IEA Bioenergy Task 37

**BIOGAS IN SOCIETY**
A Success Story from
IEA BIOENERGY TASK 37
"Energy from Biogas"

# MORE THAN 10 YEARS PRODUCTION OF FOSSIL FREE AUTOMOTIVE FUEL AND CERTIFIED DIGESTATE FROM FOOD WASTE

## VERA PARK IN HELSINGBORG, SWEDEN

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## SUMMARY

The production of fossil free automotive fuel started at the NSR biogas plant in 1996. The substrates used in the co-digestion biogas process are the organic fraction of household waste from municipalities, residues from food production companies and manure. The digestate is distributed to agricultural land via pipeline or by trucks effectively recirculating nutrients such as phosphorous. The purified biogas is used as automotive fuel for buses, waste collection trucks, taxis and private cars.

This plant showcases a successful example of food waste digestion, with almost 15 years (since 2000), of biogas production from source separated food waste. Today 60% of the household food waste is source separated, which corresponds to 55 kg food waste per inhabitant each year.

The plant also has a very long experience from injecting biomethane into the natural gas grid, which has been in service for over a decade (since 2002). No problems related to injection of biomethane have been reported by the local grid owner during the entire time period of operation.

Today, in 2014, facilities for pre-treatment of household waste, anaerobic digestion, upgrading, grid injection to the natural gas pipeline and biogas refuelling are co-located at the site Vera Park in Helsingborg (Figure 1).

**Figure 1:** Illustration of the NSR biogas plant 2014.

## BACKGROUND

Nordvästra Skånes Renhållning AB (NSR) is jointly owned by six municipalities (Helsingborg, Ängelholm, Båstad, Höganäs, Bjuv and Åstorp) in the south of Sweden. The vision of NSR is "A world-class environmental company". NSR promotes waste minimisation and is working to reach a more sustainable society. The plant re-uses material where ever possible, including two digester tanks from a sugar mill for two of its digesters as well as crushed bricks as land cover and re-used furniture for the offices and common area. The production of fossil-free automotive fuel in the NSR biogas plant started almost 20 years ago in 1996.

**Facts & Figures**

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| Organic waste capacity | 160 000 tons/year |
| Methane in raw gas | 65–72% |
| Biogas production | 80 GWh |
| Digestate production | 145 000 tons |
| Digester tanks | 2 x 3000, 1 x 6000 $m^3$ |
| Post-digestion tanks | 2 x 1000 $m^3$ |
| Digester temperature | 37 °C |
| Digestate pipeline | 10 km |
| **Three upgrading units:** | |
| PSA | 350 $Nm^3/h$ |
| Water scrubbers | 650, 1400 $Nm^3/h$ |
| Operational start-up | 1996 |
| Refurbishment doubling cap | 2007 |
| Refurbishment doubling cap | 2014 |

## SOURCE SORTING OF FOOD WASTE

The collection system with source sorting of household food waste in paper bags started in 2000.

The food waste is collected in a separate compartment in the waste bin and emptied 2–4 times per month. Through several information campaigns, the inhabitants in the area around Helsingborg now sort 60% of the household food waste (Figure 2). This corresponds to 55 kg of collected food waste per person each year. However, 37 kg remains unsorted and so ends up in the residual waste (2013 average). Even though the source separated fraction is already high, the goal is to achieve 80 %, and simultaneously to minimise the amount of the food wasted.
Today, the organic fraction of household waste from all six municipalities of NSR is processed in the same pre-treatment plant, which delivers substrate to the adjacent biogas plant via a short pipeline.

## THE DIGESTION PROCESS

Household waste, residues from the food industry and manure are co-digested at the NSR biogas plant. The process comprises three reception tanks followed by two hygienisation units where the substrate is heated for one hour at 70° C and then mixed in a blending tank and digested in one of the three bioreactors of 3000, 3000 and 6000 $m^3$, respectively. The retention time in the reactors is 25–30 days, and the organic loading rate (OLR) is 3.5–4.0 kg volatile solids / $m^3$ per day. From the bioreactor tank the slurry is pumped to one of the two 1000 $m^3$ post-digestion tanks and kept there for another 6 days, where approximately 10 % additional biogas is produced. For odour reduction NSR has long experience of using biofilters. In 2014 an additional biofilter unit with activated carbon was installed for treatment of odour from the new receiving tank.


