in the city centre and is now too small for current traffic flow. The high number of buses passing through this area is responsible for the high emissions and noise levels registered. In the suburbs, as population density is quite low, public transport services are not highly developed and the inhabitants are not well served.

The Municipality has changed most of the buses of its fleet for low-floor vehicles easier to get into for less mobile people. Most of them are equipped with a system that gives them right of way at traffic lights and with a vocal system indicating the name of the next stop to the users. Many of these new buses run on alternative fuels which are more friendly to the environment than conventional ones.

By the end of 1999, all public transport stops should be refurbished so as to make them more users' friendly and accessible and the system of giving right of way at traffic lights should also become the norm.

## EXPERIENCE OF LINKÖPING

The increase in private motorised traffic and the subsequent rise in air pollution motivated local authority decision-makers to limit traffic flows in the centre of the city and to make of the development of public transport a top priority on the municipal agenda.

Air quality, however, remained poor in several city districts. To improve these results, the municipality decided to experiment with biogas fuel on its fleet of urban vehicles. Initiated in 1989, the operation really started off in 1991. From 1989 to 1993, five Scania buses were tested. Their introduction being a success, a total of 20 units were integrated into the fleet. In 1998, the number of vehicles running on biogas fuel in Linköping amounted to 57 urban buses and 14 cars, including 4 taxis. 8,000 Nm<sup>3</sup> of biogas are supplied daily to make them run.

### Biogas production in Linköping

Biogas is produced from organic waste being decomposed by micro-organisms, as in a heap of compost. But in the case of biogas, decomposition is anaerobic, which means that it takes place in an oxygen-free atmosphere. The digestion process of organic waste produces mainly methane and carbon dioxide. Several types of organic waste can be used to be decomposed. The result is always satisfactory provided that the amounts of nitrogen and carbon are sufficient.



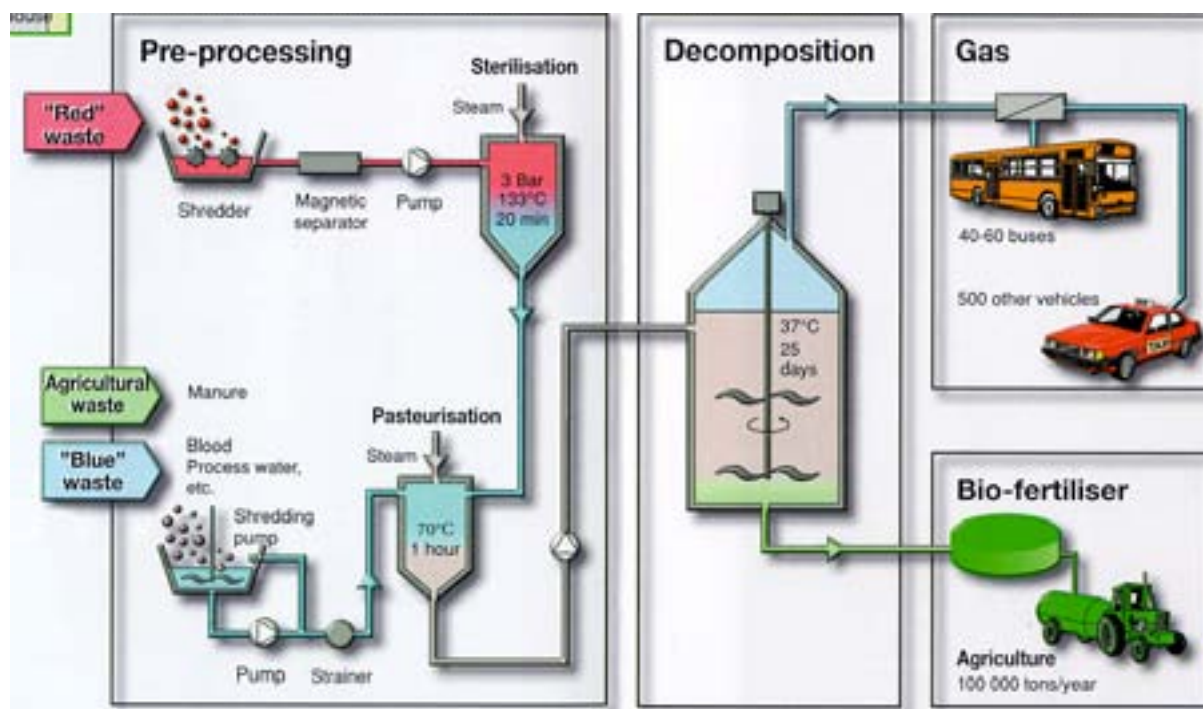
To be used as fuel in vehicles, biogas needs to be cleaned of carbon dioxide and must be composed of at least 95% of methane. When these conditions are complied with, one Nm<sup>3</sup> of biogas equals to around one litre of diesel oil or petrol. As a general rule, a bus can take enough biogas fuel to travel 300-400 kilometres. As for cars running on biogas, they are usually equipped with two tanks (a traditional petrol tank plus a gas tank) and can travel 200 kilometres with each of them.

