Cattle manure has traditionally been used as a source of biomass for heating and cooking. It can also be used to produce electricity. The Bronkhorstspruit Biogas Project (BBP) is the first large scale animal waste-to-energy project in South Africa, addressing clean and secure energy needs while resolving waste issues. BMW South Africa (the electricity off-taker) has signed a power purchasing agreement (PPA) with the project developer, Bio2Watt. This development has been made possible through agreements with the City of Tshwane and Eskom for the wheeling of the power between the project developer (Bio2Watt) and the power purchaser (BMW). New and complex wheeling arrangements have taken time to be developed, but the project aligns well with the City’s Sustainability Programme. The City is now finalizing a plan to divert some of its organic waste to be processed directly in the biogas plant.

**Project Overview**

The Beefcor feedlot, situated 40km east of Pretoria, houses in excess of 20,000 heads of cattle which produce over 40,000 tonnes of manure per annum. The feedlot provides the project with key fuel supplies, grid access and water from its storm water collection dams. Bio2Watt will supplement the cattle manure with chicken abattoir waste from Early Bird (Pty) Ltd, vegetable and fruit market waste, paper sludge and dairy waste, thereby processing approximately 60,000 tons of organic waste per annum. Through an anaerobic digestion process, biogas will be collected and burnt in a gas engine to produce electricity.

Cattle manure pollutes rivers and water supplies during the rainy season. Manure collection for biogas production will alleviate this environmental problem. South Africa’s new Waste Management Act, to be incrementally implemented by municipalities, aims to ban the disposal of organic waste in landfills by 2015. This Act represents the basic regulatory condition for the biogas project’s continued success. Bio2Watt and the City of Tshwane are currently finalizing a waste diversion transportation plan. The City is willing to supply the organic waste, as long as this does not incur additional costs to the municipality.
**Key Project Data**

**Location**
Beefcor Feedlot
Bronkhorstspruit

**Technology**
Anaerobic digestion of solid waste

**Key Actors**

**Owners**
Bio2Watt
(Bronkhorstspruit Biogas Project (Pty) Ltd)

**Developers**
Bio2Watt
(Bronkhorstspruit Biogas Project (Pty) Ltd)

**Financers**
Bio2Watt, Industrial Development Corporation (IDC), and various donor/funding agencies

**Some Indicators**

**Powered mid income households**
(based on an average monthly consumption of 500 kWh)

5 850

**Average output per MW installed**

8 750 MWh/MW installed/year

**Capacity factor**
= ratio of actual output to potential output at full capacity, over the same period of time

95%

**Capital cost per MW installed**
(MZAR/MW installed)

R 32 million
(27 when production ramps up to 5 MW)

**Operational cost per MW installed**
(ZAR/MW installed/month)

Not available

**Operational costs per MWh**
(ZAR/MWh)

Not available

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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.

All values are projected and not actual since the project was under construction at the time of the study.
The supply of organic waste

Feedstock for the gas turbines has been secured through agreements with Beefcor, Early Bird and other surrounding farms. The developer has also approached the City of Tshwane and asked whether they could use organic waste from the City's waste collection processes.

New waste regulations call for the diversion of organic waste (separation at source). Tshwane is moving towards meeting this requirement and have started with the Pretoria East and CBD area, which includes the City's markets and many restaurants, which generate sizeable volumes of organic waste. At the same time, the City was engaging with private business and stakeholders around Sustainability Proposals. Waste related projects, including diversion of organic waste were considered within this framework and the call for proposals published.

The City received a number of expressions of interest relating to waste, including garden refuse for composting and waste to energy at landfill sites. As no other requests were submitted for organic waste, they have engaged with the Bronkhorstpruit project. The plant has indicated it will be ready to receive waste from March 2015 and an agreement is in place for this. The City is finalizing a Transportation plan for the waste delivery that ensures no additional costs are incurred by the Municipality.

As this is a new area of engagement for the City, they have been clear that they are not offering any guarantees that the waste stream will be a permanent arrangement. Should other proposals

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**Technical Description**

The process involves the anaerobic digestion of agricultural waste in a Covered In Ground Anaerobic Reactor (CIGAR). Gas harvested is then used to drive the gas turbines producing power. The project is being constructed by the South-African construction and engineering company Bosch Projects. The Danish company ComBigaS (Complete Biogas Solutions) supplied the biogas technology.

Due to the size of the proposed development (a footprint of greater than 1-hectare of agricultural land), a full environmental impact assessment (EIA) had to be undertaken according to the EIA regulation (2006).

**Project Business Model and the Wheeling Agreement**

The project is a private development undertaken by Bio2Watt who partly financed the project themselves, along with obtaining donor funding and debt or equity financing. Bio2Watt financed most activities during the concept design phase and received a grant of EUR 50,000 (approximately R425,000) from the Finnish Development Organisation in 2011 for the pre-feasibility study.

Debt financing for the project was structured as a limited recourse finance transaction. For the construction phase, the Industrial Development Corporation (IDC) provided a commercial loan equal to 70% of total project costs. The remaining 30% took the form of equity finance with a range of private investors and participants, including mezzanine finance of approximately 9.1 million Norwegian Krone (approximately R14 million), development funding from the Netherlands Enterprise Agency and equity funds from a range of private investors, including Bio2Watt.

**A limited recourse finance transaction** is a debt in which the creditor has limited claims on the loan in the event of default.

**Mezzanine financing** refers to debt capital that gives the lender the rights to convert to an ownership or equity interest in the company if the loan is not paid back in time and in full.

http://www.investopedia.com/
or request for the waste stream come on board, the Municipality would be obliged to consider these, and undertake evaluation for the award against set criteria that ensure fairness and transparency.

