

## Implementation of the Landfill Methane Gas (LFG) to Electricity Project in the City of Joburg: Waste Sector Contribution to Low Carbon Economy

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Waste disposal by landfill is one of the contributors in the Green House Gas (GHG) emissions, through the generation of methane gas during landfill operations. South Africa is a signatory of the Kyoto Protocol and the City of Johannesburg has set targets for greenhouse gas emissions reduction in the City's Climate Change Strategy. This project will contribute significantly in the GHG emission reduction strategy of the City.

The City identified five of its landfill sites - Robinson Deep, Marie Louise, Linbro Park, Goudkoppies and Ennerdale to implement the landfill gas to electricity Clean Development Mechanism (CDM) project.

Through the implementation of a CDM project, the City will contribute to the country's realization of the Kyoto Protocol commitments and simultaneously generate revenue through the sale of Certified Emission Reductions (CERs) and sale of electricity generated from the project.

The project was initiated in 2007. The main aim was to mitigate the harmful greenhouse gases (GHG) emitted from the landfills, generate renewable energy which will be fed into the municipal grid, thus off-setting largely coal derived electricity.

In May 2009 the City entered into an agreement/contract with EnerG Systems Joburg (Pty) Ltd to construct and operate the landfill gas to electricity CDM project at no cost to the City for a period of 20 years. They also have exclusive rights to mine gas and generate electricity at the five landfill sites. Approximately 19MW of electricity will be generated comparable to electricity usage of approximately 12500 middle income households.

Currently the gas collected is being flared. This is due to late signing of the Power Purchase Agreement (PPA), which was finally signed with Eskom's Single Buyer Office in August 2015. This is the first municipal waste management project to participate in the REIPPPP (Renewable Independent Power Producers Procurement Program) of the department of Energy. Electricity generation is expected to start in August 2016, with first 3MW of electricity to be fed into the City Power electricity grid.

An average of 1756m<sup>3</sup>/h of landfill gas has been recovered and flared at both Robinson Deep and Marie Louise landfill sites since May 2011 and May 2012 respectively which would have been emitted to the atmosphere as a harmful greenhouse gas. This is expected to increase as more of the wells are installed for gas collection, in preparation for energy generation. The project has so far accumulated 243 859 certified emission reductions (carbon credits).

This project will reduce GHG emissions by 60-70% from landfill site during its operation.

### 1. INTRODUCTION

In South Africa, landfilling is currently the more viable option for the disposal of South Africa's solid waste, and even though recycling and re-use will help in reducing the amount of waste delivered to landfill, it will continue to provide the least cost option for disposal of waste. Methane from landfills is produced by the decay of organic waste in anaerobic conditions and is generated over a period of several decades (usually beginning 1 to 2 years after the waste is put in place). Methane makes up approximately 50 percent of the landfill gas, with the remaining 50 percent being carbon dioxide (35%) mixed with small quantities of other gases. If landfill methane is not collected, it will escape to the atmosphere through the waste body or migrate laterally through the ground to off-site areas where the gas can escape. If not properly controlled, landfill gas may be flammable, toxic and asphyxiating and create explosive conditions in enclosed environments.

The production of landfill methane gas depends on several key characteristics, including the waste composition, landfill design and operating practices, and local climate conditions. For example, the presence of more organic waste (paper, food scraps, grass cuttings) will result in a higher and sustained level of methane production, and high levels of moisture in the waste will accelerate the rate of methane generation. In addition, if the landfill has used soil for cover and if the site is a sanitary engineered site with liners and capping will enhance the gas capturing process. The approach to filling the landfill whether by broad filling and raising one level at a time or a cell by cell construction will also effect the project and approach to the selection and method of well installation and gas collection

The City of Johannesburg's Infrastructure and Services Department initiated the landfill gas-to-electricity CDM project in 2007 in an effort to mitigate the harmful greenhouse gases (GHG) emitted from the landfills. The renewable energy generated from the project will be fed into the municipal grid, thus off-setting largely coal derived electricity.

