

MUNICIPAL LANDFILL GAS TO ELECTRICITY

Ekurhuleni Metropolitan Municipality

Project: Simmer and Jack Landfill Site grid- tied electricity generation

A 1MW gas-to electricity generator
set at Simmer and Jack landfill site.
Source: EMM Waste Management Services

Ekurhuleni Metropolitan Municipality's (EMM) most recent development towards meeting its 10% renewable energy target is the installation of a 1MW landfill gas to electricity plant at the Simmer and Jack landfill site in Germiston. This project, which was commissioned in September 2014, has the potential to reduce electricity purchases from Eskom by 7 GWh/year. The gas capture has also greatly improved local air quality and the environmental conditions of the communities living alongside or nearby the site.

Project Overview

The landfill gas to electricity project has its roots in an initial feasibility study and trial of landfill gas extraction and flaring which was done by the Municipal Waste Department in 2005. At that stage a 2-phase Carbon Development Mechanism (CDM) project was envisaged: an initial landfill gas extraction and flaring, followed by a gas to electricity generation development. Gas extraction and flaring has taken place since August 2007 at four EMM landfill sites, including Simmer and Jack.

With the failure of the CDM to deliver financing, the Energy Division (formally established within the Electricity Department in 2010), responsible for Phase 2 of the project - the gas to electricity phase - applied for council funding. This was motivated through the municipal commitment to a 10% renewable energy supply, set

out in the Energy and Climate Strategy (2007). Council approved the project and in January 2013 a tender was published for the design, supply installation and commissioning of a landfill gas to electricity plant. Ener-G Systems were awarded the contract in June 2013.

The Simmer and Jack Landfill Site was chosen as the most suitable site for this first plant. Construction started only in April 2014, due to contractual delays, and the 1 MW Simmer and Jack plant was commissioned in September 2014. The plant is currently feeding power in to the municipal grid. As of 22 October 2014, the generator has been operational for 727 Hours and 594,600 kWh of electricity has been generated. Ekurhuleni plans on installing gas engines on its other landfill sites in the next two years.

Key Project Data

Location

Simmer and Jack
landfill site in Germiston,
Gauteng



Technology

**Landfill gas
to electricity**



Key Actors

Owners

**Ekurhuleni
Metro**



Developers

**Ekurhuleni
Metro**



Financers

**Ekurhuleni
Metro**



Some Indicators

Powered mid income households

(based on an average
monthly consumption
of 500 kWh)

1 200



Average output per MW installed

7 135
MWh/MW installed/year



Capacity factor

[= ratio of actual output
to potential output at
full capacity, over the
same period of time]

81%



Capital cost per MW installed

(MZAR/MW installed)

**R 12.8
million**



Operational cost per MW installed

(ZAR/MW installed/
month)

R 140 000



Operational costs per MWh

(ZAR/MWh)

R 235



The calculations are high level based on average data and limited available information. Comparison between projects is risky and should not be done without full understanding of the projects and their particularities.

At the time of the study the project had been in operation for some months only. The values reflected here might change over time to reflect the reality of project development.

Technical Description

The design, installation and commissioning of landfill gas extraction and flaring systems at Simmer and Jack was undertaken by Envitech Solutions, in consortium with Enviro-Fill, in the Landfill Gas CDM project. This included the installation of vertical and horizontal gas wells, gas collector pipework, high temperature gas flares and continuous gas monitoring system.

In the second phase – electricity generation – the project contractor installed a 1 MW gas engine in a container, which uses the landfill gas to generate electricity at 400V AC (alternating current). The power is then stepped up to 6.6 kV AC and fed into the municipal distribution grid.

A landfill acts as an anaerobic digester producing methane gas from the organic waste. The methane gas can be produced for several years after the waste has been landfilled. With the current quantity of waste, and if no additional organic waste is added on site, it is estimated that the landfill will produce enough gas to run the generators for at least 12 years. Given the lifespan of at least 12 years, with proper maintenance, the payback period on the electricity generation infrastructure (excluding the cost of the gas extraction) is estimated to be 4-5 years.

A hitch in installation arose when it was discovered that the flaring compound had in fact been built on an old mine scrapper gully. This meant that the ground was unstable and an unanticipated civil works process to stabilise the site had to be undertaken.

The first month's actual production has been 594 MWh. Gas continues to be flared on site as the gas production is greater than the generator can utilise. EMM plan to expand the capacity to 2MW. Energy is exported to the municipal grid, for own use within the municipality. Because electricity is for "own use", EMM may qualify for generating license exemption in terms of Schedule 2 of the Electricity Regulation Act, 4 of 2006. They have however submitted an application to the Regulator.

