



## Biogas in Sweden

Energy source for the future from sustainable waste management

*Biogas technology enables long-term, sustainable waste management that turns waste into a carbon-neutral energy resource.*

### **An energy source for cities**

Biogas production and utilization, e.g. production of heat, electrical power and vehicle fuel, can function as island solution for waste to energy concepts in cities without gas infrastructure. Wherever there is a natural gas infrastructure, it can be used to increase the use of biogas, including for transport purposes.

### **Development until today**

Biogas has been produced in the Swedish sewage treatment plants since 1940's. The sewage sludge was initially digested to reduce the sludge volumes. The energy crisis of the 1970's led to an increased interest in the development of the technology where renewable methane gas is produced from other organic material. The purpose was to reduce the environmental impacts from energy production and to be less dependent on fossil fuels.

In the following decade large scale biogas plants were built and more research and development programmes were introduced. The industry showed the way, as sugar refineries and pulp mills started to use the biogas process to purify the process water in the 1970's. During the same peri-

od farm plants for digesting manure were also introduced. Major investments backed by national programmes, have since then resulted in a broad expertise related to how the management and use of various residual products, waste and crops can be optimised.

As waste management and waste water treatment in Sweden is a responsibility of local governments a lot of competence was built up in the municipalities as well. In order to decrease methane emissions from landfills, extraction of methane from landfills was introduced in the 1980's. During the 1990's large scale co-digestion of collected organic waste from different sources was introduced. Quite a number of new biogas production facilities have been built where different kinds of organic substances are digested, e.g. waste from dairy industries, slaughterhouses, as well as source separated food waste from households and restaurants.

Upgrading technology, substrate optimization and process optimization are new areas of cutting edge competence in Sweden. As a consequence the knowledge about the whole system management in itself is also advanced.

## Current production of biogas in Sweden

The total amount of biogas produced in Sweden 2010 amounted to 1.4 TWh, based on a population of approximately 9.4 million (2010). The biogas is produced from sewage water treatment plants (44%), landfills (22%), co-digestion plants (25%) and industrial facilities (8%). Small scale farm plants produces about 1% of the total amount.

