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THE VIABILITY OF WASTE DISPOSAL FACILITY MANAGEMENT AS AN ALTERNATIVE ENERGY SOURCE IN SOUTH AFRICA

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A research report submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Masters of Business Administration

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Abstract

The world has an energy problem and the root cause of this problem is the growing world population and the energy consumption per capita. The main source of energy, oil, is gradually running out. The use of coal, oil and fossil energy sources are polluting the planet with greenhouse gasses (GHG).Internationally waste disposal facilities are currently providing energy to industry and humans. This research determines if waste disposal facilities in South Africa can produce a viable source of energy.

The exploratory research process involved structured interviews with key informants and experts in the waste disposal facility management in South Africa. A survey questionnaire was sent to waste disposal facility managers and this questionnaire was close-ended questions. The structured questionnaire consisted mainly of open-ended questions. The data collected from the questionnaires and the surveys were analysed through descriptive statistics and content analysis.

The results of the research were that waste disposal facilities in South Africa, not all, could produce energy that can be integrated into the Eskom grid, and will also contribute significantly in the reduction of harmful GHG, and to the Clean Development Mechanism.

Declaration

I declare that this research project is my own, unaided work. It is submitted in partial fulfilment of the requirements of the degree of Masters of Business Administration for the Gordon Institute of Business Science (GIBS), University of Pretoria. It has not been submitted before for any degree or examination in any other university.

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Hendrik Schoeman 13 November 2008

Every person has milestones in his or her life. Completing the MBA program at Gibs is one of these milestones for me and more specifically the research project. The past two years was a journey that has shaped me in more ways than I expected it would, and it affected so many people around me, both personally and professionally

Firstly and most importantly I would like to thank my wife, Karen and my two beautiful children, Juan and Inge, for supporting me throughout the past two years and for understanding. I love you. To my family and friends, thank you for accepting that I was not available and for the support. Leon Grobbelaar, thanks for all the input, advice and support over the past two years. To all the new friends and class mates, thanks for the good times and contributing to making this such a life changing experience. Thank you to the entire Faculty at Gibs, and to my supervisor, Donald Gibson. A special thanks to San-Marie Aucamp and to Lynette Loubser for all your assistance.

Thank you to the Management of Interwaste for affording me the opportunity to enrich myself in these studies. Everyone that assisted me in the questionnaires and the surveys, your valuable contributions, experiences and knowledge enriched my growth in this field of study.

Lastly, thanks to the Lord for giving me the power and the believe.

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CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
DANCED	Danish Co-operation for Environment and Development
DBSA	Development Bank of Southern Africa
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Mineral and Energy
DSW	Department of Cleansing and Solid Waste
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
EFW	Energy from Waste
GHG	Greenhouse Gas
IWMSA	Institute of Waste Management of Southern Africa
MW	Mega Watts
Nersa	National Energy Regulation Authority of South Africa
NWMS	National Waste Management Strategy
PDG	Palmer Development Group
UNFCCC	United Nations Framework Convention on Climate Change

Chapter 1: Introduction to the Research Problem

1.1 Research Title

The viability of waste disposal facility management as an alternative energy source in South Africa.

1.2 Research Problem

South Africa is not the only country in the world facing an energy crisis. Experts agree that it is a growing global problem (Bulatov, Klemes and Perr, 2008) caused by the world's growing population and an increase in energy consumption per capita.

Oil is the world's major energy source. However, the production of oil is steadily declining because fewer and fewer new oil fields are being found. Energy sources such as oil, coal and fossil fuels are contributing significantly to the pollution of the planet through the release of greenhouse gasses into the atmosphere and environmental groups pressurizing governments to find alternative energy source. Although there are various alternative energy sources available, some of them require vast areas of land, for example bio-fuel and solar cell plants as well as wind mills.

Consistent electricity supply to households and industries in South Africa was severely affected during the first part of 2008. Eskom's solution to the problem was load shedding and power cuts. This had major repercussions for businesses in South Africa. One of the country's leading industries, the mining sector, had to severely restrict its activities for several weeks. Industries warned of looming job losses (Africa Research Bulletin, 2008) as a result of the electricity crisis.

South Africa's electricity demand is in the region of 30 000 megawatts (MW) per year. Eskom's capacity is approximately 40 000 MW. During January 2008, nearly 25% of this capacity was offline because of the following reasons:

- 3 800 MW due to maintenance;
- 3 500 MW faults due to poor maintenance; and
- 2 700 MW due to coal shortages.

The latter encapsulates the critical capacity shortages in the mainstream energy provision in South Africa (with an emphasis on electricity).

A fundamental focus on alternative energy sources should be embedded in the overall strategy of energy provision. Different alternative energy sources such as bio-fuels, hydro, solar, wave and wind power already exist and have been used with tremendous success in some countries (Endesa, 2008). One such country is Spain, an extremely windy country. Spain is currently the second largest producer

of wind energy in the world. Approximately 9% of the country's total electricity requirements are met through the harnessing of wind energy. How effective and viable are alternative energy sources? This research project focuses on one such alternative, which can be derived through the production of energy using waste. The specific focus of the study is whether or not waste disposal facilities can be used to produce energy, which can be utilised to address the energy shortfall in South Africa.

It has already been established that South Africa is facing an energy crisis. In addition it is clear that neither government nor Eskom has an efficient short-term strategy in place. Furthermore, government has decided to delay Eskom's expansion until 2012. The reasons for this delay are the long lead times required to secure equipment, and the waiting period for environmental and regulatory approval (Enslin-Payne, 2007).

As a result, the first new power station will only be online in 2011. The first new coal fired power station, known as Medupi, will be constructed in Lephalale in Limpopo. There is a possibility that Medupi will have one unit operational by 2012 and that it will be fully operational by 2015 (Enslin-Payne, 2007).

There is no short-term solution for the energy crisis in South Africa. The reason for this is that the country's only energy supplier, Eskom, is

between five and ten years away from going online with its first new coal fired power station.

The South African government identified the energy crisis as far back as 1994. Although some attempts were made since then to improve service delivery, government waited until 2004 to take action. Shortcomings in the current infrastructure have been identified as one of the major problems and it is essential that South Africa improves its infrastructure if it wants to compete with other upper-middle income group countries (Bogetic & Fedderke, 2006).

The National Energy Regulation Authority of South Africa (Nersa) confirmed that Eskom will be required to supply 50% of the country's renewable energy and that it will buy the remaining 50% from independent producers. In addition, South Africa needs to source 10 000 gigawatt hours of electricity from renewable sources by 2013 (Africa Research Bulletin, 2008).

The lack of energy sources could have a devastating effect on South Africa's economic growth. Electricity has a robust impact on a country's economical growth. The solutions that have been used to deal with the shortage in electricity supply have been costly to the South African economy. Load shedding and scheduled and unscheduled power outages have cost millions and could erode investor confidence (Africa

Research Bulletin, 2008). According to Statistics South Africa's (Statsa) statistical release P0441, which covers the first quarter of 2008, the electricity, gas and water industries reflected an annualised decrease of 6.2 percent while during the same period in 2007 an increase of 3.4 percent was recorded. Statsa reports that the decrease in 2008 can be attributed to a decline in electricity consumption. It can be argued that this decrease was due to the non-availability of electricity. In addition, the value add decreased by 0.3 percent from 2007 to 2008.

The question arises whether or not there are alternative energy sources available - other than the energy that will be produced by Eskom's three new facilities – that can be used to address South Africa's energy crisis. Eskom's new facilities, which will produce 16 000 mega watts, will cost approximately R200 billion to erect and will only be operational by 2013.

1.3 Aim of Research

The aim of this research project is to determine if waste disposal facilities in South Africa can be used to produce viable alternative energy source. The way in which these facilities are managed, will play a crucial role in its successful implementation. Alternative solutions are necessary to address shortages in the energy supply, because methods currently employed by Eskom, such as load shedding and power outages, are not economically viable.

One of the alternative solutions is the use of existing energy source "locked up" or contained in waste. However, this solution is only viable if waste disposal facilities are managed effectively. The question arises if the use of energy from waste is a viable option for South Africa.

This research project investigates the circumstances under which a waste disposal facility can be utilized to produce a viable alternative energy source.

The potential use of waste disposal facilities to produce alternative energy sources has two possible results/impacts:-

- Solving our energy crisis; and
- Resolving the poor management of waste disposal facilities.

The focus of this research project is on the former.

The research project will attempt to proof that the effective management of waste disposal facilities can result in the production of an alternative energy source. The alternative energy source that can be extracted from a waste disposal facility is known as methane gas. A waste disposal facility can be seen as a bio-reactor, where the methane generated from the bio-degradation of waste, can be harnessed and converted into an energy source. In addition, carbon dioxide (Co_2) is removed from the atmosphere. According to the Waste Bill (National Environmental Management Waste Bill of 2007), energy from waste is

an important suite of technologies, with the ability to provide both renewable energy and to address the growing challenges in the waste management industry.

Chapter 2: Literature Review

In the literature review, the researcher looks at the various factors that influence the manner in which waste disposal facilities are managed or should be managed. He briefly discusses the National Waste Management Strategy (NWMS) and its objectives regarding waste management in South Africa and takes a closer look at an effectively managed waste management system. In addition, he discusses the requirements for success as well as the opportunities available in the waste management sector and those that can be created if a waste disposal facility is managed more effectively. The researcher also provides some insights into methane gas projects and what have been achieved to date. He investigates which of these projects have been successful and the reasons why one has failed. International trends on the management of waste disposal facilities and the successes that have been achieved in the United Kingdom (UK) and the United States of America (USA) are also discussed.

2.1 Introduction

Landfilling is used to dispose of waste material and is a worldwide practise. Waste material is treated and then covered by soil. One of the drawbacks of this process is that methane gas is released as a result of the anaerobic decomposition of organic material (Climate change and

waste, 2007). The use of composting or combustion can lead to a reduction in methane emissions. However, methane from waste disposal can be utilised as an alternative energy source and can be harnessed to produce electricity for industries and businesses (Climate change and waste, 2007). The objective of Article 2 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is to encourage countries to reduce or limit the emission of greenhouse gasses. In addition, the article calls for the limiting or reduction of methane gas emissions through recovery and use in the waste management process, as well as in the production, transport and distribution of energy (Kyoto Protocol, 1998). According to a report published by the Department of Environmental Affairs and Tourism's Palmer Development Group (2007), there are more than 2 000 waste handling facilities countywide, of which only 530 have permits.

The Minimum Requirement for Waste Disposal by Landfill (2005) classifies disposal facilities as follows:

Table 1: Disposal Facility Classifications

Class	Description	Area
G:C:B-	General Waste	East Rand
G:C:B+	General Waste	Ethekwini
G:S:B-	Domestic Waste	North Free State
G:S:B+	Industry Waste	East Rand
G:M:B-	Dry Domestic and Industrial Waste	North Free State
G:M:B+	General Domestic Waste	Eastern Cape
G:L:B-	Domestic and General Industrial Waste	Gauteng
G:L:B+	Industrial Plant Waste	Mpumalanga
H:h	Domestic Waste and Hazardous Waste	Gauteng and Western Cape
H:H	Domestic and Hazardous Waste with various ratings	Gauteng and Free State

The energy that waste disposal facilities produce through the process of decomposition also has the potential to solve other social problems and concerns. In addition, the energy produced by waste disposal facilities will contribute significantly to the Clean Development Mechanism (CDM). CDM is an arrangement under the Kyoto Protocol which allows industrialised countries with a greenhouse gas reduction commitment to invest in projects that reduce emissions in developing countries as an

alternative to more expensive emission reductions in their own countries. Gas generated by waste disposal facilities contains between forty and sixty percent methane gas, a potent greenhouse gas (Lee International, 2005). The recovery of gas produced by waste provides South Africa with an excellent opportunity to attract foreign investments by providing developed countries with a means to achieve their greenhouse gas reduction targets.

Waste management activities include the following (National Environmental Management: Waste Bill, 2007):

- the importation and exportation of waste;
- the generation of waste, including the undertaking of any activity or process that is likely to result in the generation of waste;
- the accumulation and storage of waste;
- the collection and handling of waste;
- the reduction, re-use, recycling and recovery of waste;
- the trading in waste;
- the transportation of waste;
- the transfer of waste;
- the treatment of waste; and
- the disposal of waste.

2.2 Waste Disposal Facilities and Waste Management

Waste management is emerging as a key sector for sustainable development in South Africa (Karani & Jewasikiewitz, 2005), because it will enhance opportunities for investment in carbon credits. Carbon credits target the reduction of methane gas from waste, and moveable assets in relation to environmentally sound equipment required for effective waste management (Karani & Jewasikiewitz, 2005). The waste management industry is dominated by the private sector and selective operations in what is economically viable, through the recycling of saleable products (Karani & Jewasikiewitz, 2005).