**Figure 2:** Information campaign illustrating the importance of source separation of food waste.

**Figure 3:** The blending tank to the left and the digester and post-digester tanks to the right.


**Figure 4:** To the left, the digestate storage tank from which the digestate is transported to farmers by pipe-line or truck. To the right the heating tanks for the hygienisation process.

## INCREASED PRODUCTION THROUGH R&D

NSR continuously improves its knowledge regarding biogas production and co-digestion of different types of substrates such as food waste from households and industrial food waste from the potato, dairy or slaughterhouse industries. For example, in 2010 the OLR had to be decreased since a relatively high ammonium-N concentration inhibited the microbial process. Research on the impact of different substrates resulted in improved process control, increase in OLR and consequently more biogas produced. Further research was performed in 2011 on the effect of the addition of trace elements. Results showed that when trace elements were added the OLR could be raised without significantly increasing VFA (volatile fatty acid) content. Trace element additions and improved process control permitted an overall 30 % increase of the OLR.

## DIGESTATE HANDLING

The digestate is a slurry containing nitrogen, phosphorous, potassium and micronutrients. From 160,000 tons of digested food waste in the biogas plant, approximately 490 tons of N, 90 tons of P, and 170 tons of K are available for recirculation as fertiliser each year. The digestate is certified according to the Swedish certification system SPCR 120 and thus approved for fertilising cultivated crops aimed for the food industry.

The digestate is transported to the farmers' storage tanks either through a 10 km long pipeline or by truck. Some farmers deliver manure to be digested and NSR returns a fertiliser with reduced odour.

## UPGRADING AND GRID INJECTION

Biogas is upgraded to automotive fuel, in operation since 1996. Since 2002 a share of the biomethane has been directly injected into the natural gas grid. Today there are three upgrading units in Vera Park, managed by the company Liquidgas Biofuel Genesis AB (LBG AB): one PSA (350 $Nm^3$ raw biogas/h), and two water scrubber units (650 and 1400 $Nm^3$ raw biogas/h). Flue gas from the water scrubber is treated in a regenerative thermal oxidation (RTO) unit for air pollution control.

Before the injection point to the natural gas grid the following parameters of the purified biogas are determined online; concentrations of methane, carbon dioxide, oxygen and hydrogen sulphide, dew point and Wobbe index. Based on the measured Wobbe index, a specific amount of propane is added in order to ensure constant energy content within the natural gas grid. According to the distribution grid owner, Öresundskraft AB (ÖKAB), no operational problems associated with the quality or content of the biomethane have been noticed during the entire period of operation. The only operational problem has been due to propane quality.

The upgraded biogas is used as a vehicle fuel by buses, waste collection trucks, taxis and private cars.

## FUTURE DEVELOPMENT IN VERA PARK

Existing and new facilities at Vera Park are being continuously developed with new and optimised technology in mind, and operation from both economic and environmental perspectives. Plans and projects for the near future include: a liquefaction plant, LBG/LNG refuelling station, additional odour reduction, increased source separation of food waste, reduction of truck transportation of digestate by expansion of the pipeline network as well as production of dry fertiliser, and a pretreatment plant for household waste and other organic waste delivered in plastic bags.

**Figure 5:** The biogas upgrading plant based on water scrubbing technology with a capacity of 1400 $Nm^3$ raw biogas/h.

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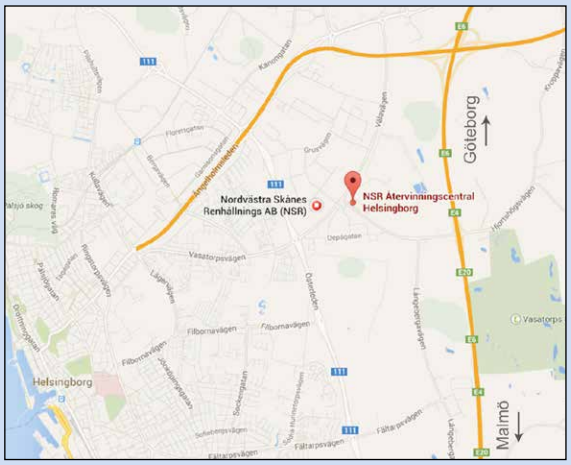




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