

# Recovery of Landfill Gas from Toruń Landfill, Toruń, Poland

## 1. Aim

The aim of the project is to disseminate to Poland the recuperation of energy from landfill gas in a CHP application. The project is located within the municipality of Toruń, northern central Poland, at the municipal landfill site.



**Photo 1: The Combined Heat and Power plant**

There were four main objectives for this demonstration project:

1. reduce the detrimental effects of the methane gas produced in the landfill site,
2. provide energy in the form of district heating and electricity,
3. save the use of fossil fuels and provide an economic benefit for Poland,
4. introduce state-of-the-art Landfill Gas Plant technology to Poland as a demonstration project, which is also economically viable.

## 2. Introduction

The landfill in Toruń covers an active area of approximately 9 hectares. It has been in use since 1964 and the capacity is expected to be sufficient until about the year 2010. The present total amount of waste is approximately 1,500,000 tonnes.

The gas from the landfill is of a quality well suited for engine use, however, the gas quality varies from well to well as well as over time. The typical composition of the landfill gas is:

Methane	CH <sub>4</sub>	45-55%
Carbon Dioxide	CO <sub>2</sub>	25-45%
Nitrogen	N <sub>2</sub>	10-20%
Oxygen	O <sub>2</sub>	< 0.2%

The project was commissioned in September 1997 and full commercial operation was achieved practically from the beginning, with only minor operational problems. The novel feature of the system is the automatic regulation in the gas recovery module which has been developed by Hedeselkabet. This regulation system provides individual measurements of gas flow and gas quality for each extraction well, as well as the combined total.

### 3. Technical Description

#### Extraction System

The extraction system consists of 40 extraction wells and associated piping to the Gas Recovery Module. The extraction wells are 12 - 20 meters deep. Each well is filled with filter gravel or similar material, surrounding the extraction pipe, which is a perforated PEM gas pipe, 110 - 160 mm in diameter. The top of the well is sealed with clay to prevent entrance of atmospheric air. Each well is connected to the Gas Recovery Module by a standard gas pipe as shown in photo 2.



**Photo 2: The gas extraction lines and their connection to the pumping module during the construction phase**

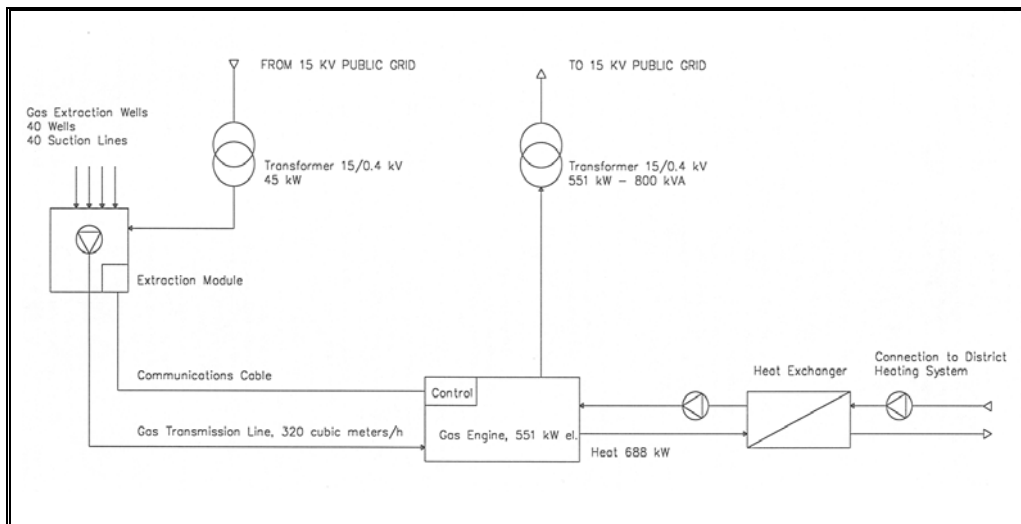
#### Gas Recovery Module

The Gas Recovery Module contains the entire process equipment for pumping, filtering and analyzing the gas extracted from the landfill, as well as extensive safety features to protect personnel and equipment. The Module is constructed in a standard 40-foot container. The Module is divided into two compartments, the Control Room and the Compressor Room. In the Control Room, all control and supervision of the installation is made, including analyses and control of the gas quality and quantity from the individual gas wells. The Compressor Room contain the process equipment, such as control valves, gas flow indicators, gas filters and flame arrestors, gas compressor, gas cooler, gas detectors, gas analysis panel, gas flow meter and control air compressor.

