The LFG Baltic project – Landfill gas in Sweden

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1. Introduction

The LFG Baltic project is a seed funding project financed by the Swedish Institute, Gdansk University of Technology, Lithuanian Energy Institute and the Baltic Energy Innovation Centre.

The overall aim is to encourage the use of landfill gas as an energy resource and reduce aggressive greenhouse gas emissions from landfills by cross border knowledge exchange and technology transfer.

The project period runs from 1st of January 2018 to 30th of June 2019. The activities include screening of landfill gas extraction and utilisation in Lithuania, Poland and Sweden, compilation of a Best Practice and Lessons Learned report, and offering the possibility for landfill gas experts from the Baltic countries and Europe's Eastern Partnership to present posters at REGATEC 2019 for free.

2. LFG Baltic - Sweden

There is no unambiguous number of landfills in Sweden but Östman [1] indicates that the number of landfills for household waste can be as high as 8,000 while the Swedish Waste Management Association [2] estimates the number to be between 4,000 and 8,000. Due to the EU landfill directive and the introduction of a landfill tax many landfills were closed in 2001. In January 2005 a ban to landfill organic material was introduced.

In 2015 there were a total of 265 landfills in operation in Sweden. The number includes also not yet closed facilities with permission to deposit, and not only those where waste is actually deposited. Of these, 60 landfills were for hazardous waste, 133 landfills for non-hazardous waste and 72 landfills for inert waste.

Landfill gas extraction corresponding to 145 GWh was done at 51 landfill sites in Sweden in 2017 [3]. The production has declined since the ban to landfill organic material was introduced. There is currently no upgrading of landfill gas to natural gas quality in Sweden and considering the declining gas production (see Table 1) it's not likely that there will be. Most of the landfill gas produced in 2017 was used for heating, 91 GWh. 18 GWh was used for power production and 37 GWh was flared.

Table 1. Landfill gas extraction in Sweden [3-15].

	GWh	Nr of sites	% flared
2017	145	51	26
2016	174	58	21
2015	187	60	32
2014	219	60	21
2013	240	60	21
2012	254	55	19
2011	270	55	12
2010	298	57	13
2009	335	57	13
2008	369	58	28
2007	342	59	18
2006	342	60	18
2005	457	70	16

3. Power production

During the last three decades different power production technologies have been demonstrated and used.

As a result of the 1991 Energy Policy Agreement, a support for CHP production with biofuels was launched. A small fraction of the support went to CHP production with gas engines based on landfill gas and biogas. The 24 facilities which received public funding undertook to report practical experiences of operation during a five year period. The electric efficiency ranged from 19% to 37% with an average of 29%. The production cost differed a lot between the different plants depending on the operating and maintenance costs. Problems with siloxanes causing increased engine wear and need for additional maintenance showed up but two out of twelve plants that were investigated in more detail actually produced heat and power at a competitive cost without the public support. The capacity of the gas engines ranged from 10 to 2,000 kW [16].

Figure 1. The two Stirling engines at Rönneholms waste management facility, [17].

Externally fired Stirling engines have also been tested. At Rönneholms landfill outside Eslöv the methane content had fallen to 25-30% but there was still an ambition to produce power. Two Stirling engines with a capacity of 7 kW each were installed in 2012. During five years the facility has produced 300 MWh electricity, and 800 MWh heat used internally at the waste management facility [17].

According to a study conducted by a Swedish supplier of Stirling engines, Clean Energy (now Azelio AB,) it's possible to produce power using landfill gas with a methane content down to 15%, [18].

Other technologies for producing power using landfill gas include micro scale gasturbines. The Turbec T100 gas turbine has for example been installed at landfills in Filipstad, Skövde and Norrköping, [19]. Based on natural gas the gas turbine consumes 333 kW fuel and produces 100 kW electricity plus heat, [20].

MEGTEC Systems AB offers flameless thermal regenerative oxidation technology for conversion of landfill gas with methane levels down to 0.15%. The excess heat generated above this concentration limit is recovered in an integrated embedded heat exchanger, [21].

4. Other technology development

In a project geo-electrical methods for better understanding of the conditions below the surface of the landfill were further developed. The geo-electrical methods used were mainly resistivity and induced polarization (IP). One of the aims was to improve the understanding of the impact of material parameters on sub-surface processes such as movement of gas and water in landfills (e.g. pore pressure, temperature and soil moisture), as well as to characterize the internal content and structure of landfills. The project therefore also aimed for a better exploitation of the energy potential of the landfill gas and a reduction of the leakage of climate gases to the atmosphere, [22].

5. Discussion and conclusions

Due to the ban to landfill organic material introduced 1 January 2005 the landfill gas production has declined since then. The methane content in the landfill gas is also

declining. It's not likely that there will be any upgrading of landfill gas in Sweden unless really cheap upgrading technology is developed. One may suspect that the landfills could probably produce more gas if they were optimized and utilized in an efficient way. The relatively large share of the landfill gas that is flared shows the need for simple, robust and cost-efficient power production and upgrading technologies.

6. References

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