The materials recycled include paper, plastic, glass, hard board, tinplate and aluminium. On average, a South African generates about 1kg to 1,5kg of waste per day. The rest of the waste products, estimated at 10,2 million tons of hazardous and non-hazardous material, end up at waste disposal facilities (Karani & Jewasikiewitz, 2005). Due to the involvement of various development agencies, such as the Development Bank of Southern Africa (DBSA) and the Danish Co-Operation for Environment and Development (DANCED), more opportunities for sustainable development and investments are being identified. These opportunities include the capturing of methane gas emissions at waste disposal facilities and the financing of moveable assets to enhance sustainable development.

Waste disposal facilities play an important role in the cradle-to-grave approach of waste management in South Africa. Disposal facilities are often not sited, engineered or operated efficiently. The impact is both negative and enduring (Ball & Fiehn, 2005).

Effective waste disposal facility management has the potential to limit the impact of Greenhouse Gases on the environment. This was clearly demonstrated by a town in the Northwest Province during the past year.

The Townland's Disposal Facility in Rustenburg proved that an improved disposal management programme can lead to a decrease in the impact of WHAT? on the environment. The programme makes provision for the development of formal and low cost housing close to the disposal facility as well as the appointment of a professional landfill management contractor. In the past the buffer zone between a disposal facility and a residential area was completely ignored. As a result of poor management, salvagers/scavengers were exposed to serious health and safety risks (Ball & Fiehn, 2005).

The inability at municipal level to administer waste management programmes, to collect rates and taxes to ensure effective waste management and the management of disposal facilities are placing constraints on the efficiency of the public sector (Karani & Jewasikiewitz, 2005). That is why the National Waste Management

Strategy was compiled by the Department of Environmental Affairs and Tourism (DEAT) and the Department of Water Affairs (DWAF).

2.3 The National Waste Management Strategy (NWMS)

The National Waste Management Strategy (NWMS) was developed to assist in the development of efficient and cost effective waste management systems. During 1997 several baseline studies were commissioned to assist in this process, and it formed the basis of the NWMS. The long-term plan (up to 2010) was drawn up to address specific issues, needs and problems experienced in waste management in South Africa. The strategy also puts into action governments policy on waste that was set out in the Draft White Paper on Integrated Pollution and Waste Management for South Africa. The aim of the strategy is to reduce the, environmental impact of waste generation. The Local Government Waste Capacity Assessment (2007) refers to the following: *"…waste generation rates are often considered to reflect the economic status of society, the more affluent the society the greater the waste produced per capita".* While the long-term objective of the NWMS is the prevention and minimization of waste, a number of alternative actions such as improved waste collection and waste treatment are required in the short-term, due to prevailing inadequate waste management practises (National Waste Management Strategy Version

D, 1999). In Section 2.4 of this paper, the elements of a basic management system are discussed.

2.4 Elements of Basic Waste Management Systems

Although evidence of successful waste management systems is found in Botswana, where a number of new waste disposal facilities have been designed and developed together with an awareness campaign that included the successful involvement of local communities (Karani & Jewasikiewitz, 2005), in South Africa waste management systems are mainly handled by municipalities, and are often constrained by limited funds, skill shortages, deficits and institutional inability that lead to service backlogs.

Figure 1 emphasizes that landfill is the ultimate means of waste disposal.

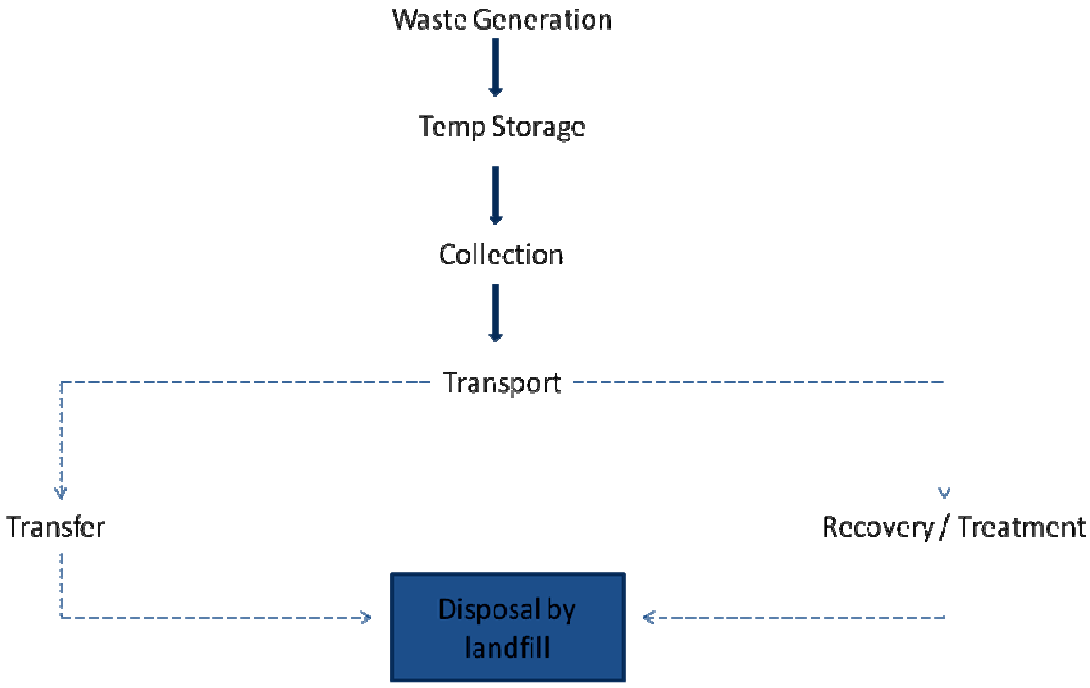

Figure 1: Elements of Basic Waste Management System, Minimum requirements for waste disposal by landfill, Third Edition, 2005.

The international waste management hierarchy was developed. Table 2 illustrates the flow of the system. In addition to the implementation of a basic waste management system, appropriate philosophies and ethics need to be developed in the evolution of waste management practices (Karani & Jewasikiewitz, 2005). There should be a logical reduction of waste generation through prevention and minimisation, through efficient production methods and the use of resources. The waste hierarchy focuses on cleaner production as a primary objective followed by recycling, treatment and disposal as a last priority. Waste disposal in general has been below standard in South Africa and very few disposal facilities are operated in compliance with DWAF's minimum

requirements. One of the major challenges facing government is to ensure that waste is disposed of safely and correctly into the right landfill sites (PDG, 2007).

Table 2: Hierarchy of Waste. Minimum Requirements of Waste Disposal by Landfill, Third Edition, 2005.

Waste Hierarchy	
Cleaner Production	**Prevention**
	Minimisation
Recycling	**Re-Use**
	Recovery
	Composting
Treatment	**Physical**
	Chemical
	Destruction
Disposal	**Landfill**

2.5 Opportunities in the Waste Management Sector

Services rendered by local authorities such as waste-water treatment and solid waste disposals (landfills), generate significant volumes of

methane gas, which enters the atmosphere. Methane gas is seen as a local pollutant and a very powerful greenhouse gas (GHG). GHG locally and globally is one of the gases that have to be reduced in accordance with the Kyoto Protocol. According to Karani & Jewasikiewitz (2005), methane gas is a source of energy as it contains a constituent of natural gas. The reduction of methane gas is not only beneficial to the environment, but it also offers new revenue and investment opportunities to local authorities (Karani & Jewasikiewitz, 2005). Under the CDM, methane gas reduction can give rise to the generation of certified emission reductions (CERs), commonly known as Carbon Credits.

Ball & Fiehn (2005) identify 14 opportunities for waste management. As natural resources are becoming limited and the price of raw materials is escalating, waste should be seen as a natural resource according to Ball & Fiehn (2005). Wastages reduction should be the focus of all strategies related to waste management. Waste-separation-at-point-of-generation not only offers opportunities to create employment, but will also contribute to high volumes of recyclable waste being recovered for re-use.

2.6 Methane gas projects

Evidence indicates that the best use of gas produced at a waste disposal facility, is to convert the methane gas generated by anaerobic bacteria bio-degrading, into energy. This process has been implemented at the Alton Landfill in Richards Bay. The beneficiary of the project is the uMhlathuse Municipality and the residents, because the development is right on their doorstep (Resource Vol. 9 August 2007).

Similar gas extraction projects have been commissioned in:

- Bisasar Road, Durban

  This project is managed by Durban Solid Waste. This disposal facility has a GLB+ classification. The extraction of landfill gas from the Bisasar Road disposal facility will extend the facility's life by seven years and will bring about a saving of R60 million in the municipality's operational budget. The eThekwini Municipality in Kwazulu Natal, wanted to establish the first renewable energy project in Southern Africa. This facility accepts a daily average of 3 500 tons of Municipal Solid Waste (MSW) (Lombard, 2004).

- Marianhill, Pinetown

  This disposal facility was opened in 1997 and Durban Solid Waste (DSW) views it as a new generation disposal facility (Strachan, 2002). This facility was designed in such a way to

ensure that it is out of the public eye and is surrounded by large trees on the peripheral buffer zone. The facility receives a daily average of 700 tonnes of MSW and its gas extraction scheme consists of six gas wells, which generate about 170m3/hr landfill gas (Strachan, Couth and Chronowski, 2004).

- New England Road, Msunduzi
- Luipaardsvlei Landfill, Mogale City
- Ekurhuleni Metro Council (EMC)
    - Rooikraal
    - Simmer & Jack
    - Weltevreden
- Sheffield City Council (UK)

  The UK government is committed to reducing the use of waste disposal facilities and have shifted their focus to the provision of cost effective waste treatment and sustainable waste management, which will result in important environmental benefits. The system that was implemented in Sheffield has led to the following notable achievements:

    - on average every year the Sheffield District Energy Network prevents over 21 000 tonnes of CO_2 being released across the city. This has a direct impact on the UK's carbon footprint and is contributing to the prevention of climate change;

- the facility generates 60 mega watts of thermal power energy and up to 19 mega watts of electricity; and
- the facility creates heat for the following receivers in the city:
    - Sheffield Ponds Forge International Sports Centre;
    - Park Hill Plats;
    - The Crucible and Lyceum theatres;
    - Millennium Galleries;
    - Western Park Hospital; and
    - City Hall.

The problems associated with waste disposal are turned into an opportunity to generate income from heat or power sales. The UK's changing environmental legislation demands that local authorities reduce the quantities of waste-to-waste disposal facilities (UK Trade & Investment, 2008).

The UK is the second largest recipient of foreign direct investment (FDI) globally and number one in Europe. The UK, as with many other developed countries, is facing escalating waste disposal costs. They need between £9 – 11 billion over the next twelve years to expand their facilities and plants to produce energy from waste.

2.6.1 Disposal facilities management in developing countries

There are distinct differences in the way developed countries manage their disposal facilities as opposed to methods used by developing countries. According to Al-Khatib et al (2006), developed countries have a greater understanding of the process of waste storage, collection and sanitary disposal. In contrast, landfill management in developing countries is insufficient and unsophisticated methods such as open dumps are often used. It is also rumoured that landfill management in developing countries is not controlled and executed at random. As a result, large quantities of waste are not collected.

There are some developing countries that have implemented waste reduction programmes, but due to a lack of proper disposal facilities, waste is burned. Unfortunately little cognisance is taken of the harmful effects this have on the environment. The burning of waste releases toxic and carcinogenic gases such as dioxins - especially if the waste contains plastic materials (Al-Khalib et al, 2006).

In the USA there are 89 waste-to-energy facilities. These facilities dispose of about 29 million tons of waste per year (Waffenschmidt, 2007). This waste is used to produce 17 million megawatt hours. Waffenschmidt indicates that 13% of the USA's waste is disposed of at disposal facilities that are geared to transform waste to energy. Another

54% of solid waste that goes to disposal facilities in the USA, which amounts to 132 million tons, theoretically holds the potential to generate between fifty and sixty million megawatt hours.

2.7 Consequences of inefficient waste management

The Gauteng Paper on Waste Management (GDACE, 2008) states that it is difficult to quantify what the effects of non-sustainable waste management will be. However it does identify some consequences:

- pollutants that enter ground water resources, air and soil, affect usability;
- increased costs of waste management;
- increased illegal dumping;
- health and environmental risk; and
- poverty encourages scavenging and place these individuals at risk. Disposal facilities need to establish Materials Recovery Facilities (MRF).

It is therefore imperative that effective and sustainable waste management systems are implemented. A study done by the PDG in 2007, found that the primary obstacle in the implementation of sustainable waste management at municipal level is the lack of capacity to render effective services and the inability to move the services from “end-of-pipe” scenario to a waste minimisation approach. Waste management is a highly specialised function and requires a large

degree of technical capacity (Local Government Waste Capacity Assessment, DEAT, 2007).

In South Africa there are currently over 2 000 waste handling facilities of which only 530 have legal permits (Local Government Waste Capacity Assessment, 2007). Permitted waste disposal facilities are facilities that have been approved by DWAF. DWAF has established minimum requirements that have to be met by waste disposal facilities. If a waste disposal facility does not meet these minimum requirements, the facility is required to upgrade to meet the specifications. During its upgrading or rehabilitation, the facility is closed (Waste Management, Gauteng Provincial Government, 2008).

