# DURBAN's ELECTRICITY FROM LANDFILL GAS CDM PROJECT

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## Introduction

The first phase of the multi million rand project to generate electricity by utilizing the methane gas released from Durban's garbage landfill sites went live in December 2006. With the environmental impact assessments complete and a positive Record of Decision (ROD) received, the project received the blessing of the Designated National Authority (DNA) in the Department of Mineral and Energies (DME), and was registered with the Clean Development Mechanism (CDM) executive board of the United Nations Framework Convention on Climate Change (UNFCCC). Durban was proud to turn on South Africa's first (CDM) landfill Gas to electricity project.

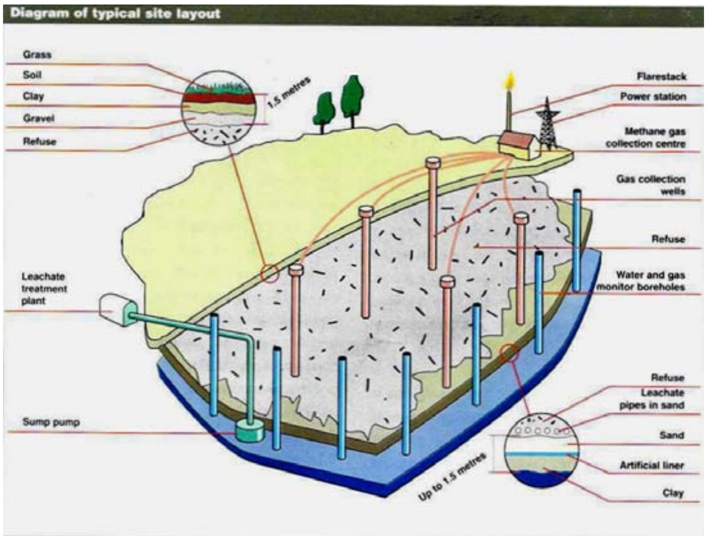


**Diagram showing a typical arrangement for a landfill site power generation scheme.**

The project is aimed in the first instance at addressing global warming and climate change which is one of the most serious environmental issues facing the world today. The recent ratification of the Kyoto Protocol, by numerous Governments worldwide, is a significant step towards cost-effectively reducing greenhouse gas emissions and averting impacts of climate change. According to the Kyoto Protocol, methane ($CH_4$) is a listed greenhouse gas (GHG) and its effect is some 21 times worse than carbon dioxide. It is widely known that landfill sites, with wastes undergoing a methanogenic stage of biodecomposition, produce large volumes of landfill gas (LFG) typically containing some 40-60% methane. For many years Durban has been doing limited "flaring' of methane from these sites to reduce the risk of uncontrolled fires, and to control odours.

Since landfill electricity-from-gas generation projects are currently not competitive with local electricity costs - being about 66% more expensive than current Eskom figures - the project is made possible through "Carbon Finance" which for the first phase of the project is channeled through the World Bank's Prototype Carbon Fund (PCF), a Public Private Partnership with participants from several countries worldwide. This recently available carbon finance – accessible since South Africa's signing of a Host Country agreement allowing for the acceptance of *Clean Development Mechanism* (CDM) projects - has made it possible for financially viable landfill gas utilisation projects to be developed on the African continent.

**Durban's Marianhill landfill site showing the new generation station.**

The proven method of extraction of the landfill gas through pipe work systems from the landfills allows the gas to be fed into the purpose-built spark-ignition engines.  On the Marianhill site a 1000 KW machine was installed.  The site was sized to accommodate a $2^{nd}$ engine which will only be commissioned when additional gas wells are  installed in newer zones which are still receiving rubbish on a daily basis.  At LaMercy a 500 kW machine was installed.  As this site is already closed to new rubbish the gas production is limited.

Methane is "the petrol" to this power generation process and carbon dioxide will be emitted as exhaust gas. This project is aimed at the destruction of methane in engines and is proven to be greater than 99% effective. In addition there will be significant emission reductions by way of the reduction in Durban's electricity demand from Eskom by  up to 10MW when all three sites are fully operational. This project will reduce some 450,000 tons of carbon dioxide which would have been emitted by Eskom's power stations over the project life span of the sites. In total, the project is expected to reduce equivalent emissions in carbon dioxide to our atmosphere by 3.8 million tons!

While it is not part of the current financial model an additional source of income could be from the sale of "green electricity at a premium,  generated from this project. Countries that have highly developed environmental laws and policies are starting to ask South African companies who export their products how environmentally clean their production is.  Electricity is one of the inputs to production, and these SA companies may be willing to pay a premium for electricity generated from a clean or renewable source.

## Technical Issues.

Durban has no local generation and buys all its electricity in bulk from Eskom at 275 KV, and distributes it to customers via its network of 275, 132, 33 and 11 KV cables and overhead lines.
When an opportunity for locally distributed generation is presented it is not a simple case of connecting into the nearest overhead line or cable. System stability, voltage regulation and other quality of supply issues must be carefully analyzed and this is a subject on its own requiring professional system analysis. Local system constraints will occur at low consumption times over weekends and late at night. Unfortunately the landfill gas is produced at a constant rate and short of spending additional capital to build gas storage facilities, the gas must be used continuously as it is produced by the landfill site. The challenge is to accommodate the generation 24 hours per day 7 days a week without causing localized system instability. Complex protection schemes are needed to monitor power flow and trip the generators when primary supply from the network is lost, to prevent islanding of the generator and a part of the network.