Capital & Operating Expenditure at the Simmer and Jack landfill site

Description	Capital Cost	Operating Cost
Installation of landfill gas extraction wells and flare systems (for the 4 landfill sites)	R69.7 million	-
1 MW generator set at Simmer and Jack landfill site(including installation)	R12.8 million	R140,000/month

The Waste Department have been progressively expanding the landfill gas harvesting capacities at each site over time and the Electricity Department have plans to install 1MW on each site per year over the next years.

Indicative gas potential for EMM's landfill sites from the 2005 feasibility study and trial extraction and flaring

Landfill Site	Gas potential (Nm ³ /hour)	Landfill size (tonnes, 2010/11)	Planned capacity
Simmer and Jack	3 000	429 771	1 – 2 MW
Weltevreden	2 000	329 002	2 MW
Rooikraal	2 000	217 246	1 MW
Rietfontein	1 300	355 336	Doubtful

Project Business Model

The gas harvesting and flaring phase of the project has been developed and financed by the municipality. The whole project was envisaged and designed as a CDM project, with an anticipated revenue stream coming from carbon credits. This was to finance the phase 2, electricity generation component. Edesa (the Spanish Utility) were committed to investing in the certification process and purchasing the carbon credits. However, with the lengthy CDM carbon credit certification process, the virtual collapse of the carbon market and the economic downturn, Edesa cancelled their contract with EMM. Their departure left the project stranded, and the municipality stepped in with an investment through their capital expenditure budget.

The construction and commissioning of the electricity generating plant, as well as its operation and maintenance has been outsourced to a service provider. The operation and maintenance contract was built into the development and installation contract, through an O&M item listed under the Bill of Contract. The O&M contract will run to June 2015, when the O&M tender will once again be advertised. At this stage the contract has been short-term (shorter than 3 years).

The gas collection remains the business of the EMM Waste Department. This service is also under contract. While no performance standards, or volumes of gas, are specified in these

contracts, there are tight conditions around maintenance of the operations (e.g. 24 hour period turn around on fixing breakages/ stoppages).

Similarly, Ener-G Systems are paid a fixed monthly O&M fee, with no performance component based on electrical output. At this early stage of the development of such projects, this model was considered the most manageable. The separation of the two contracts—one for gas extraction (feedstock) and one for electricity generation - and their management by two different municipal departments presents challenges, e.g. around responsibility for stoppages or equipment breakages. However, the project is still considered by all parties to be working well and very worthwhile.

Electricity produced is for 'own use' by the municipality. The plant is grid-tied to the municipal distribution grid and electricity is exported to the municipal grid at an effective 'offset' rate equivalent to average Eskom Megaflex tariffs. The value of the electricity produced, in other words, is represented through the saving achieved by reduced electricity imports from Eskom. This is still a small fraction of what the municipality uses for its own requirements. No actual electricity sales take place.

The municipality is, however, developing systems to account for the power produced. They are exploring a process whereby the Electricity and Energy Department will invoice the municipality for the power (at Eskom Mega flex equivalent rates) and a budget vote number has been set up into which the money will be transferred. First allocations of the "payment" will be visible in the July 2015 Budget Vote. It is still unclear what the money will be used for but the broad idea is that it should be paid across to the Energy Department, through the budget vote process in order to support the further development of the gas utilization for electricity production.

Despite the current low value of carbon, the municipality is still pursuing the carbon market as a potential revenue stream. This is driven through the Waste Department. The CDM Project's first verification (comprised of all of the Verified Emissions Reduction (VERs) generated before registration and all the Certified Emission Reduction (CERs) generated from the time of registration through 29 February 2012) is currently underway. Aenor (Spanish Association for Standardisation and Certification) has been appointed by EMM as the Designated Operational Entity (DOE) to conduct the verification.

Initial approval by the Emissions Board was given in November 2014, and the municipality is hoping for issuance of VER certificates in March 2015. These can be sold into the voluntary market while the lengthy CDM carbon credit certification process is underway. The municipality intends to put these VERs out to tender in 2015, to test the market for interest in the project and to gauge the value of the emissions reductions. The municipality is also hoping that the carbon offsets programme, set to be implemented in South Africa in 2016, alongside the introduction of the Carbon Tax, will open up a potential Emission Reduction market with a much higher value than the current carbon market. Since project inception a total emission of 573 494 tCO_{2eq} (as at 29 February 2015) has been avoided.

Project Timeline

2005

Initial feasibility studies relating to gas extraction and flaring potential were commissioned by the municipality.

2007

Phase 1 built, involving gas extraction and flaring, led by the Municipal Waste Department.

2007

EMM Energy and Climate Strategy, with 10% renewable energy target, approved by council.

2010

Energy Unit established in the Electricity and Energy Department, to drive the Strategy.

2012

Project proposal and associated budget approved by council.

January 2013

Tender published for design, supply, installation and commissioning of landfill to electricity site.

June 2013

Ener-G Systems appointed as service provider.

April 2014

Construction begins.