2.8 Literature Conclusion

There is no doubt that South Africa's economy, as well as its population, are growing. As a result, the demand for energy is increasing. This is not limited to South Africa, but to both developed and developing countries. As a result of capitalism, the world's dominant economic system, mankind's economic needs keep growing, which lead to increases in the demand for goods and services. In the developed world, the waste management process is based on the hierarchy of reduce, recycle, compost, combust with heat recovery and only then is it send to a waste disposal facility. The waste that is combusted into

energy and the waste that goes to the disposal facility have two different footprints.

The effective management of disposal facilities could alleviate some of the problems associated with South Africa's energy crisis. Disposal facilities in South Africa can assist in the generation of energy and heat. By effectively managing these facilities; South Africa can reduce fossil fuel imports, eliminate costly transportation of waste to disposal facilities, create a cleaner environment, provide jobs and encourage recycling. Initiatives to implement alternative energy sources still have a long way to go before they can offset the quantities of fossil fuels. Every alternative energy source must be utilised. Every ton of MSW has the potential to offset a barrel of oil (Waffenschmidt, 2007). In addition, the energy that is generated at disposal facilities reduces the impact of greenhouse gas emissions.

Chapter 3: Research Questions

3.1 Purpose of the Research

This research seeks to determine if waste disposal facilities have the potential to provide South Africa with an alternative energy source if it is managed efficiently. Energy is produced by using a process known as methane gas extraction. Once extracted, the methane gas is converted into energy.

3.2 Research Question 1

What is the status quo of waste disposal facilities management in South Africa?

- The Minimum Requirements For Waste Disposal By Landfill (Jewasikiewits and Karani, 2005; Ball and Fiehn, 2005; NWMS, 1999) provides clear guidelines on how these facilities should be managed.

3.3 Research Question 2

How can energy from waste disposal facilities and the management thereof compensate for the energy shortfall in South Africa?

- Waste disposal facilities' gas extraction projects are already underway (Lombard, 2004 ; Resource, August 2007; Chronowski, Couth and Strachan, 2004; UK Trade and Investment, 2008);
- improved management practices have been introduced in certain metropolitan municipalities including Ekurhuleni and eThekwini. These municipalities are way ahead of their counterparts in other areas;

  (Elements of Basic Waste Management, 2005; PDG: Assessment of status of waste service delivery and the capacity at local government level, 2007);
- international trends show that energy from waste disposal facilities are viable (UK Trade and Investment, 2008; Al-Khabib et al, 2006; Waffenschmidt, 2007); and
- future waste disposal facilities should be designed from inception as a waste-to-energy treatment facility (Waffenschmidt, 2007).

Chapter 4: Research Methodology

4.1 Introduction

The methodology that was used in this research project was a replication of the methodology used by Little (2006) in his project entitled *Accelerating the implementation of the clean development mechanism in the South African Industry.* Little (2006) used exploratory research techniques with particular emphasis on semi-structured interviews of subject experts. The author tried to determine the factors that are causing South Africa to lag behind other developing countries in the implementation of industrial CDM projects, and the interventions that will have the greatest impact on accelerating the implementation of these projects. The research methodology used was based on exploratory research techniques and qualitative research (Welman and Kruger, 1999) with particular emphasis on structured interviews. All interviews were structured as all the respondents received the same questionnaire in the same format. One of the drawbacks of doing research in this manner is that the author did not have the opportunity to explore or clarify answers while the respondents completed their questionnaires. The author did however include questions that requested that the respondents explain or elaborate on their responses.

The aim of this research project was to determine if waste disposal facilities in South Africa can produce alternative energy sources. Various factors influence waste disposal facility management and the ability to produce energy during the process of landfill management. These factors were determined as well as the interventions required to ensure that waste disposal facilities are utilised and developed as active energy sources in future.

The use of alternative energy sources in the current South African context are important to every citizen. As a result of the rising oil prices, various studies have been conducted on finding alternative fuel sources (Department of Minerals and Energy, 1998). Similar, studies have also been conducted on finding alternative energy sources (Jewaskiewitz & Jewaskiewitz, 2006). This research project focused on the potential of waste disposal facilities as producers of a potential alternative energy source, as well as the factors that influences the effectiveness of waste disposal facility management in South Africa.

Energy from waste (EFW) is a relatively new process and has been implemented successfully in towns such as Leicester in the UK. The city has a population of 330 000 residents and annually generates just under 160 000 tonnes of waste. The waste is put through a system of homogenising. Only 12,5 % of the waste goes to waste disposal facilities. The remainder is utilised to generate 8 000 tonnes of methane

gas that produces 1,5 megawatts of electricity (UK Trade & Investment, 2008).

Due to the limited information available internationally, and the lack of research conducted locally, qualitative exploratory research is currently indicated. Exploratory research gives clarification of ambiguous problems (Zikmund, 2003). Semi-structured or unstructured interviews are usually employed in exploratory research (Welman & Kruger, p 166). Although the author used a structured questionnaire with open ended questions, the ideal would have been to explore and clarify the respondents' answers. The author had limited time to gather the data from the surveys, due to the slowness of the respondents to return the questionnaires.

A two part investigation was conducted:

- An e-mail survey; and
- a qualitative survey approach to obtain an in-depth understanding of the findings of the above-mentioned survey. Key respondents in the waste management industry were targeted.

4.2 Population of relevance and unit of analysis

4.2.1 Population of Relevance

The research was based on stakeholder perceptions. The author took the fact that personal bias influence respondents answers, into consideration. Mail surveys have the possibility that the respondent intended for the original questionnaire does not answer it. The population of relevance was defined as the various individual role-player/stakeholders involved in waste management in South Africa. Stakeholders were divided into five broad categories; namely government, local government, branches of industry as users of electricity, landfill management companies and supporting catalysts. The population was limited to people within these stakeholder groups who are involved in waste disposal facility management in South Africa.

4.2.2 Sampling Method and Size

The sampling method that was used was non-probability judgement sampling. The author selected a sample based on appropriate characteristic of the sample members (Zikmund, 2003). In qualitative research the respondents' experience and characteristics are more important than what the author is interested in. Respondents were

selected on this basis. Key respondents in the waste management industry were identified and requested to participate in the research.

The selection criteria for the key respondents included, but were not limited, to the following:

- extensive experience in the field of waste management/waste disposal facility management;
- a facility or acting facility manager or who have acted as a facility manager during the past five years;
- familiar with the National Environmental Waste Bill of 2007;
- familiar with the new NWMS; and
- supporting catalyst working on waste to energy projects.

The sample that was identified for this research project included key respondents in each of the groups identified as stakeholders. A list of the key respondents is supplied in Appendix ii. Due to the nature of this research project, the names of the respondents have been withheld. The research was based on aggregated results and respondents' anonymity was guaranteed.

The author also used an e-mail survey method. E-mails were sent to stakeholders in all the major provinces in South Africa, but were not limited to these provinces. The provinces that were targeted were:

- Gauteng;

- KwazuluNatal;
- Western Cape ; and
- NorthWest.

It must be noted that both permitted a non-permitted waste disposal facilities were targeted. .

Contact details for relevant persons at waste disposal facilities were obtained from the Institute of Waste Management South Africa (IWMSA), and permission was granted to contact them. The author found that these lists were outdated and the information incomplete. Contact information for waste disposal facilities that could add value to the surveys that was sent out, was provided by stakeholders.

4.2.3 Data Collection

E-mail surveys were sent out in two formats. The first format was close ended questions addressed to waste disposal facility managers. From their responses, the author wanted to establish the levels of expertise available in the industry. In addition, the author wanted to establish if the volume of waste has increased over the past 12 months and if the facilities that they manage comply with the minimum standards.

The second format was structured e-mail questionnaires that were sent out to all the stakeholders identified as key respondents. The questionnaires were constructed using descriptive guidelines. The objectives of the research project were provided in the same format to all the respondents Appendix i. After the surveys were returned, some of the respondents were contacted by telephone to clarify answers to questions that were not complete. Although telephonic interviewing is not ideal, (Welman and Kruger, 1999), Welman and Kruger (1999) make allowance for telephonic interviews because of its cost saving implications. Although the author would have preferred all interviews to have been conducted face-to-face, circumstances did not allow for that.

4.2.4 Data Analysis

Basic descriptive statistical analysis was then performed in order to get preliminary results from the data. The following terms were calculated:-

- Mean – is an average of all the scores recorded. It also indicates the significance to all the stakeholders mentioned;
- Mode – is the most frequent occurring value in the set of scores recorded; and
- Median – is the score found in the exact middle of the set of values. All scores were listed in numerical order and the scores in the centre were located.

Answers to the questions (data) were analysed and the author then read the responses and additional comments. Where required, e-mails were sent to key respondents for further clarification. Content analysis (Welman and Kruger, 1999) was performed to extract the main ideas and opinions of the various stakeholders. Stakeholders were initially divided into five groups according to their fields of expertise and their involvement in waste disposal facility management in South Africa (Table 3). The five groupings were:

- Industry – this group represented companies that have experience in alternative energy sources. These industries are driven by profits and ensure the creation of shareholder value. The power outages that were experienced in early 2008 had a negative impact on their abilities to expand. The impact of not having electricity also had social consequences; namely job losses, an increase in crime and escalating production costs, which have been passed to the end consumer;
- landfill management companies – this group included several representatives of companies directly involved in waste disposal facility management and design. Some of these stakeholders own disposal facilities, while the remaining companies manage these facilities on behalf of various local municipal authorities. They are Company A and Company B;
- supporting catalysts – this group comprised individuals who are actively involved in gas extraction projects. At the time of this

research project, one of the stakeholders delivered a paper on waste-to-energy. In his paper he asked whether or not South Africa was ready for the implementation of a waste-to-energy strategy. This group comprised consultants involved in the implementation of gas extraction projects and who were doing further research regarding gas extraction and fuming it into energy. This group is represented by Company C, which focuses on technologies and projects in waste management, waste-to-energy (including gas to energy) and intergraded waste handling, including sorting and treatment; and

- local government – this group of stakeholders comprised local metropolitan councils and municipalities. The group was represented by the Ekurhuleni Metro Council. This group is responsible for the effective management of various waste disposal facilities across Gauteng. The implementation of the correct management structure forms a major part of the NWMS. Several of the facilities are in the process of introducing gas extraction projects from waste disposal. They are not directly responsible for the projects, but play a pivotal role in the successful implementation of these projects. They include:
    - Ekurhuleni Metropolitan Municipality, which is responsible for five major disposal facilities. These facilities are Rooikraal in Boksburg, Simmer & Jack in Germiston, Rietfontein in Springs, Weltevreden in Brakpan

and Platkop outside Alberton in the Suikerbos Rand vicinity.

- government – this group was supposed to include respondents from DEAT, DWAF, the Department of Trade and Industry (DTI) and GDACE. None of these departments were willing to be interviewed – neither telephonically nor via e-mail. Government is the key role player in delivering essential services. Government departments determine policies and are also responsible for the implementation of these policies. With the cost of establishing new power facilities, they were expected to participate in this research project as the need for alternative energy sources is increasing.

Table 3: Stakeholders and the respondents representing the five groups.

Stakeholder Group	Stakeholder Interviewed
Industry	Respondent A Respondent B
Government	N/A
Local Government	Respondent C Respondent D
Supporting Catalyst	Respondent E Respondent F Respondent G Respondent H
Landfill Management	Respondent I Respondent J

	Respondent K Respondent L Respondent M Respondent N Respondent O Respondent P Respondent Q Respondent R Respondent S

The data obtained from the surveys was analysed using content analysis and descriptive statistics. Descriptive statistics are used to describe or summarise information about a population or sample (Zikmund, 2003). The data from the key respondent interviews was recorded and transcribed and content analysis was then conducted on the opinions expressed by the key respondents during the interviews. By using content analysis, the researcher was able to get an objective, systematic and quantitative analysis of the contents of the interviews (Zikmund, 2003).