Both Projects have provided a steep learning curve for the team of civil and electrical engineers. The main contractor for both sites was Envitec solutions in a consortium with Construction and Plant and Organics Ltd. The Engineer was Enviros Consulting with Wilson Pass Singh jv as a sub consultant. The GE Energy Jenbacher JCG 312 GS-L.Ll and JGC 320 GS-L.L units are state of the art, and when used in stand alone "island" type installations require very little on site electrical engineering to get them up and running. The first challenge came when Durban's local 11kV Network was found to be causing unnecessary tripping of the 11kV breaker feeding the generator, when remote earth faults were detected. After many technical discussions between the protection staff at Durban Electricity and the Genbacher experts it was decided to install neutral earthing resisters on the star point of the 440/11kV delta / Star generator transformer. In simple terms every time a distant remote earth fault happened in the network the generator protection relays assumed that the local 11KV circuit directly connected to the generator substation had an earth fault and due to the speed of the local protection would incorrectly disconnect the generator. In the meantime the remote 11kV circuit which did have the earth fault had also been disconnected and the rest of the network, including the supply to the generator had remained on. These false trips then required 11kV authorized field staff to visit the site and close the breaker. The generator would then re-sync to the network automatically as designed after an outage.

The second lesson learnt was that gas supply for these engines requires a greater degree of monitoring and control then had been necessary with the simple flaring done in the past. Methane needs to be approximately 50% and oxygen needs to be kept below 5% of the total gas input for safe and efficient operation. While all the initial calculations had shown sufficient gas at Marrianhill site to supply a 1MVA machine, in the first 3 months it was found that the gas supply was unstable. If too much gas was "sucked" from the field the oxygen level rose above 5% and the machine tripped on gas safety. The 1000 KVA generator then had to run at 600 KVA for the first 4 months to allow the gas field to stabilize. This output has now been increased to 900KVA and the site will be closely monitored. At the LaMercy site the gas was found to be too "wet" and engine performance is very erratic. Additional civil works on the gas wells has been done and it is expected that this site will start producing sufficient good quality gas soon and the engine can be used. Up to now the gas has been flared. While carbon credits are still earned from flaring, the income from electricity generation is lost, as well as income from carbon credits due to avoided generation by Eskom is also lost.

## CDM registration.

For anyone thinking of starting a CDM project the administration issues are substantial. The first point to note is CDM will not turn a "poor" project into a good project. The basic engineering fundamentals must be sound. CDM is only an additional source of revenue which can be used to make a sound technical project financially viable. The administration burden both in terms of human resources and cost must not be under estimated. There are a series of administration steps which must be followed and to date there is no short cut. As projects like this become more routine this burden should reduce, but for now each project still needs considerable admin resources. Once you have a sound project idea which will clearly mitigate CO2 emmissions in line with the CDM rules the 1$^{st}$ step is to submit a project idea note (PIN) to the DNA at DME. The PIN should not be more then a few pages fully describing the project, the CO2 savings and a financial business plan. The DNA staff will provide guidance in the next step which is a full Project Design Document (PDD). Depending on the type of project the PDD can be 40 to 50 pages and is required by the CDM executive board. All applications for registration of CDM projects world wide have their PDD's published on the UNFCCC's CDM website (WWW.CDM.com) for public comment, and this is only after an independent "Validation". Only after this process, and following support from the host country's DNA, and subject to positive ROD's in any EIA required, will the CDM Executive Board (EB) consider and hopefully approve and register the project. The above process is a mouthful just to read. It is a long, costly and sometimes difficult process for someone doing a CDM project for the first time.

But the admin challenge story does not end at CDM registration. Once your project is up and running you can't simply claim carbon credits and expect a cheque. In February 2007 a world bank (ie our CER's buyer) appointed CDM audit / monitoring team visited Durban for a week. Both sites were fully audited. With the exception of some minor admin items both projects received full CDM "Certification". Durban can therefore now invoice the world for the first 6 months of carbon credits which will form the bulk of the income. An average of 420 000 kWh of electricity was generated at the Marrianhill site per month, which at Megaflex summer rates has saved Durban approximately R50 000 per month on our Eskom Bill. This figure went up to R 75 000 per month when Eskom's Megaflex winter rates were used in June, July and August. The LaMercy site generation was still experiencing gas quality problems so generation was limited and most of the gas had to be flared. The CDM credits are still subject to CDM Audit and were not available at the time this paper was completed.

## Summary

Durban is very proud of the 1st phase of a project which has taken over 5 years to see the light of day. It has been a very long road with many lessons learnt. Global climate change is a critical issue facing our planet so we need many more CDM projects, but, anyone wanting to go down this road needs a great deal of patience and determination. The red tape and admin costs are very much higher than first anticipated. The engineering was relatively simple. The EIA's and the admin necessary to comply with the CDM financing was a huge challenge. Without a dedicated and passionate project champion and the full backing of your Council and City / Town manager / Company CEO it will be all but impossible. In Durban's case Lindsay Strachan from our solid waste department was that champion and the project had the full backing from the Mayor and City Manager. Credit must also go to Andrew Gielink from the Electricity Department who taught the international consultants a few tricks. We plan to commission the first 4MVA out of 8MVA at the Bisasar Rd site in early 2008. Even with all the experience picked up on the 1st two sites we continue to learn new tricks every day which should help us for the next phase.

Anyone wishing to discuss various aspects of the project should telephone Roy Wienand from eThekwini Electricity, at +27 (0) 31-311 9003 or via e-mail at Wienandrf@elec.durban.gov.za