



## Upgrading of Biogas to Natural Gas Quality

### Summary

Since 1991, 10 municipalities in the southern Netherlands have been participating in a project to extract and upgrade biogas from vegetable waste. At Tilburg, a “Valorga” vegetable, garden and fruit (VGF) waste digester has been built which produces high-quality compost as

well as 3,000,000 m<sup>3</sup>/year of biogas. This gas is upgraded to natural gas quality in a facility originally designed to refine landfill gas for distribution through the national grid. The net yield of the entire process is 1,360,000 m<sup>3</sup>/year of synthetic natural gas – enough for 1,360 households.

### Highlights

- ▼ Biogas distributed through existing grid
- ▼ Produces 1,360,000 m<sup>3</sup>/year of natural-gas-quality biogas
- ▼ Reduces the amount of solid waste to landfill
- ▼ Payback period 4.75 years

The biogas and landfill gas plant at Tilburg; the digester tanks are on the right of the picture.



Photograph: Hans Pattist

## Project Background

It is widespread practice in the Netherlands to make fertilising compost out of VGF waste by means of aerobic or anaerobic fermentation. Anaerobic digestion of organic refuse yields methane, a potentially valuable by-product.

Use of biogas could be a viable option in the Netherlands, since the country has a dense distribution grid for natural gas. However, a methane content in biogas of 56% results in a calorific value of around 20 MJ/m<sup>3</sup>, as opposed to 31.7 MJ/m<sup>3</sup> for natural gas. This prevents biogas from being used in natural-gas-fired equipment unless significant adjustments are made. For natural gas and biogas to be distributed through the same grid, the biogas must be refined and upgraded to natural gas quality.

In the past, several projects have shown the technical feasibility of upgrading landfill or biogas to natural gas quality. This project demonstrates the technical and economic feasibility of generating synthetic natural gas by upgrading biogas produced in a Valorga digester.

## The Project

The Samenwerkingsverband Midden Brabant (SMB), a co-operative of 10 municipalities in the province of Brabant, commissioned the construction of a Valorga processing plant for the anaerobic digestion of VGF waste. The plant began operating in 1994.

A central refuse treatment company collects and separates

municipal waste from the participating communities. The VGF waste is transported to the Valorga plant, where fine and coarser materials are separated in a rotating sieve. The coarse material is dewatered and then composted. The fine fraction is mixed with process water and remnants of previously digested material. This mixture is fed into two 2,750 m<sup>3</sup> reactor vessels, where it remains for 21 days at a target temperature of 37°C. The digestion process produces biogas, some of which is pressurised and pumped back into the reactor to improve mixing. The rest of the biogas is transported to an upgrading plant, where it is refined to natural gas quality. Electrical energy for the plant is generated by a gas-fired power station, with external heating supplied by the combustion of natural gas. The solid residue from the digested VGF waste is dewatered and composted in a separate hall.

The gas upgrading plant was built in the late 1980s, to treat gas produced by a nearby landfill. The process consists of three stages, the first of which compresses, cools, dries and desulphurises the gas. Biogas is predominantly made up of carbon dioxide (CO<sub>2</sub>) and methane and these need to be separated. This is done by counter-current washing with water in a CO<sub>2</sub>-absorbing spray tower. Carbon dioxide dissolves in the water, leaving concentrated methane gas. After the methane has been dried, chlorofluorocarbons (CFCs) are removed by adsorption onto active carbon. Finally, compressed natural gas is produced and fed to the grid.



Arrival of VGF waste at the SMB site.

## Performance

Between 1994 and 1999, the Valorga plant processed 40,000 tonnes/year of waste – about 80% of its 52,000 tonnes design capacity. The unit produces 75 m<sup>3</sup> of biogas/tonne of processed waste, with a methane content of about 56%. This is equivalent to 50 m<sup>3</sup> of synthetic natural gas. Working on an average of 40,000 tonnes/year of waste, the production of synthetic natural gas is about 2,000,000 m<sup>3</sup>/year. Heating the plant uses about 7 m<sup>3</sup> of natural gas/tonne of waste, which is 14% of its total production. Electrical energy produced by the



co-generation unit is about 40 kWh/tonne, equivalent to about 9 m<sup>3</sup> of natural gas. Total energy consumption is, therefore, 16 m<sup>3</sup>/tonne (or 640,000 m<sup>3</sup>/year at 40,000 tonnes/year), so the plant's net yield is 1,360,000 m<sup>3</sup>/year.

Solid waste left for disposal is 15% of the original mass.

## Economics

When the project began in 1991, investment costs were NLG 35,000,000 (where NLG is the Dutch guilder).

The plant has two sources of revenue: the fees paid by the

municipalities for waste treatment, and income from the sale of the synthetic natural gas. The average fee for waste treatment between 1994 and 1999 was NLG 180/tonne, so the average revenue has been NLG 7,200,000/year. At an average gas price of NLG 0.12/m<sup>3</sup>, the net gas production has a value of NLG 163,200/year. The total revenue of NLG 7,363,200/year gives a payback of 4.75 years.

## Environment

The plant produces 1,360,000 m<sup>3</sup> net of synthetic natural gas annually. According to guidelines from the Intergovernmental Panel on Climate Change (IPCC), the CO<sub>2</sub>

emission from the combustion of natural gas is 56.1 kg/GJ; in the case of Dutch gas, this is equivalent to 1.78 kg/m<sup>3</sup> of natural gas. Thus, use of the synthetic natural gas produced at the plant reduces CO<sub>2</sub> emissions by 2,421 tonnes/year.

The process reduces the amount of solid waste for disposal as landfill to 15% of its original mass, which constitutes a major environmental benefit. The upgraded gas can be distributed via the grid and the existing infrastructure can be used.



Collecting VGF waste.

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