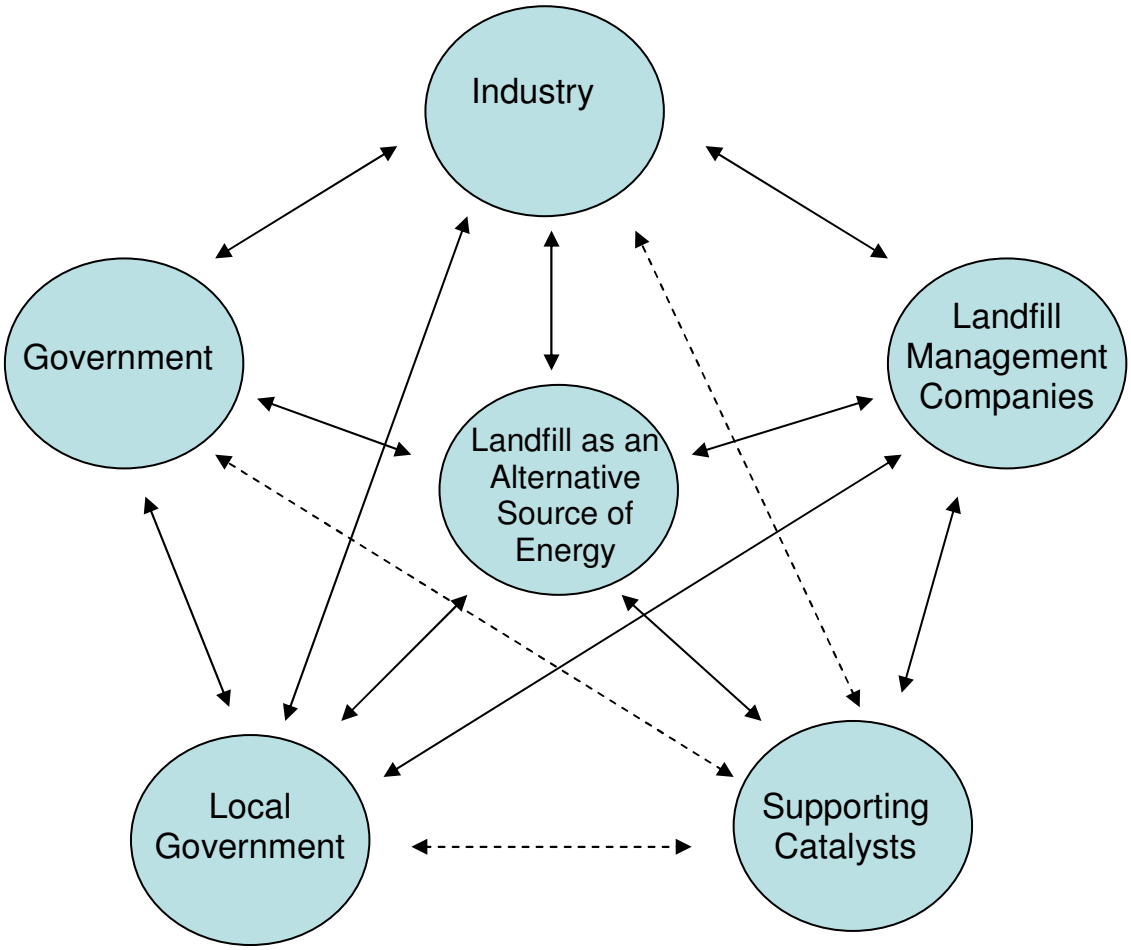

Figure 2: Relationship between stakeholder groups. Source: As adapted from Little, (2006). Accelerating the implementation of the Clean Development Mechanism in the South African Industry. The solid lines indicate a direct dual interaction between the stakeholder groups, and the dashed lines indicate indirect influence.

Trochim (2001) indicates that the traditional criteria for quantitative research are the following:

- Internal validity;
- external validity by way of statistical sampling;
- reliability; and

- objectivity.

4.3 Research Limitations

The research project focused on waste disposal facility management and specifically on waste disposal facilities ability to provide alternative energy sources. Not all waste disposal facilities are equipped to extract gas from waste. The following limitations are expected:

- Limited data available on methane gas extraction in South Africa;
- willingness of key stakeholders to complete surveys;
- surveys are not returned and the sample will therefore not be representative of the population;
- excluded from this research will be sewerage waste, medical waste and chemical waste;
- the sample selection will be based on the judgement of the researcher and his/her opinion of the characteristics required of the key respondents; and
- surveys are seen as a nuisance and respondents chose not to complete them.

Chapter 5: Results

5.1 Introduction

The findings of the surveys that were sent to disposal facilities and the questionnaires that were sent to stakeholders identified as key respondents, are presented in this chapter. The data will be presented as follows:

- An overview of the data collection process;
- Research Question 1; and
- Research Question 2.

The data analysis was done using content analysis (Welman and Kruger, 1999). Trochim (2001) describes content analysis as the analysis of text documents and the identification of patterns in the text.

The author is aware of the fact that there are advantages as well as disadvantages to using content analysis. This was taken into consideration. .

5.2 Overview Of The Data Collection Process

5.2.1 Analysis Of Surveys And Survey Questionnaires

The author originally wanted to conduct face-to-face interviews with waste disposal facility managers and stakeholders identified as key respondents. However, the author realised that this will be a difficult, if not impossible task, and opted to conduct data collection by sending surveys and questionnaires via e-mail. E-mails were sent to facilities with permits whose e-mail addresses were available. The author also wanted to send e-mails to non-permitted disposal facilities, but unfortunately these facilities have no infrastructure. The author investigated the possibility of going to the councils under which these facilities reside and to request the person in charge to complete the survey, but that was not the objective of this research project. The author left twenty surveys at non-permitted facilities in the hope that it would be completed by the person in charge. After two weeks the author returned to those facilities hoping that some of the surveys would have been completed. Unfortunately the author could not find the surveys and again left copies. A week later the author returned, but to no avail. No completed surveys were received. The possible reasons for the non-completion of the surveys will be discussed in Chapter 6. In contrast to the surveys sent to non-permitted

disposal facilities, permitted facilities did respond. Only 35% of the respondents returned the surveys. Table 4 below indicates the number of surveys sent to disposal facilities and the number of responses received.

Table 4: Surveys To Waste Disposal Facilities And Responses Received.

Surveys sent to permitted facilities 40	Surveys received back 14	Percentage (%) 35 %
Surveys sent to non-permitted facilities 20	Surveys received back 0	0 %

Sixty surveys were distributed and only 14 of the respondents completed and returned the surveys. The author sent out various reminders to the respondents targeted. The author also provided a time schedule for the completion and return of the surveys. The last two surveys were only received two days before the research proposal had to be submitted.

Table 5 indicates the number of questionnaires that were sent to key respondents and the responses received. Key respondents were divided into five stakeholder groups. Some of the respondents indicated that they did not agree with the authors classification. These were

mainly respondents classified as supporting catalysts. They indicated that they belonged in the stakeholders to industry category. In these instances, the author contacted them and explained the difference between a supporting catalyst and a stakeholder. As with the surveys, the author sent reminders to the stakeholders to complete and return the questionnaires. The stakeholders' questionnaires that were received will not be presented individually as a percentage. The reason being that the base size was too small for this to be meaningful. Example: receiving two responses from five respondents give a response rate of 40%. If another questionnaire is received, the response rate for that group jumps to 60 %.

Table 5: Interview Questionnaires To Key Respondents.

Stakeholders	Questionnaires sent	Questionnaires received
Landfill Management	15	11
Supporting Catalysts	10	4
Local Government	7	2
Government	5	0
Industry	5	2
Total	42	19

The major challenge during the data collection process was to get the respondents to complete and return the surveys and questionnaires on time. Only 45,24 % responded as illustrated in Table 5.

5.2.2 Description Of The Respondents

The respondents were divided into two groups; namely disposal facility managers and stakeholders, who were the key respondents. Table 6 indicates the period that the facility managers have been employed by their current employers. From this data it can be seen that these managers have been with their current employer for an average of 7,71 years, which mean that they are quiet experienced in terms of managing waste disposal facilities.

Table 6: Employment In Years Of Disposal Facility Managers With Current Employer.

	Years
Mean	7,71
Mode	7
Median	6,5
Minimum	1
Maximum	32

The range of the time period that waste disposal facility managers have been managing these facilities is shown in Table 7. From this data, it can be seen that the people managing these facilities have significant experience as the mean is 10,94 years.

Table 7: Period That Waste Disposal Facility Managers Have Been Managing Disposal Facilities (In Years).

	Years
Mean	10,94
Mode	10
Median	10
Minimum	4
Maximum	21

Table 8 below indicates the volumes of waste that the various waste disposal facilities receive and manage on a monthly basis. From the data collected, most of the facilities manage more than 20 000 tons of waste per month and there has been a substantial increase over the past 12 months. This shows that the economy is growing and that industry and the public are consuming more products and services than ever before.

Table 8: Volumes Of Waste Managed By Waste Disposal Facility Managers On A Monthly Basis.

Volume in tons	Number of Respondents	Percentage (%)
< 5 000 tons	1	5,9
> 5 000 < 10 000 tons	1	5,9
> 10 000 < 20 000 tons	2	11,8
> 20 000 tons	13	76,5

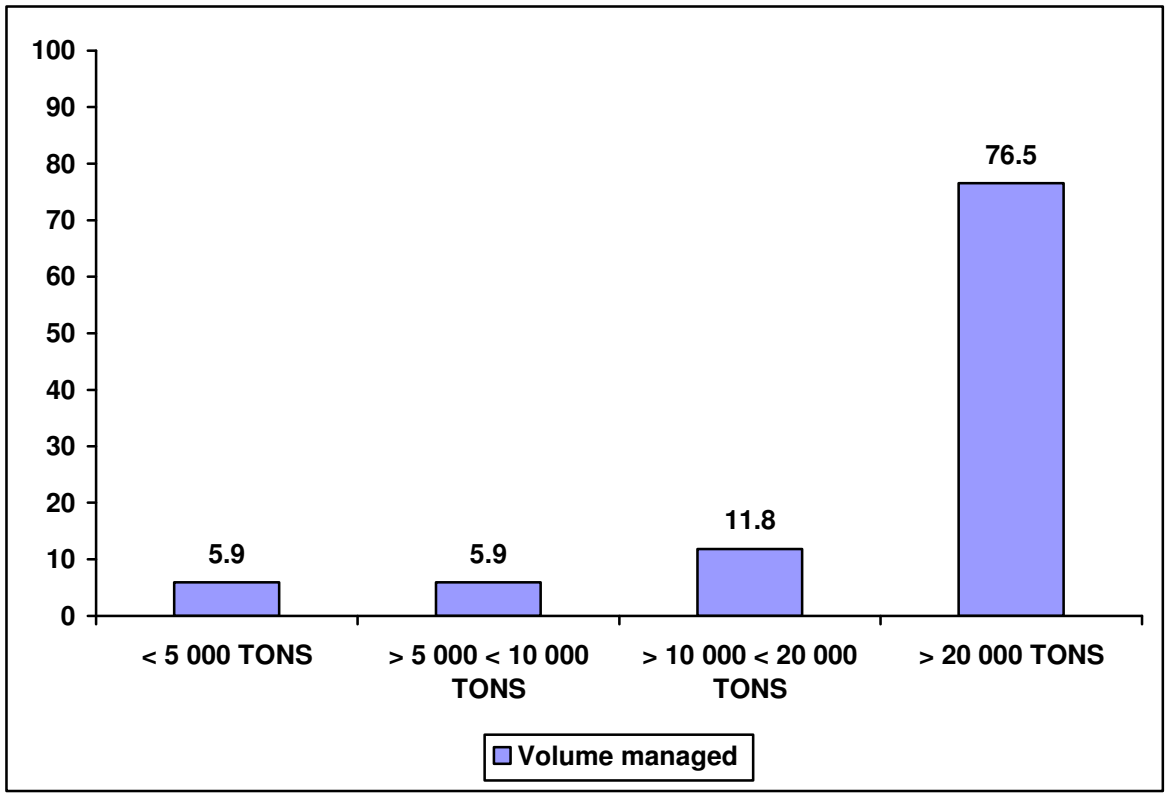

Figure 3: Volumes Of Waste Managed By Waste Disposal Facility Managers On A Monthly Basis.

The experience of key respondents in the industry was important to the author. Table 9 illustrates that 17 of the 19 respondents or 89%, have at least five years experience and that ten of the 19 respondents or 53 %, have more than ten years experience. The fact that at least 50% of the respondents have significant experience in the industry and 53% fall into that parameter was a key indicator for the author.

Table 9: Years Of Experience – Key Respondents.