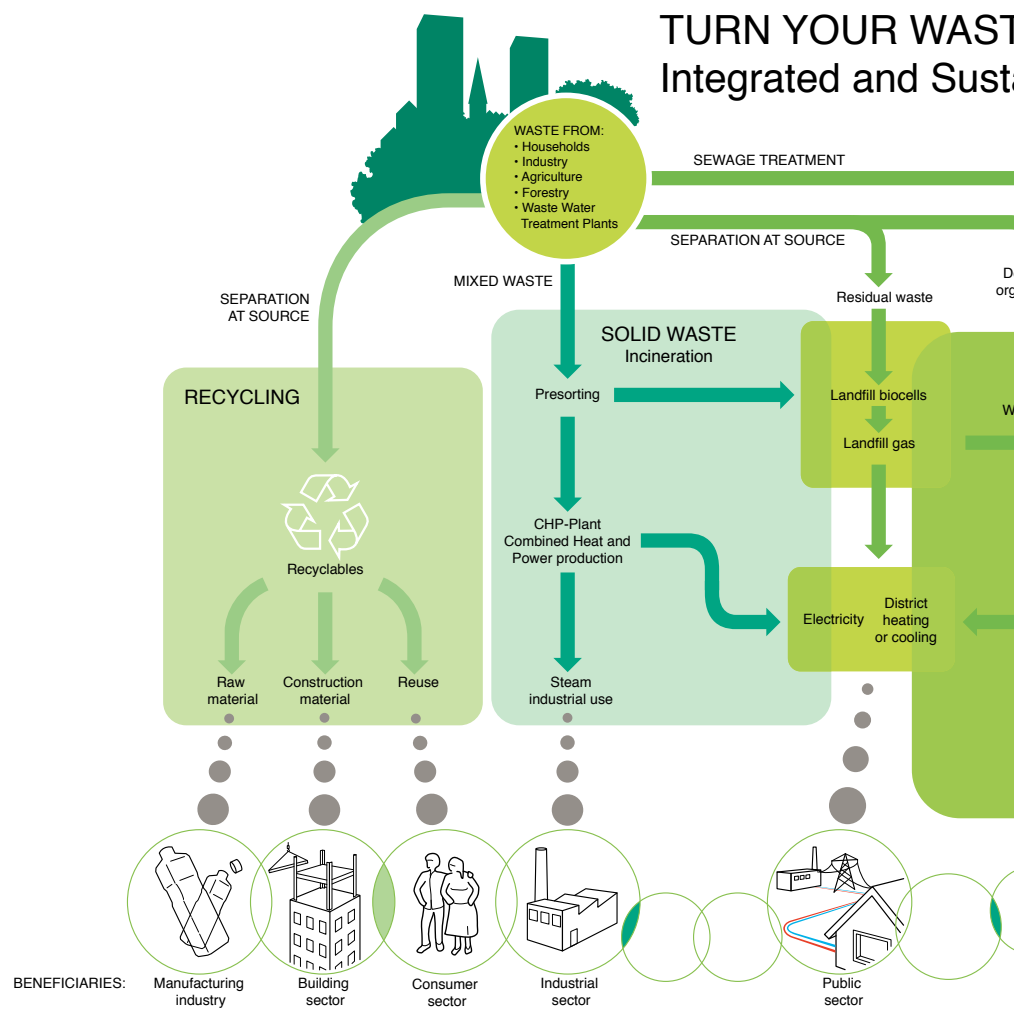


Digester at the Henrikssdal sewage treatment plant. Photography from Sweco.

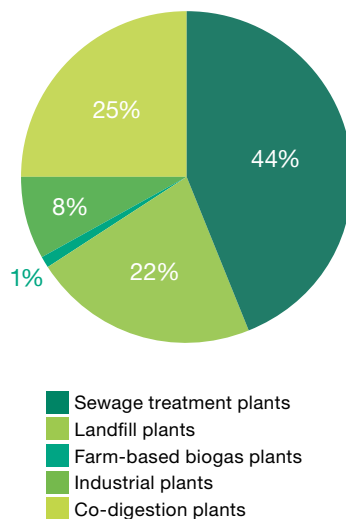
Between 2006 and 2008 the total amount of produced biogas increased with more than 12%. The main share of the increase is generated by co-digestion and industry plants. The increase will continue, although landfill gas will significantly be reduced as a result of the Swedish ban on deposit of organic material that was introduced in 2005. According to the national Swedish biogas statistics there were 135 biogas producing sewage treatment plants in Sweden 2010. The number of active landfill plants was 57. The number of farm plants and co-digestion plants is increasing. In 2010 there were 14 farm plants and 18 co-digestion plants, see figure 1. The total number of biogas plants was 229.

## Biogas usage in Sweden today and in the future

In Sweden biogas is used for local heating, district heating and industrial heating processes, generation of electric power, and vehicle fuel. Approximately 44% of the produced biogas 2010 was used for heat