### Biogas production site

The organic waste treatment plant is located at Åby Västergård. Waste is mainly composed of so-called “red” and “blue” waste. Red waste corresponds to different types of waste from slaughterhouses requiring special treatment in terms of safety. Around 70% of the biogas produced at Åby Västergård result from the digestion of red waste. “Blue” waste comes from local slaughterhouses and is composed of blood, stomachs and bowels of animals as well as large quantities of process water. It is to be noted that this process water was previously

directed to the local sewage plant to be treated. In order to slow down the digestion process, waste is mixed with manure from farms. Other forms of organic waste can also be used.

The mixture is heated and placed in digestion tanks where bacteria transform the nutritive substratum into methane and carbon dioxide essentially. Methane is the component that will be used to produce biogas. To be used as fuel in vehicles, biogas needs to be cleaned of the carbon dioxide, vapour and trace levels of hydrogen sulphide it contains. In Åby Västergård, the cleaning technique used is the absorption technique.



Once cleaned, biogas is conveyed by pipeline at a pressure of 4 bars to the bus depot in Barhäll. It is then compressed up to 200 bars. Bus filling up is done automatically at night by means of slow-filling stations. Forty five buses can be filled-up simultaneously. There is also a quick-filling station.

### Partners involved

The partners are:

- Linköping Biogas AB, which is jointly owned by Tekniska Verken i Linköping AB (the municipal engineering firm of Linköping) and the agricultural organisation Scan-Farmek,
- Tekniska Verken i Linköping AB, which looks after the city energy and water supply and is also responsible for managing waste water treatment and industrial and household waste collection in the region,
- Scan-Farmek, one of the biggest foodstuff producers in Sweden,
- Konvex, which runs several recycling plants for slaughterhouse waste,
- The Swedish Farmers' Federation (LRF).

## EVALUATION AND PERSPECTIVES

The money invested in Linköping amounts to 8.4 million Euro. Using biogas as fuel contributes to reducing nuisance in terms of pollutant emissions (no emissions of particles or dust, low emissions of nitrogen oxide) and noise.

The following table shows the emission cycles for the different fuels and the amount of money granted (by the Swedish government) for using them. It is clear that biogas appears as an extremely attractive solution to diesel, either from an economic or environmental point of view.

	NO <sub>x</sub> ECE R49	CO <sub>2</sub> index	Premium per km (Euro)
Diesel Euro II	7.0	100	0
Diesel Euro IV (expected)	3.5	100	0.03-0.04
Biogas	2.0	0-5	0.04-0.05
Ethanol	3.5	5-15	0.05-0.08

In Linköping, each bus running on biogas fuel contributes to reducing nitrogen oxide emissions (NO<sub>x</sub>) by 1.2 tonnes and carbon dioxide emissions (CO<sub>2</sub>) by 90 tonnes per year.

The experience carried out in Linköping is economically viable for three reasons:

- Any person who disposes of waste on a dumping ground or discharges waste water into a sewage plant has to pay a tax,
- The price for biogas is comparable to the price of diesel, which makes it easy to sell,
- Manure produced in Åby Västegård (100,000 tonnes per annum) is sold.

A second filling station is planned to be built if the demand for biogas fuel increases significantly (taxis, company vehicles, delivery vehicles and private cars).

## FOR FURTHER INFORMATION

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