Years of experience	Number of Respondents	Percentage (%)
0 – 5 years	2	10,53
5 -10 years	7	36,84
10 – 15 years	5	26,32
More than 15 years	5	26,32
Total	19	

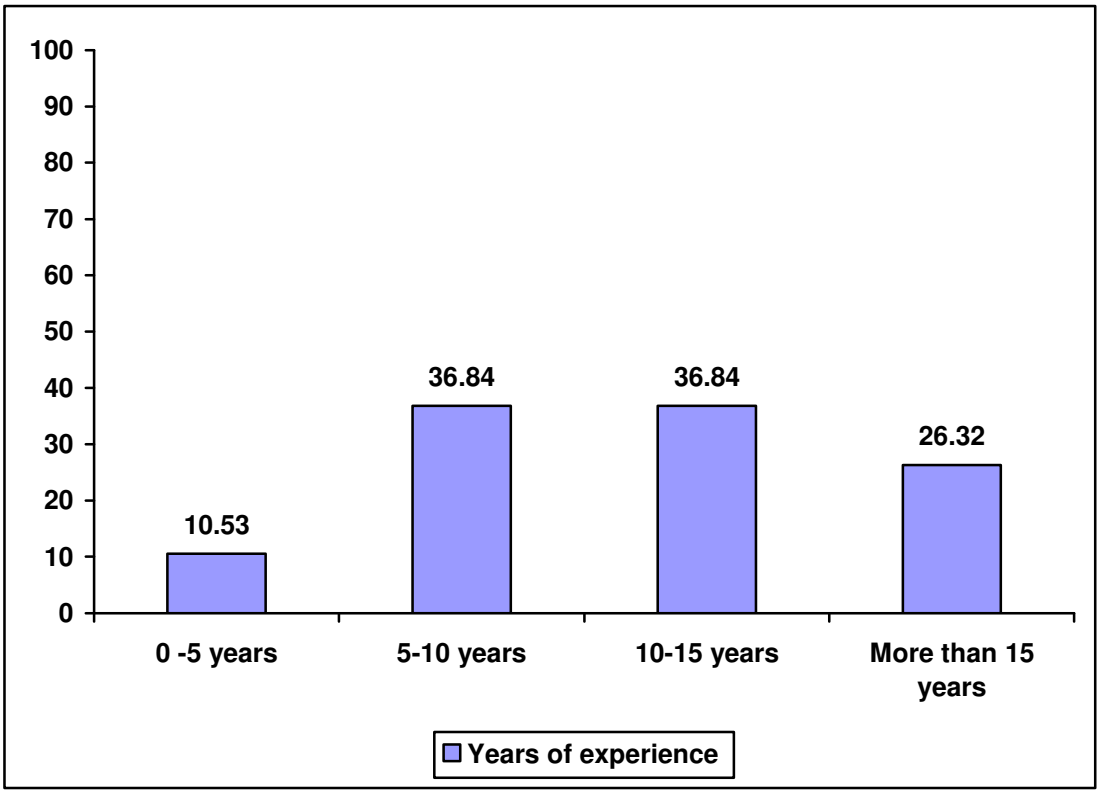

Figure 4: Years Of Experience – Key Informants.

5.3 Research Question 1

What is the status quo of waste disposal facilities in South Africa?

Table 10 represents the views of stakeholders who responded to the questionnaire on the status quo of waste disposal facilities.

Table 10: Status Quo of Waste Disposal Facilities in South Africa as Perceived by Key Respondents in the Waste Management Industry (n=19).

Item	Respondents = yes	Percentage (%)	Respondents = no	Percentage (%)
Have you seen any changes in waste disposal facilities over the past few years?	16	84.2	3	15,8
Have the volumes of waste entering the disposal facilities under your management increased over the past 12 months?	16	84.2	3	15,8
Does your waste disposal facility cater for on-site waste separation?	8	42.1	11	57,9
Do you believe that all waste disposal facilities should be permitted?	19	100	2	10,5
Do you believe that local authorities and government are doing enough to ensure that waste to disposal facilities is minimized?	0	0	19	100
Do you believe that Materials Recovery Facilities (MRF's) at waste disposal facilities will impact the way in which you manage your facility?	14	73.7	5	26,3
Do you believe that your organization is doing enough to ensure that the lifespan of the facility is prolonged beyond its original expectancy?	12	63.1	7	36,8

Do you believe that the way your current facility is being managed, is the most cost effective way?	14	73.7	5	26,3
The National Waste Management Strategy has set certain targets. Do you believe these targets are attainable and are you doing what is required to attain those targets?	3	15.8	16	84,2

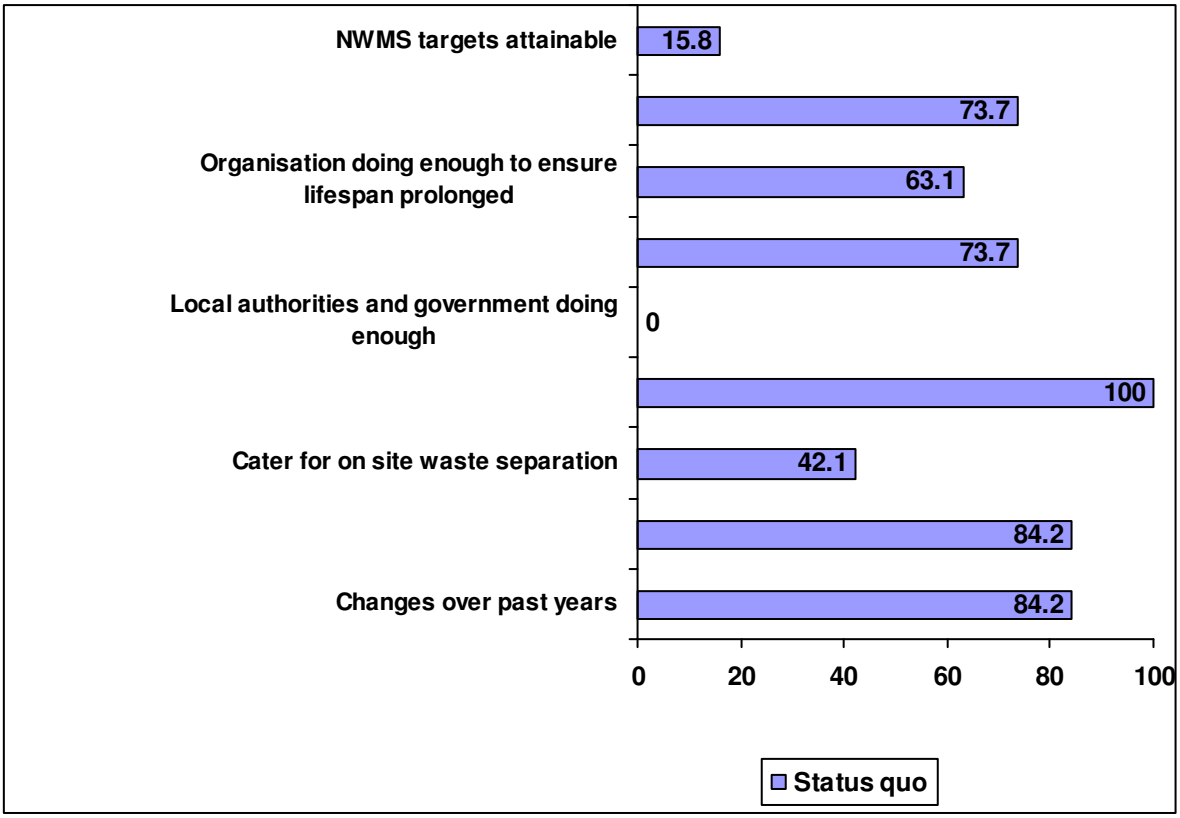

Figure 5: Key Respondents Answering Yes to the Status Quo of Waste Disposal Facilities in South Africa.

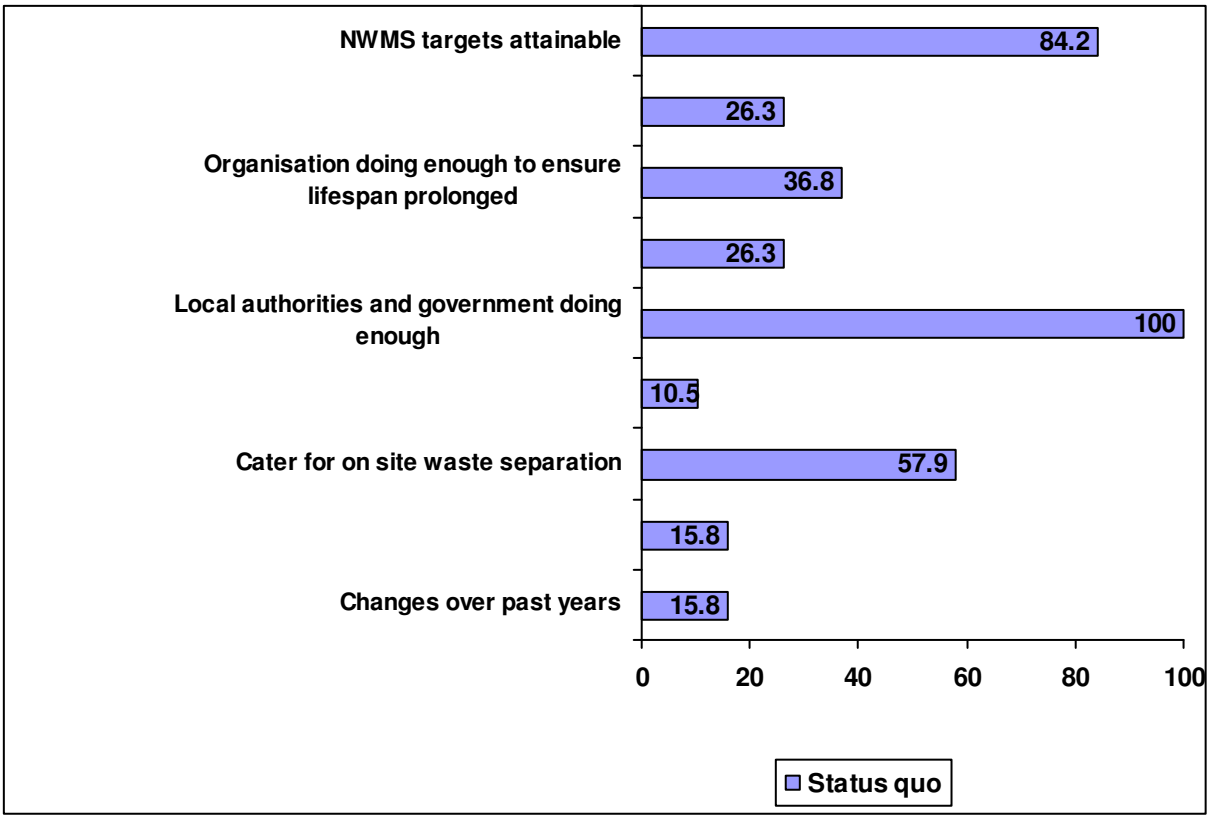

Figure 6: Key Respondents Answering No To The Status Quo Of Waste Disposal Facilities In South Africa.

5.4 Research Question 2

How can energy from waste disposal facilities and the management thereof compensate for the energy shortfall in South Africa?

Energy can be generated through the following processes:

- Gas from landfills;
- improved management practices;
- international trends; and
- future waste-to-energy facilities.

Table 11 indicates the level of awareness among waste disposal facility managers with regard to the technologies available to generate and extract renewable energy from waste.

Table 11: Waste Disposal Facility Managers' Familiarity With Terminology*.

Term	Number of responses	Percentage (%)
Gas extraction	14	82,4
Waste-to-energy	14	82,4
MRF	11	64,7
Bio-reactors	9	52,9

*Two respondents answered yes, without clarifying the reasons for their answers. Those respondents are not included in the above frequencies.

From Table 11 it is evident that 70,6 % of the respondents are familiar with the terminology as posed in Research Question 2.

Most respondents gave general opinions about the technologies included in Table 12 and did not specify whether they were referring to specific terminology. There were no significant differences between the responses from stakeholders in industry, landfill management, supporting catalysts and local government.

Table 12: Opinions Of Key Respondents On Gas Extraction, Waste-To-Energy, MRF And Bio-Reactors.

Essential:

- Energy needs to be tapped from any available sustainable source; 75 %
- Left for too long before implemented and tapped; 64 %
- Necessary progression as proved in Europe; 54 %
- Becoming a way of life; 65 %
- Extends lifespan of landfill; 76 % and
- Cost saving; 83 %.

Environmental benefits:

- Prevent further damage to environment; 74 %
- Can be used instead of natural resources; 63 %
- Minimisation of greenhouse gasses; 71 % and
- Reduction in waste; 62 %.

Not primary focus area:

- Focus is in right direction, but more focus should be given to educating people with regard to waste minimization and recycling at source; 61 % and
- Final option – reduce, re-use and recycle; 62 %.

Requires proper management:

- Good as long as it is run properly; 65 %
- First world technology in third world country; 80 % and
- Can be successfully implemented with proper planning, adequate historical information in terms of gas extraction and a professional team with the required competencies; 72 %.

Most respondents expressed the view that the current state of waste disposal facility management in South Africa, is poor and that many of the facilities are on the verge of collapsing. The good news is that there are exceptions. Some facilities are in excellent conditions and managed in accordance to prescribed standards. These are mainly in metropolitan areas such as Ekurhuleni and eThekwini and are managed by professional landfill management contractors.

Table 13 illustrates some of the challenges that respondents have identified regarding the current state of waste disposal facility management.

Table 13: Opinions Of Key Respondent regarding The Current State Of Waste Disposal Facility Management In South Africa.