**Figure 1.** Biogas plants in Sweden 2010. Figure from the Swedish Gas Association.



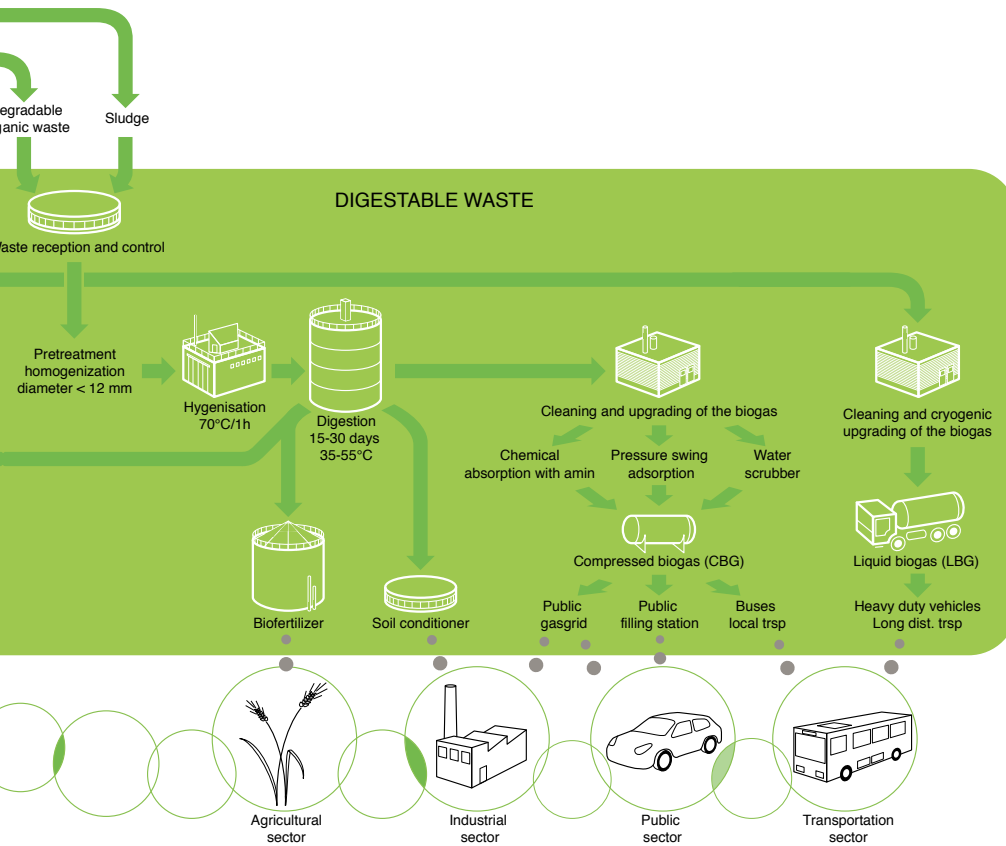
production (see figure 2) while 44% was upgraded and used as vehicle fuel. The production of vehicle fuel is increasing with approximately 20% per year.

Vehicle gas is made up of natural gas (CNG), biogas (CBG) or a mix of the two. Vehicle gas can replace petrol or diesel in passenger cars, buses and heavy goods vehicles. In addition to reducing emissions of carbon dioxide, vehicle gas cuts emissions of nitrous oxides, sulphur oxides, carcinogenic substances and particulates.

Since natural gas produces 25% lower emissions of carbon dioxide than petrol or diesel, it is also considered as a good alternative vehicle fuel, although not renewable.

# WASTE INTO ENERGY

## Sustainable Waste Management in Sweden

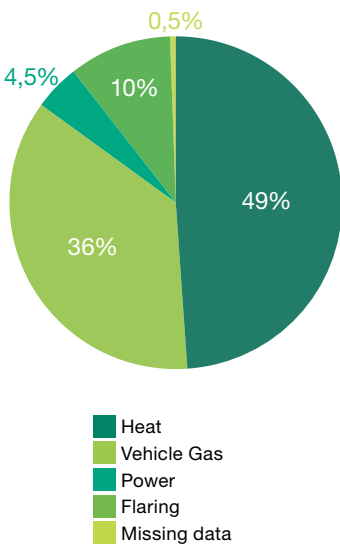


As a result of the long term strategy, Sweden has a very high percentage of biogas in vehicle gas compared to the rest of the world, see figure 3. During the first half of 2010, 64 % of the sold volumes of vehicle gas in Swedish was upgraded biogas – a higher percentage than any other country.