Since gas quality can vary from one well to another, as well as with time in the individual well, an automatic control system is installed to regulate the control valves based on gas quality and oxygen content. A manual valve control is also provided.

The samples are analyzed for content of CH<sub>4</sub>, CO<sub>2</sub> and O<sub>2</sub>. From the well branches, the gas is collected in a manifold and filtered. The Oxygen level in the gas is measured continuously, giving an alarm to the control system, if the level exceeds 3% O<sub>2</sub> and shutting down the installation if the level exceeds 6% O<sub>2</sub>. This prevents an explosive gas/air mixture from forming in the pipes. Gas alarms are also provided in the container compartments.

The gas compressor is of the Roots Blower type and has a maximum capacity of 550 Nm<sup>3</sup>/h at a suction pressure of 50 mbar. The gas is cooled and the condensate is removed after the cooling. A simplified process flowsheet is given in Figure 1.



**Figure 1: Simplified process flowsheet**

### Combined Heat and Power Plant

The CHP plant is located in the existing administration building at the landfill, close to the District Heating connection. The Gas Recovery Module is connected to the CHP plant by a 560-meter long transmission line. Condensate separators are installed in the line. The core of the CHP Plant is a Jenbacher gas engine type 312 with a Stamford synchronous electrical generator, having a rated electrical output of 275 to 551 kW. The heat output of the system is in the range of 350 to 688 kW from the engine cooling water and an exhaust gas boiler, cooling the exhaust gas to a temperature of 150°C. Maximum forward temperature to the District Heating System is 130°C.

## **4. Performance of the Plant**

### Technology Performance

A rated operational time of 8,000 hours per year is expected, and the collected data show that this is entirely feasible. An availability of >95% has been demonstrated. The power output of the plant in normal operation is as follows:

Electrical output:	525 kW average
Heat output:	660 kW average
Operational hours:	> 8,000 hours/year
Electrical efficiency (full load)	38.5%
Thermal efficiency (full load)	48.0%
Nominal gas flow at 45% CH <sub>4</sub>	320 Nm <sup>3</sup> /h

For an annual power output of 4.5 million kWh electrical and 6 million kWh heat, it can be estimated that approximately 2.65 million cubic meters of landfill gas has to be extracted.

It has been demonstrated that Danish Landfill Gas technology can be successfully disseminated in Poland. Very few technical problems have been experienced for an installation of this complexity.

### Environmental Performance

In a conventional Polish CHP plant over 1,500 tons of fuel oil would have been used to produce the same amount of energy. Therefore the equivalent amount of pollution from the fossil fuel needed to produce the same amount of energy as the landfill gas CHP plant is eliminated.

In addition, the atmosphere is relieved of almost one million tons of methane which would have been otherwise emitted, while instead it is burned very cleanly to carbon dioxide and water.

This results in savings of 2,840 tons of carbon dioxide and 53 tons of sulphur dioxide annually (after subtraction of the amounts produced by the landfill gas).

## **5. Economic Performance**

The project was financed by the Municipal Waste Company of Toruń, and the THERMIE Programme.

The operating costs have been somewhat higher than expected in the first operating year, but new management has taken the problem in hand. The plant was severely overstaffed from the start.

### **Investment and financing**

The total installation cost is DKK 12 million, equivalent to approximately 1.6 million Euro. The majority of the funds have been obtained by the Polish investor (Biogaz Inwestor Sp. zo.o.) through the Polish Bank of Environmental protection (Bank Ochrony Środowiska). The European Commission, DG XVII has supported the project with 35% of the cost.

### **Pay-back Time**

With the current energy price level in Poland, the pay-back time is about 10 years.

### **Potential and Current Users**

The potential for installations of this kind in Poland is considerable. Not many installations have been installed yet, but several are under way. Most installations are of a simpler, non-regulated type, as used in several European countries.

It is to be expected that several installations of the present type will be constructed, since this first plant has generated considerable interest.

## **6. Project Identifiers**

<b>Project:</b>	<b>BM/173/93-DK</b>
<b>Owner:</b>	<b>BIOGAZ INWESTOR Company Ltd</b>
<b>Contractors :</b>	<b>HEDESELSKABET Miljø &amp; Energi as</b> Klostermarken 12 DK-8800 VIBORG DENMARK Tel: +45-86-67 61 11 Fax:+45-86-67 51 01 <b>&amp; BIOGAZ INWESTOR Company Ltd</b>
<b>Technology:</b>	<b>HEDESELSKABET, PM Energi A/S,</b> <b>A-Tek Miljø A/S</b>
<b>Total Cost:</b>	<b>1,666,042 ECU</b>
<b>EC Support :</b>	<b>574,018 ECU</b>