Challenges:

- Improper management by unskilled people;
- DEAT should take firmer stance regarding “dumps” being operated;
- Municipalities are not being held accountable for the state of their disposal facilities;
- Most towns and villages do not have the ability, capacity or financial means to operate their landfill sites to the required standard;
- Waste management facilities are being ignored and not perceived to be a priority;
- Some local authorities lack knowledge, skill & sense of responsibility (especially smaller authorities);
- Municipalities cannot run these types of projects optimally due to departmental constraints; and

Landfilling is seen as an easy solution.

A total of 16 out of 19 respondents or 84,2 %, were of the opinion that methane gas can be extracted effectively and that it could be utilized to alleviate South Africa's energy crisis.

Table 14: Opinions Of Key Respondents On Whether Methane Gas Can Be Extracted Effectively, And Whether It Could Be Utilized To Alleviate South Africa's Energy Crisis.

Answer	Number of Respondents	Percentage (%)
Yes	16	84,2
No	0	0
Yes / no	2	10,53
Didn't specify	1	5,2

Reasons why key informants believe that methane gas produced at waste disposal facilities are extracted effectively are:

- Proven global technology is used;
- proper planning was done for current projects; and
- current projects show promising results although improvements can still be made.

Reasons why key informants believe that the extraction of methane gas could alleviate South Africa's energy crisis are:

- It is a renewable source of energy;
- it can alleviate the problem, but won't solve it;

- the sale of carbon emission reductions is a potential source of revenue; and
- the removal of noxious gases will have a positive impact on the environment. .

Key respondents' opinions on how waste disposal facilities in South Africa should be optimized to produce energy are:

- Proper standards must be applied;
- must be managed by properly trained people;
- waste management strategies must be developed that are in line with final objectives;
- waste disposal strategies must be designed using an integrated management approach.
- authorities must be informed of the revenue generating potential;
- facility must be designed strategically; and
- larger landfills must be established.

Table 15 presents the opinions of key respondents on whether it would be cost effective to develop future waste disposal facilities as bio-reactors.

Table 15: Opinions Of Key Respondents On Whether It Would Be Cost Effective To Develop Future Waste Disposal Facilities As Bioreactors.

Answers	Number of Respondents	Percentage (%)
Yes	9	47,4
No	1	5,2
Maybe / ambivalent	2	10,5
Need more information to answer question	4	21,1
Not answered	3	15,8

The opinions of key respondents about the cost effectiveness of developing future waste disposal facilities as bioreactors are:

- A comprehensive feasibility study must be done to determine the cost effectiveness;
- a quantitative comparison of advantages and disadvantages of different waste disposal options must be undertaken;
- larger sites in developed areas will be more cost effective; and
- it will become a necessity in future – will mean that the cost of waste disposal will increase substantially in future.

Key respondents' opinions on the purpose of waste disposal facilities as bio-reactors:

- Controlled way of handling non-recyclable and hazardous waste

streams;

- Production of landfill gas for use as an energy source;
- Reduced volumes of waste requiring final landfilling/Saving cost and space;
- Reduced emissions to atmosphere (methane gas) and to groundwater (leachate)/minimise environmental pollution; and
- Can generate income.

As seen in Table 16, 76,5 % of the respondents are of the opinion that a waste disposal facility should be designed to cater for gas extraction from inception.

Table 16: Opinion Of Key Respondents On Whether A Waste Disposal Facility Should Be Designed To Cater For Gas Extraction From Inception.

Answers	Number of Respondents	Percentage (%)
Yes	14	73,7
Yes (under certain conditions)	5	26,3
No	0	0

Conditions necessary for a waste disposal facility to be designed to cater for gas extraction from inception are:

- Size of site;
- viability of solution; and
- must be operated and managed to prescribed standards.

Opinions of key respondent on why a waste disposal facility should be designed to cater for gas extraction from inception, are:

- Will allow access to gas being generated at an earlier stage;
- Will prevent emissions to the atmosphere; and
- Will not cost much more.

The benefits that the design of a waste disposal facility that can cater for gas extraction from inception will have on the way that waste disposal facilities are managed, are:

- Environmental benefits;
- improved waste management practises;
- greater commitment to waste management practises;
- gas extraction can start earlier;
- will become self-sustainable; and

will be seen as en essential link in the energy supply chain.

The findings regarding the construction of a waste disposal facility in a cost effective manner, are illustrated in Table 17.

Table 17: Opinions Of Key Respondents On The Cost Effectiveness Of Constructing A Waste Disposal Facility To Cater For Gas Extraction From Inception.

Answers	Number of Respondents	Percentage (%)
Yes	13	68,4
Yes (under certain conditions)	4	21
No	0	0
Maybe	1	5,3
No answer	1	5,3

The conditions under which the construction of a waste disposal facility to cater for gas extraction from inception would be cost effective are:

- Minimum requirements for waste disposal should be used as the baseline for financial comparison (and not current state);
- will reduce need for finding and establishing new landfill sites; and
- become more cost effective as resources are running out.

Some 68,4 % of the key respondents were of the opinion that waste disposal facility management costs in South Africa are cost effective in comparison to the rest of the world, as illustrated in Table 18.

Table 18: Opinions Of Key Respondents On Whether Waste Disposal Facility Management Costs In South Africa Are Cost Effective In Comparison To The Rest Of The World.

Answers	Number of Respondents	Percentage (%)
Yes*	13	68,4
No / not everywhere	4	21,1
Unknown / not sure	2	10,5

*Many respondents indicated that their "yes" answers were conditional.

The reasons why waste facilities management costs in South Africa are cost effective in comparison to the rest of the world are:

- Current rates are economical if managed according to standards; and
- tariffs are low because of lower operating standards, but costs will increase with the implementation of higher standards.

As seen in Table 19, 68,4 % of the key respondents were of the opinion that other waste disposal solutions should be considered in South Africa.

Table 19: Opinions Of Key Respondents On Whether Any Other Waste Disposal Solutions Should Be Considered In South Africa.

Answers	Number of Respondents	Percentage (%)
Yes	13	68,4
No	3	15,8
Need more information on subject	1	5,3
Not answered	2	10,5

Opinions of key respondents on the value of sorting waste before it is accepted at a waste disposal facility, removing scrap metal and removing organic matter from the waste stream, are:

- The entire process is more cost effective;
- natural resources are preserved;
- job are created;
- demand for airspace is reduced and the lifespan of the landfill is increased; and
- ground water is protected;

A total of 47,4 % of the key respondents indicated that waste disposal facility management in its current form is not viable in South Africa.

Table 20: Opinions Of Key Informants On Whether Waste Disposal Facilities Management Is Viable In South Africa In Its Current State.

Answers	Number of Respondents	Percentage (%)
Yes	8	42,1
No	9	47,4
Yes / no	2	10,5

A total of 73,7% of the key respondents indicated that disposal facility management is not monitored effectively.

Table 21: Opinions Of Key Informants On Whether Waste Disposal Facilities Management Is Monitored Effectively.

Answers	Number of Respondents	Percentage (%)
Yes	2	10,5
No	14	73,7
Yes / no	3	15,8

According to 89,5% of the key respondents, government is not doing enough to ensure that waste disposal facilities are managed effectively.

Table 22: Opinions Of Key Informants On Whether Government Is Doing Enough To Ensure That Waste Disposal Facility Management Is Done Effectively.

Answers	Number of Respondents	Percentage (%)
Yes (conditional)	2	10,5
No	17	89,5

5.5 Presentation Of The Results

In order to give the author a clear understanding of the results, the stakeholders' responses are presented below. Data is presented by indicating both the positive and the negative factors prevalent in waste disposal facility management. In addition, the author presents the prospect of using methane gas, which is currently being extracted and which will be extracted in the future, as a renewable energy source to alleviate South Africa's the energy crisis. The negative factors will be those that were raised by the key respondents as issues that are influencing the effective management of waste disposal facilities. Because of the poor management or lack of management, these waste disposal facilities are not viable to use for the extraction of methane gas, which in turn will be used to produce energy.

5.5.1 Positive Factors

Data collected from the survey questionnaires that were returned by the key respondents indicates that most of them are familiar with the terminology that is currently affecting the way in which waste disposal facilities are being managed and what needs to be done to ensure that these facilities can help alleviate South Africa's energy crisis. The respondents are briefly indicated in Table 23.

Table 23: Grouping Of Stakeholders.

Stakeholders	Number of Respondents
Landfill Management	11
Supporting Catalysts	4
Local Government	2
Government	0
Industry	2
Total	19

A total of 14 respondents or 82,4 %, were familiar with gas extraction from waste and three of the four supporting catalysts or 75 % were currently involved in gas extraction at waste disposal facilities in Kwazulu Natal. More than 50 % of the respondents believe that waste disposal facilities could be utilized to produce alternative energy sources. Of the key respondents, 64,7% were familiar with the term

MRF (Material Recovery Facility) and only 52,9 % were familiar with the term bio-reactors. The author was encouraged by this because these themes form the basis of future strategies aimed at extracting energy from waste.

5.5.2 Negative Factors

The negative factors that emerged as themes are:

- Lack of control of Government, 18 of the 19 respondents or 95 %, indicated that government is not doing enough;
- inability of local authorities to implement measures to reduce waste to landfills and to educate citizens on separation of waste at source. Some 80% of the respondents indicated that more can be done;
- more than 50 % of the respondents indicated that although the National Waste Management Strategy is effective, government should be more involved;
- according to 76% of the respondents, South Africa's industrial sector is the biggest user of energy, but is doing the least to investigate and implement alternative energy sources and to reduce their waste volumes that are dispatched to disposal facilities; and
- some 85% of the respondents indicated that the Kyoto Protocol is a first world plan and not suitable for third world countries.

5.5.2.1 South African Government

Although the South African Government identified the energy crisis in 1994, their reaction to the problem has been slow. While the industrial sector is expanding and the energy requirements per capita are growing, government is not coming to light with a short-term solution. As mentioned in Chapter 1, the only solution that has been introduced to date has been load shedding and power cuts, which had a severe impact on the industrial sector as well as citizens of the country.

The country has various other challenges that enjoy priority. These are HIV/Aids, housing, crime, poverty alleviation and the looming Soccer World Cup which will be hosted in 2010. However, if government becomes involved in the renewable energy process; this can lead to job creation and in turn to the alleviation of poverty. As a result of all the processes, regulatory controls and environmental impact assessments that have to be adhered to, many opportunities are missed to implement projects at waste disposal facilities that are aimed at producing or generating renewable energy sources. One of the stakeholders had the following to say: "G*overnment is acting as a handbrake, instead of being an accelerator*".

5.5.2.2 Local Government Authorities

These authorities are responsible for the collection, management and treatment of waste. However, these authorities do not have the necessary skills, competencies or knowledge in terms of managing waste disposal facilities. Most local government authorities have outside contractors that manage waste disposal facilities on their behalf. Some local authorities that are not involved in gas extraction projects are diverting all garden waste away from disposal facilities. As a result, the reduction of methane gas is limited to the other waste streams entering the facility.

5.5.2.3 National Waste Management Strategy (NWMS)

The NWMS sets out certain long-term goals. These goals were devised in 1999 when the NWMS was drafted. Some of the goals are:

- Waste prevention;
- waste minimisation;
- improved waste collection; and
- improved waste treatment.

A stakeholder from local government indicated the following: "…*that waste volumes entering the facilities under our management has*

nearly doubled over the last two years". As the migration of rural inhabitants to the densely populated areas around developed cities increase, more informal households are created, and little to no services are rendered in these areas. The implementation of the strategy's long-term goals are hampered by severe human resource shortages that need to be addressed before the focus can change to the actual regulations contained in the NWMS.

5.5.2.4 South African Industry

The South African industrial sector has felt the effects of the energy crisis experienced during the first half of 2008. Yet few industries have actually changed their operating systems in order to become more energy efficient. The industrial sector is the largest consumer of energy in South Africa and is also one of the largest emitters of CO_2 gasses. Industry needs to take a leadership position in the implementation of the targets and objectives set by the NWMS. In short, they need to reduce their waste and to prevent waste by changing the way in which they do business.

5.5.2.5 Kyoto Protocol Requirements And Processes

The processes and requirement of the Kyoto Protocol are not necessarily applicable to South Africa. Many of the projects aimed

at reducing greenhouse gasses are inappropriately managed projects and are not meeting the delivery criteria as set out in the protocol. The other major concern is what will happen after 2012 when the Kyoto Protocol reaches its conclusion. Will the protocol be replaced by other similar projects aimed at reducing greenhouse gasses? One of the major criticisms against the Kyoto Protocol has been the fact that the world's two largest emitters of greenhouse gasses; namely Australia and the USA are not participating in the process, which has exacerbated the situation.

5.6 Stakeholder Views On The Way Forward

All the stakeholders that responded remarked that intervention by Government was required to fast trek the production or generation of alternative energy sources - especially energy that can be extracted from waste.

5.6.1 Industry Leadership

Strong leadership is required in all stakeholder groups. Action needs to be taken now and the various stakeholder groups need to take the lead in the development of waste disposal facilities that can be used to produce or generate energy. Cognisance should be taken of the fact that not all disposal facilities will be able to deliver sustainable and viable methane gas that can be turned into energy.