The project is therefore in support of Government's 2002 agreement to the Kyoto Protocol on World Climate Change, which aims to reduce the amount of GHG emitted in countries and the implementation of supportive CDMs in Third World countries. The project is also in support of the City's GDS 2040 outcome of shifting to low carbon economy and the City's Climate Change Strategy. Approximately 19MW of electricity will be generated from the project comparable to electricity usage of approximately 12500 middle income households.

In May 2009 the City entered into an agreement/contract with EnerG Systems Joburg (Pty) Ltd to construct and operate the landfill gas to energy CDM project at no cost to the City for a period of 20 years. The agreement also gave EnerG Systems exclusive rights to mine gas and generate electricity at the five landfill sites mentioned above

## 2. PROJECT IMPLEMENTATION

### Environmental Impact Assessment (EIA) Process

The project was issued with the required waste licenses for each site necessary to undertake the project activity in June 2010. To date the conditions of each license has been complied with at the developed sites.

### (b) Project Schedule and Construction

Construction of the Robinson Deep landfill started on 21 February 2011 and was completed in May 2011 where the site was commissioned to commence with flaring of gas. 68 gas wells were installed and will be increased during the second phase of the project to cover the entire site. The daily pumping rate of landfill gas at Robinson Deep is at 1400 cubic meters per hour and this will be increased over time. The plant can reach optimum pumping rate of 2000 cubic meters per hour when it is operated at full capacity.

Construction of the Marie Louise project commenced in February 2012 where 28 wells were installed and the site was commissioned in May 2012. The daily pumping of landfill gas at Marie Louise is at 500 cubic meters per hour and will also be increased when electricity is generated. There are positive signs of improvement of air quality at Robinson Deep and Marie Louise sites since the implementation of the project. There is limited smells experienced and few complaints of odour received from the surrounding landowners since the commissioning of the two sites.

The CDM registration process of the project with United Nations Framework Convention on Climate Change (UNFCCC) Executive Board finalized in November 2012. Ener-G Systems Joburg has already identified buyers for the CER's in the voluntary market and this includes one buyer in South Africa.

Robinson Deep installation of gas collection system and the generator is underway, the site will generate 3MW of electricity that to be fed to City Power electricity grid. The generation of electricity will commence in August 2016.

Goudkopies construction of waste collection will start in August 2016 and will generate 3MW, and site commissioning will be in November 2016.

Marie Louise construction of waste collection starting in July 2016 and will generate 3MW, and the site commissioning will be in February 2017.

Ennerdale and Linbro Park are both expected to generate 1MW.

A total of 7449m<sup>3</sup>/h of landfill gas has been recovered and flared at both Robinson Deep and Marie Louise landfill sites since May 2011 and May 2012 respectively which would have been emitted to the atmosphere as a harmful greenhouse gas. This is expected to increase as more of the wells are laid for gas collection, in preparation for energy generation. The project also previously accumulated and sold 243 859 certified emission reductions (carbon credits) to Nedbank



**Figure 1:** Production plant used

### 3. CONCLUSION

With the a growing focus on reducing, reusing and recycling waste the option of using waste as an energy source by both municipalities and private waste operators is growing rapidly. This provides a fresh set of challenges for the waste sector with the incorporation of electricity generation as part of a holistic successful waste management strategy. This along with the opportunity to reduce the effects that the waste sector has on greenhouse gas emissions is increasing the complexity of landfill gas projects as well as waste to energy projects. It is evident from more developed waste sectors like Europe that all of these aspects need to be considered together and need to work in ever increasing interdependency in order for the industry to adapt to a rapidly changing financial and legislative environment.

### ACKNOWLEDGEMENTS

Cornish, D.R. (Wastecon paper -2008). Guide to Developing Landfill Gas Collection and Utilisation Project Through the Clean Development Mechanism

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