September 2012

Site commissioned and electricity production underway.

Challenges, enablers and lessons learnt

The project is developed on top of an emissions reduction project. This meant that the foundation for the renewable energy project was already in place (gas extraction infrastructure). If the electricity project is considered as a stand-alone project, not accountable for the gas extraction and management costs, then an analysis of costs, lifespan and payback periods indicate a very viable project. EMM plans to take this model into their other landfill sites.

The project (both the gas extraction and utilisation components) has resulted in the importation of new technology to the country and the transfer of skills to everyone involved from the operations and maintenance personnel as well as the project design engineers. A number of different companies have been involved in this project and this has resulted in skills development and training in terms of project management, technical skills (electrical, mechanical and civils), contracting and construction management.

The project has also resulted in the indirect employment and transfer of skills by engaging with local manufacturers and suppliers for the manufacture of specialised landfill gas equipment. Many of these engineering companies have now become experts in the field of landfill gas well field installation – a skill that was previously not available in South Africa.

Permit and licensing processes

Thanks to adjustments to the environmental regulations, landfill to gas extraction projects no longer require a full EIA process to be undertaken. As electricity was to be fed into the municipal grid, for municipal 'own consumption', no wheeling agreement or generation license process needed to be undertaken (exempted from generating license requirements in terms of Schedule 2 of the Electricity Regulation Act, 4 of 2006). EMM have, however, applied to the Regulator for a generation license.

Procurement and contracting

Contractual capacity has been the main challenge: An error in the scope of work document (failure to indicate the % guarantee that must be put up by the contractor) resulted in months of delay. When presented with the first invoice, the Finance Officer refused to pay on account of there being no guarantee in place. Negotiations between the Energy Division, who pointed out that the contractor had paid millions upfront for the generator, and the Finance Department finally resulted in a waiver of the guarantee requirement.

This procurement error related back to human resource challenges. As a new Division, and in the absence of the Institutional Review having been finalized, the Division had only one staff member supporting the Director. Although two more have been appointed since then, all are on contract, rather than in permanent positions. Staff are new to the municipal systems and have limited authority to implement complex new procedures. However, the indication is that through undertaking such pioneering projects, staff capacity is rapidly developed.

Finance

The collapse of the anticipated emissions reduction/carbon credit revenue stream has presented challenges. However, the municipality stepped into the breach, providing financing from its own capital expenditure budget. The process to develop VERs is underway and may prove fruitful in time. The certification of carbon credits within CDM, however, is very costly and without an investor and committed buyer of the credits may remain on hold.

Operational and technical challenges

The discovery that the site was unstable meant that additional funds to undertake the civil works were required. EMM were lucky

in that the project had achieved savings, and could accommodate this unanticipated cost. However, this can delay a project and indicates the need for some contingency budget to be built into project proposals and budgets.

The division between the gas extraction contract, managed by the Waste Services Department, and the electricity generation contract, managed by the Energy Department, can be challenging. This requires ongoing communication and time to assess conflicting claims by service providers, e.g. around breakages.

Enabler

Alignment to other municipal service delivery projects or initiatives: municipalities need to reduce the emissions from their landfill sites in order to comply with air quality licensing thresholds and improve the quality of life of local residents. There is also strong political commitment to national GHG emissions reduction. Landfill sites, with powerful greenhouse gases, offer an important opportunity to do this. Aligning the renewable energy development to the existing initiative around landfill gas provided the impetus for this project and greatly enhanced its viability.

Political and institutional commitment: This initiative indicates the power of a strong political and institutional commitment to renewable energy development, backed up through a well-developed, council-approved, Energy Strategy and dedicated staff. Ekurhuleni Metropolitan Municipality has a commitment to source 10% of the city's energy requirements from renewable energy, as laid out in its Energy and Climate Change Strategy, which was adopted by Council in 2007. This has been further updated and detailed in a Metropolitan Energy Plan recently put to council. The Municipality has a dedicated Alternative and Renewable Energy Unit within its Energy Division, which is leading the way towards the ambitious target of 260 MW of renewable energy with the installation of municipal PV and waste to energy plants. Current budget allocations from within the municipality allow for 1MW capacity installation per year.

The Energy Plan, if approved, will explore even greater budget allocations through, for example, the recognition of savings and re-direction of these as 'seed' money towards each next investment, as well as Private Public Partnerships in instances where much higher levels of investment are required.

Key Project Data

Start of operations

September
2014

Capacity

1 MW

Average electrical output

7 135
MWh/year (anticipated)

Business Model

Project delivery model

Municipal project, with O&M contract outsourced to a service provider

Electricity production

Electricity is fed into the municipal grid

Cost

Capital cost

R 12.8
million
(for the electricity component,
i.e. excluding gas extraction)

Operational cost

R 1.68
million / year
(anticipated)

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