5.6.2 Open Electricity Market

Eskom's dominance of the electricity market needs to be reduced. Government should open this market up and allow smaller groups to sell renewable energy to existing Eskom power grids.

5.6.3 Communication

All the stakeholders agreed that better communication channels need to be established. By engaging all parties, knowledge transfer can take place and new projects can be implemented successfully. The implementation of more gas extraction projects at waste disposal facilities that have been identified as viable, will increase South Africa's capacity of produce or generate alternative energy sources).

5.6.4 Learn from the UK and the USA

One supporting catalyst commented that "…*we need to go to the UK and USA to see how successful the implementation of waste-to-energy facilities have been at waste disposal facilities, and we need to learn from them*".

Chapter 6: Discussion Of Results

6.1 Preamble To Discussion

The findings presented in the previous chapter indicate that stakeholders have both positive and negative opinions about the viability of waste disposal facilities to produce or generate alternative energy source for South Africa. No feedback was received from government. In hind sight, the author identified some factors that might have played a role in the lack of response received from non-permitted facilities. These factors are:

- Not understanding the questions that were posed or the answers that were required;
- people at these facilities might be illiterate;
- people at these facilities do not understand English; and
- it is also possible that these individuals are scared that they might be reported to authorities and get into trouble because they do not have the necessary permits.

Various factors can influence the effectiveness of the production or generation of potential energy from waste. The author recommends that this is explored further in another research project that might flow from this one.

In the discussion below, the author will interpret the findings of the surveys and questionnaires, which were sent to various stakeholders and

to show that the objectives set out in Chapter 1, and the research questions posed in Chapter 3 have been answered.

The following research questions were asked in Chapter 3:

- What is the status quo of waste disposal facilities in South Africa?
- How can energy from waste disposal facilities, and the management there of compensate for the energy shortfall in South Africa; and
- For clarification purposes four other fields were incorporated into Question 2. These were:
    - Gas extraction from waste;
    - What effect will improved management practices have?
    - What are the current international trends? and
    - Where to establish future Waste-to-Energy facilities and the viability thereof?

The questions are then revisited and stated in terms of the results and the discussions presented.

6.2 What Is The Status Quo Of Waste Disposal Facilities In South Africa?

The literature review in Chapter 2 showed that waste management is one of the key sectors for sustainable development in South Africa. The literature review also indicated that the effectiveness management of

waste disposal facilities will enhance opportunities for the future selling of carbon credits.

Respondents who were classified as stakeholders in landfill management companies indicated that there has been a major increase in waste that is delivered at disposal facilities. The majority of the respondents were from Gauteng, while one respondent was from the Western Cape. As the volume of waste increases so does the operating expenses of waste disposal facilities. The majority of the respondents felt that the disposal facilities that they manage are done so in line with minimum requirements.

The focus of these facilities should be waste reduction and minimisation. At present the exact opposite is true. Some 94,1% of the respondents indicated that the volume of waste has increased by more than 45% in the last 12 months. Indications are that it will continue to increase up until 2012. This is a contradiction of the 2001 Polokwane Declaration's "zero waste to landfill" goal by 2022.

The comments given by respondents were their perceptions and feelings about the matter. Although bias and prejudices are very common in e-mail surveys and questionnaires, the author is confident that the results shown in Table 10 are indicative of the opinion of the respondents.

Trochim (2001) indicates that mail surveys have many advantages, of which the following are some:

- It is relatively inexpensive to administer;
- the same instrument can be send to a wide range of people; and
- the respondents can complete it at their own convenience.

This was the author's biggest challenge. The surveys were sent out at the end of September 2008 with a request to complete and return the surveys and questionnaires by the second week of October 2008. The last of the surveys and questionnaires were still being returned while the author was collecting the bulk of the data. The author read the comments and insights shared by the stakeholders and made additional notes as part of the content analysis (Welman and Kruger, 1999). Where the author was not certain of the responses to the questions posed, additional e-mails were sent out to ask for clarification.

It is evident that few disposal facilities are equipped to separate waste. This inability to sort waste leads to waste disposal facilities filling up faster than expected, especially as a result of the increase in waste volumes. One of the activities of a waste disposal facility as set out in the Waste Bill (2007), is the reduction, re-use, recycling and recovery of waste. Various respondents indicated that the government departments responsible for the regulation of the facilities (DWAF and DACE) are not monitoring the

activities at waste disposal facilities. The monitoring is being done by local authorities.

PDG (2007) did an assessment of the status of waste service delivery and the capacity at the local government level on behalf of DEAT. This assessment indicated that there are more than 2 000 waste disposal facilities in South Africa, and that only 530 of these facilities have the necessary permits to operate. Survey respondents agreed that all disposal facilities should be permitted. The author, however, would like to see that there are less of these facilities. Only 25% of the facilities have the necessarily permits and it can therefore be, assumed that these facilities are well managed, which means that 75% of waste disposal facilities are poorly managed or not managed at all. These facilities can therefore be described as “dumps”. Dumps are often left open and have no control measures in place. Waste is dealt with by setting it on fire.

A reduction in the number of non-permitted disposal facilities will ensure that waste that is lost to recycling, recovery and re-use can be recovered if it goes to permitted facilities that have MRFs.

Government is not fulfilling the targets as set out in its NWMS. A total of 89,5% of the stakeholders involved in landfill management, supporting catalysts, industry and even local government, responded negatively to the question asked about government’s involvement to ensure that waste

disposal facilities are managed effectively. Some 80% of the respondents indicated that the Green Scorpions should be given a mandate to take action when stakeholders transgress from the targets set out in the NWMS. In the draft White Paper on Integrated Pollution and Waste Management for South Africa, the targets are clear: Prevention and the minimisation of waste. If government is serious about these objectives, why are they not doing more to ensure that this happens?

Some considerations that government might want to consider:

- Charge more for waste disposal. The rates that South Africans pay for waste disposal is extremely inexpensive compared to what people pay in Europe and the USA; and
- government needs to drive this process. Encourage waste separation at source to ensure that only waste that is bio-degradable ends up at waste disposal facilities. This will ensure that decomposition happens at a faster rate. This will also enable the disposal facility to generate methane gas at a faster rate and in turn energy from waste can be recovered quicker than is currently the case.

Table 24 indicates waste disposal managers' general levels of knowledge about the extraction of methane gas from waste. Some 82,4% indicated that they are aware of this technology and two respondents indicated that they have limited knowledge of the process.

Table 24: Awareness Of Methane Gas Extraction From Waste.

Level of knowledge	Number of Respondents
Nothing	0
Limited	2
Can be done	17

Based on these responses, the author can assume that at least 82,4 % of waste disposal managers know that methane gas can be extracted from waste and that the gas extracted can be converted into energy. Ball and Fein (2005) indicate that as natural resources diminish and the price of raw materials escalates, waste should be seen as a natural resource.

6.3 Discussion Of Research Question 2:

Question 2 will be evaluated based on the results presented in Chapter 5.

6.3.1 Research Question 2

How can energy from waste disposal facilities compensate for the energy shortfall in South Africa?

- Gas extraction from landfills: There are currently a few projects where various stakeholders are involved in gas extraction. The stakeholders involved are:

- Supporting catalysts;
- local government; and
- landfill management;

Although most of these projects are flaring the gas that's being extracted, 70,6 % of the stakeholders are of the opinion that waste disposal facilities can deliver sufficient gas that can be processed into energy. Some 70,6 % of the respondents had the following opinions on gas extraction, waste-to-energy, MRFs and bio-reactors.

6.3.1.1 Gas Extraction

With the carbon credit market growing and the drive to reduce greenhouse gas emission from waste disposal facilities, most of the respondents indicated that gas extraction is essential as it has numerous positive effects on the environment. One of the respondents from the supporting catalyst stakeholders remarked: "*Energy needs to be tapped from any available sustainable resource*". He also said: "*In South Africa we have left it for too long to implement*".

6.3.1.2 Waste-to-Energy

Waste-to-Energy potentially has quite a few positive implications in the South African context. Instead of using oil, coal or fossil fuels - which all contribute significantly to the reduction of natural resources and the pollution of the environment through emitting greenhouse gasses - waste can be used as an alternative energy source.

6.3.1.3 Materials Recovery Facilities (MRFs)

MRFs offer many business opportunities - especially in South Africa. It can be used to create jobs in a country where more than 22,7% of the population are unemployed, according to statistics released by Statsa in September 2007. MRFs will also assist in the extension of the disposal facilities' lifespan. A stakeholder from industry recommended that "*more should be done regarding the education and training of people regarding waste minimisation at source, instead of incurring the additional cost of transporting waste to a disposal facility and doing the separation there*".

6.3.1.4 Bio-reactors

Bio-reactors are part of the technology that plays an important role in the processing and treatment of waste at disposal facilities. When a disposal facility is operated as a bio-reactor, it serves to produce gas through active bio- mediation. A stakeholder from industry remarked that although the release of methane gas is prevented through composting or bio-mediation, there are still high volumes of methane gas that is emitted into the atmosphere at the point where it is harvested. This respondent also indicated that it does have "*benefits for energy and this in turn will prevent the need to generate fossil fuels*".

Both the NWMS and the Polokwane declaration have as their objectives the reduction of waste to disposal facilities. Yet there are still inert materials that are mixed with organic fraction that will be treated in the bio-reactor (composting process). This means that the final residue will be contaminated and the product will not be suitable for sale as commercial compost. These contaminated organics will be treated whereas the clean organics can

be treated in a bio-digester and produce gas and "clean compost".

Bio-reactors should be designed as a series of structured waste disposal cells wherein the materials are treated under controlled conditions.

6.4 South African Waste Disposal Facilities' Capacity To Generate Energy

Waste disposal facilities in South Africa are not designed with an integrated waste treatment approach in mind. It will not be cost effective to design new facilities with this approach in mind if the volumes of waste into these facilities are not sustainable and comprehensive enough. When waste disposal facilities are designed the following should be taken into account:

- Waste separation removes recyclables for sale and re-use;
- separation of wet organic waste materials for composting or processing in a bio-digester to produce biogas (fuel) and liquid compost (residue);
- separation of dry materials suitable for gasification (low temperature thermal process) to produce syngas (fuel) or char which can in turn be used as a refuse revived fuel (RDF);

- bio-gas and syngas can be used to generate steam and or electricity; and
- where existing waste disposal facilities are incorporated in the project; landfill gas can be extracted from existing waste disposal facilities and added to the above-mentioned fuels.

The process described above is an integrated process and will ensure the maximum re-use of waste materials (recyclables), extract the maximum amount of energy from the remaining waste materials and optimally minimise the amount of waste residues requiring disposal at waste disposal facilities.

Another stakeholder from industry stated that "*waste management strategies should be developed in a manner that is coherent with the final objective*". The respondent also indicated that "*if methane gas is to be harvested it will be counter productive, for instance it will have a strong drive towards composting*".

In a recent paper presented by Jewaskiewitz (2008), the presenter made some remarks that are cause for concern. Jewaskiewitz (2008) stated that many of the current waste disposal facilities in South Africa are under pressure to close. These closures are either due to political or community pressures, or the facility's life cycle has come to an end. Airspace is one of the major challenges facing the management of disposal facilities at the moment. Improved management will ensure

that facilities under pressure to close can prolong their operating life cycle. Due to the influence and the impact that these disposal facilities have on communities, it is becoming more challenging to find locations for new waste disposal facilities.

The international waste disposal trend is to ban these facilities and in many countries these facilities have been discontinued (Jewaskiewitz, 2008). Instead of waste being taken to waste disposal facilities, it is being treated, recycled and re-used. This has also led to the developments of energy-from-waste facilities (EFW). The author's interpretation of this remark is that waste disposal facilities are converted into EFWs. Cognisance should be taken of this development because many of these countries have been at the forefront of developing waste-to-energy facilities. With this, new technologies have been developed to enhance the minimisation, reduction and treatment of waste streams. Figure 1 in Chapter 2 shows the Elements of a Basic Waste Management System, Minimum requirements for waste disposal by landfill, third Edition 2005.

Waste disposal by landfill is described as the ultimate means of waste disposal. The author would suggest that this process should be taken one step further. The next step in the Elements of Basic Waste Management should be waste-to-energy. Figure 7 is an adaptation of Figure 1.