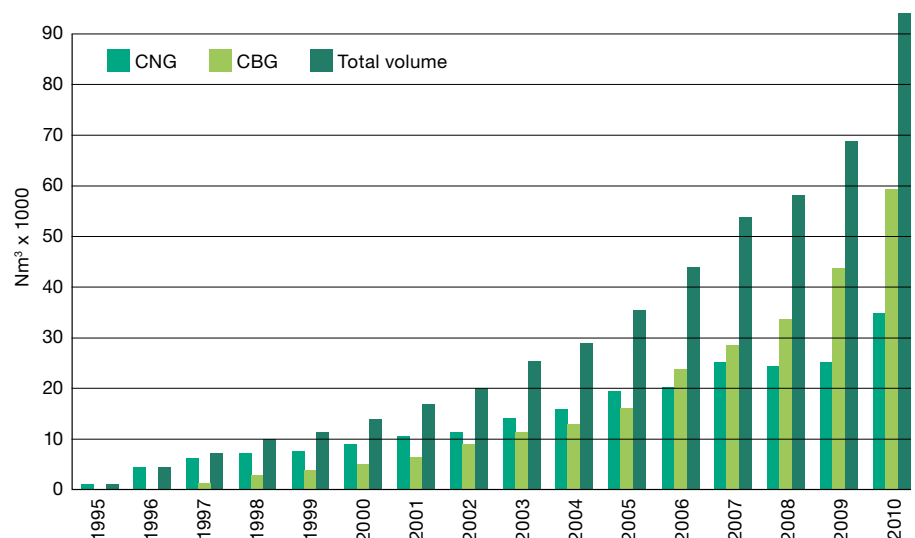
### The Swedish biogas potential from manure, organic waste and residues from forest industry

The total theoretical biogas potential from organic waste, sewage sludge, manure and other digestible residuals, as for example food industry waste, amounts to 10-15 TWh annually. Biogas, or biomethane, can also be produced from thermal gasification of wood and lingo-cellulosic material. The theoretical biogas potential from lingo-cellulosic waste from forest enterprise and forest industry, black liquor included, amounts to 59 TWh annually. Theoretically the total annual biogas potential from waste and manure in Sweden is thus approximated to 69-74 TWh.

**Figure 2.** Biogas utilization in Sweden 2010. Figure from the Swedish Gas Association.



**Figure 3.** Sold volumes of vehicle gas (Compressed natural gas – CNG, and Compressed Biogas – CBG) in Sweden from 1995 to 2010. Figure from the Swedish Gas Association.



### **The Swedish strategy for further up-scaling of biogas**

Research and development aiming at biogas production has been successful and resulted in better technology. Based on the Swedish government's strategy for biogas development in Sweden, together with the approximately 50 ongoing or planned biogas projects in the country, the total amount of biogas production in 2012 is expected to be doubled to approximately 3,5 TWh/year. This anticipated development is based upon existing digestion technology.



Photo: Per Westergård

Long-term strategic development is continued in order to improve breakdown efficiency, increase gas production and make it more cost-effective. During 2010 and 2011 a governmental programme is aiming to boost the

commercialisation of existing R&D-results that is very close to the market. Projects aimed at large-scale testing of gasification technology have also been started, and commercial results are expected on a ten years horizon.

### **Vehicle gas leads to climate benefits**

Transport fuel is one of the most difficult areas to find a replacement for in the global energy mix. That affects our opportunities for further climate-improving actions. Overall, vehicle gas entails a carbon reduction, which increases as the proportion of biogas in the mix goes up. Alongside the climate benefits, increased use of vehicle gas yields other advantages. Gas-powered vehicles reduce emissions of nitrous oxides, sulphur oxides and particulates and abate noise.

With regard to the transport sector, the work continues to optimise the technology for compression, transport, measuring and filling of vehicle gas. Research is also in progress in relation to producing hydrogen gas for vehicle gas and using membrane separation technology.

Worldwide, there is intense interest in finding solutions for managing waste, residual products and waste water in an environmentally economical way. The world's growing waste and resource problems must be managed, and Sweden can present several different process alternatives and interesting solutions.



Digester at Purac's waste management plant. Photography from Purac.