**PPA and wheeling**

The generating license obtained from NERSA allows for the export of 4.2 MW of power with the possibility of increasing that to 5MW should feedstock resources prove sufficient to support such capacity. The project developers engaged with willing buyers of green power from the private sector and have developed a Power Purchase Agreement (PPA) with BMW. When the project comes on line, anticipated to be in the first half of 2015, between 25% and 30% of the BMW Rosslyn (located north of Pretoria) plant’s energy requirement will be generated from renewable sources.

The PPA negotiation processes was one of many lengthy and difficult processes. It began in 2009, but extended into latter parts of 2011. The duration of the off-take agreement which will see the sale of 3.3 MW to the private sector off-taker (BMW), is limited by the lease on agricultural land. The project will thus operate for 10 years, with the opportunity to renew agreements for an additional 10 years. The plant will export the electricity to the buyer using both Eskom and the City of Tshwane power grids (over a 40km distance). Two 10 year wheeling agreement has thus been signed by the project developer: one with the City of Tshwane and another one with Eskom.

**Wheeling** deals with the use of the network by an energy seller and the cost of delivering the energy to a buyer.

NERSA’s Regulatory Rules on Network Charges for Third-Party Transportation of Energy (March 2012) state that:

"Wheeling of energy shall be allowed, subject to the generator receiving its approvals from NERSA to sell to a third party and the signing of the network service provider’s Connection and Use-of-System Agreement."

Wheeling must ensure that all customers are treated equitably in relation to network charges. A challenge to municipal wheeling is that the majority of municipal distributors do not properly unbundle their use of system charges (i.e. tariffs are bundled – including grid system and energy costs). Very few municipalities have wheeling policies with formulated conditions and charges.


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**Project Timeline**

**January 2007 - December 2008**

- Bio2Watt began in 2007 with a 2 year feasibility study.

**December 2008 - December 2010**

- Environmental impact assessment (EIA) undertaken.

**Mid 2009 - Mid 2011**

- Bio2Watt negotiate the power purchase agreement (PPA).

**Mid 2009 - September 2013**

- Grid connection and wheeling agreements from Eskom and City of Tshwane. Varied durations.

**2011 - 2013**

- Approaching investors for investment into the project.

**2014 - 2015**

- Construction and start of operations.
Challenges, enablers and lessons learnt

Permit and licensing processes

Among the main challenges faced by the developer was the acquisition of the required permits and licenses, which included environmental authorization, land use, water use, air quality, and waste management amongst others. The difficulty in obtaining some of the licenses, the non-alignment of the diverse licensing processes or the need for some additional permits as time passed by, induced higher development and legal costs for the project (over R6 million spent in legal fees). There exists a need to streamline all these applications into a single application process.

Getting a wheeling agreement with Eskom took 6 months as the utility has clear procedures for doing this on condition that a power purchase agreement (PPA) has been concluded. However, the process of acquiring a wheeling agreement from the City of Tshwane was lengthy as there was no framework in place and a lack of clear directives and wheeling protocols nationally. The project has demonstrated that wheeling of electricity through the national and municipal grids on a reasonable scale is possible, and is allowed by legislation, however municipalities need to be provided with clear directives on wheeling of power and should develop locally applicable wheeling conditions and charges.

Financing

Securing finance for the project was also challenging, and is demonstrated by the 56 iterations of the project’s financial model. Raising finance relies on a stable regulatory framework being in place, as well as power purchase agreements. Initially the project had looked at the government to be the off-taker of the electricity generated but that did not materialise. The role and mandates of local government with regard to the purchase and wheeling of locally generated renewable energy is still in its early days in South Africa. The policy terrain is also hugely dynamic given the electricity price changes from both Eskom electricity and the newly integrated Independent Power Producers.

Operational Challenges

Bio-methane potential tests (BMP) had to be conducted on certain waste streams to determine their potential biogas yields. The BMP tests had to be conducted outside South Africa owing to the absence of suitable laboratory facilities to carry out such tests locally. The BMP tests were therefore outsourced to CPG-Waste Solutions in New Zealand. It was only in 2012 that two local laboratory facilities, one at the Stellenbosch University and another at FarmSecure Technologies were identified and used for further tests. The project also faced various challenges in acquiring the technology to be used in the biogas-to-electricity project and has experienced delays in construction. As the industry matures through these pioneering efforts, as illustrated by the development of local biogas laboratories, many of these ‘growing pains’ will be addressed.

Enablers

Signing a PPA with the electricity off-taker (BMW) was important as it gave investors enough confidence on the potential success of the project. The strong support provided by the Department of Energy, NERSA and Eskom was essential for the successful development of the project. The new waste management legislation prohibiting the disposal of organic waste in landfills will ensure the continued success of this project.
**Key Project Data**

- **Start of operations:** 2015
- **Capacity:** 4.2 MW, potential to ramp up the project to 5 MW
- **Average electrical output:** 35 000 MWh/year (anticipated)

**Project delivery model**
- Private development

**Electricity production**
- Power Purchase Agreement between a willing seller (Bio2Watt) and a willing buyer (off-taker), Wheeling of electricity through with City of Tshwane and Eskom

**Cost**
- **Capital cost:** R 135 million
- **Operational cost:** Not yet available

**Business Model**
- **Cost**
  - **Start of operations:** 2015
  - **Capacity:** 4.2 MW, potential to ramp up the project to 5 MW
  - **Average electrical output:** 35 000 MWh/year (anticipated)

**Sources:**

**Design and Layout:** Twaai Design

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More information and other case studies from this series are also available on [www.cityenergy.org.za](http://www.cityenergy.org.za)