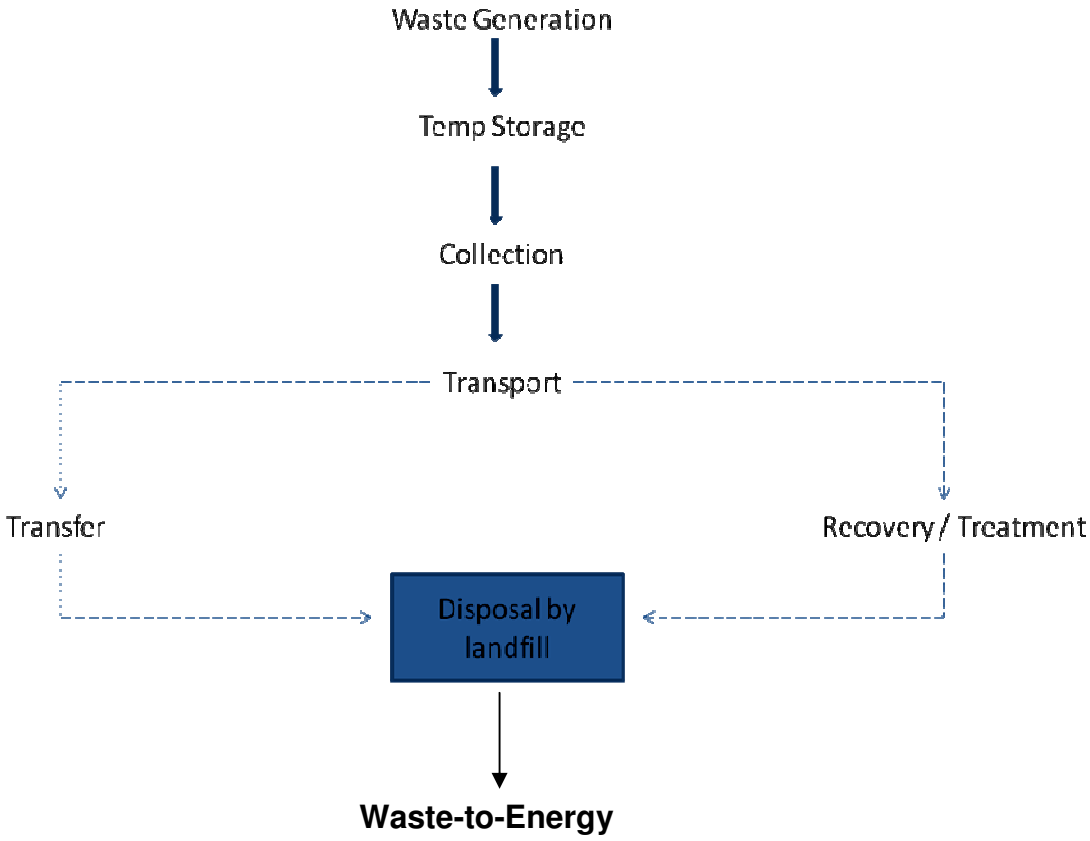

Figure 7: New Proposed Elements Of Basic Waste Management System, Minimum Requirements For Waste Disposal By Landfill, Third Edition, 2005.

6.5 Available Technologies For The Treatment Of Waste

The following technologies are available internationally for the treatment and disposal of waste and the author recommend that these technologies are introduced in South Africa. These technologies have been in use for a number of years in many countries. The author contacted the respondent that made the recommendations in terms of

the introduction of these technologies in South Africa. The stakeholder was asked to provide more information on the countries that have been using these technologies and what the impacts have been on the countries. The following was his response:

- Aerobic Composting;
- anaerobic Digestion;
- bio-reactor;
- conventional landfills;
- mass burn incineration;
- gasification;
- autoclaving; and
- plasma arc.

6.5.1 Aerobic Composting

This process is used to treat municipal solid waste in conventional compost windows that are covered; or in tanks where the correct mix of air and water movement is required. This process only allows for the use of organic materials.

6.5.2 Anaerobic Digestion

This process employs bacterial processing without oxygen in a closed tank or vessel.

6.5.3 Bio-reactor

The waste disposal facility is designed to speed up the decomposition process by recirculation the leachate back through the waste body. More gas is produced in a much shorter time period, and more gas is collected.

6.5.4 Conventional Landfills

Small waste disposal facilities become uneconomical because regional facilities have been established. The regionalising of disposal facilities has negative impacts because transport costs are higher and does not contribute positively to the reduction of harmful emissions.

6.5.5 Mass Burn Incineration

Electricity from waste uses heat that is generated through the combustion of waste. Due to changes in technology, air pollution as a result of this process has been significantly reduced.

6.5.6 Gasification

This process happens when waste is placed under high pressure and temperatures in unenclosed vessels with limited oxygen present. This process is intended to generate synthetic gas that is used as fuel or in chemical processes.

6.5.7 Autoclaving

This is a high temperature and pressure process that requires the removal of metals, tyres and yard waste through pre-sorting or separation. This process is not widely applied at MSW. The possible application of this compost as a refuse derived fuel (RDF) can be used in boilers to generate steam.

6.5.8 Plasma Arc

This process is described as the ionisation of gas through a high energy electric arc within a vessel. This process breaks down MSW at the molecular level and reforms it into CO, CO_2, and H_2 gasses.

Figure 8 illustrates an integrated waste treatment / disposal system.

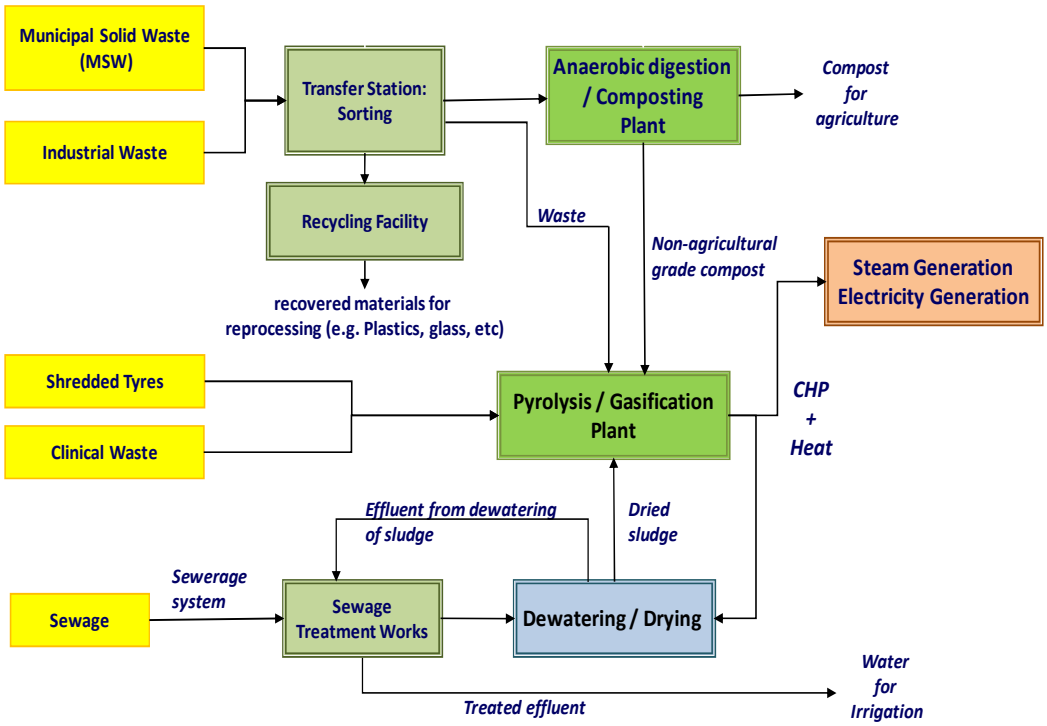

Figure 8: Source Jewaskiewitz 2008 Waste-To-Energy – Are We Ready For It In South Africa?

6.6 Discussion Summation

The title of this research project is: "The Viability of Waste Disposal Facilities as an Alternative Energy Source". The research findings indicate that it is possible and viable to extract energy from waste. Global technologies must be incorporated when projects to extract energy from waste are developed. Some 80% of the key informants indicated that

facilities should be properly engineered to ensure the maximum extraction of gas that can be turned into energy. A total of 75% of the stakeholders were of the opinion that only a small proportion of the potential gas resources are currently being utilised. In addition, 80% of the respondents were of the opinion that any additional energy that can be made available to Eskom's electricity grids will be useful – especially in the light of the fact that South Africa's energy crisis is far from being solved. Some 22% of the respondents indicated that energy from waste will not provide the total solution to the energy crisis, but that it will relieve the problem. Government has been struggling to supply housing to a substantial number of its inhabitants since taking over in 1994. Relaxing regulation on where facilities should be build would enable these communities to receive energy from disposal facilities. The other benefit is that revenue can be derived from the selling of carbon emission reductions (CERs) and that revenue can be used to implement energy efficient programmes for low cost housing. Waste disposal facilities that receive less than 20 000 tons of waste per month are not viable sources. In Sheffield (UK) 225 000 tons of MSW per annum generate sixty megawatts of thermal energy and up to 19 megawatts of electricity. Some of the waste disposal facilities in South Africa receive 420 000 tons of waste per year, and at the moment the gas that is extracted is flared – a waste of energy.

Chapter 7: Conclusion

7.1 The Aim Of The Research Project

Just like the rest of the world, South Africa is experiencing a major energy crisis. With natural resources being depleted by human consumption, alternative energy sources and renewable resources are being sought. This research project looked at the viability of waste as an alternative source of energy. In the literature review, various factors have been identified and responses gathered through the surveys and questionnaires completed and returned by key responses and experts, indicate that larger, well managed facilities can be used to produce energy. This can be done through the extraction of methane gas and various other technologies that are available.

7.2 Factors That Influence The Management Of Waste Disposal Facilities In South Africa

The factors that were identified can be divided into two groups; namely positive (accelerating) or negative (inhibiting) factors.

Table 25: Factors affecting the viability of waste disposal facilities to produce alternative sources of energy

Influences	Group Factors
Positive	Prevent further damage to environment Preserve natural resources Carbon Credits Management of certain facilities Extension of lifespan of disposal facility Cost Savings
Negative	Lack of government involvement in monitoring of facilities (DEAT, DWAF) Lack of people education Not happening at source NWMS not being implemented successfully

7.3 Methodology Employed

Although the research delivered the required result, the author believes that the responses from the stakeholders – with the exception of government, which did not respond - were conclusive in that they agree that waste can be used to produce or generate, but that not all disposal facilities will be able to render the returns of energy to capital outlay. The surveys and questionnaires were a less time consuming exercise but the

downside is that the author had to wait for the surveys to be returned. The author acknowledges that if at all possible, this research should have been done face-to-face. This would have given the author the opportunity to conduct in-depth interviews. It would also have given the author the opportunity to question stakeholders' responses should the need arise or if further clarification was needed. Due to the growing need for alternative energy sources, a follow-up study should be conducted to ensure that all stakeholders are included.

7.4 Recommendations

One of the findings of the research project indicate that most - if not all – of the respondents feel that government is not doing enough to find solutions to address South Africa's energy crisis. As energy is becoming more scares it is going to become more expensive. Although the set-up costs of a waste-to-energy facility are initially very high, it must be remembered that this facility holds long-term benefits if it is managed effectively.

Government should take a leading role in the significant reduction of the number of waste disposal facilities, ensure that all facilities have the necessary permits and are managed according to the minimum requirement as stipulated in DWAF's Draft Third Edition of 2005. In addition, government must reduce recyclable waste to disposal facilities

and ensure that the waste streams required for the generation of methane gas end up at disposal facility geared for the production or generation of energy.

7.5 Future Research Recommendations

This research project focused on waste disposal facilities in South Africa and whether or not these facilities have the potential to generate energy sources. The knowledge gained from this research was extremely enriching, but these are still unexplored areas in this field that requires future research.

The author suggests that the following research should be conducted in future:

- Wind farms as an alternative source of energy in South Africa;
- an examination of the factors that is causing South Africa to lag behind other countries in the implementation of waste-to-energy projects. These projects have been successfully implemented in a number of countries and can be replicated in South Africa;
- a case study on industry, especially those that are the largest consumers of energy and who they can be incentivized to use renewable energy sources; and
- research on what South Africa can do to become more energy efficient.

7.6 Analogue

The author hopes that this research project will contribute to a greater awareness among all stakeholders in South Africa that natural resources are being depleted and that if society is not going to do something about that, there might be nothing left for future generations.

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Appendix i: Respondents

A list of respondents and in which stakeholder group they fall into.

1.	Respondent A	Industry
2.	Respondent B	Supporting Catalyst
3.	Respondent C	Industry
4.	Respondent D	Supporting Catalyst
5.	Respondent E	Supporting Catalyst
6.	Respondent F	Landfill Management
7.	Respondent G	Local Government
8.	Respondent H	Local Government
9.	Respondent I	Landfill Management
10.	Respondent J	Landfill Management
11.	Respondent K	Landfill Management
12.	Respondent L	Landfill Management
13.	Respondent M	Landfill Management
14.	Respondent N	Landfill Management
15.	Respondent O	Landfill Management
16.	Respondent P	Landfill Management
17.	Respondent Q	Landfill Management
18.	Respondent R	Landfill Management
19.	Respondent S	Landfill Management

Appendix ii: Questio

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Survey questionnaires were sent to two groups of respondents. The first group was a survey to waste disposal facility managers, and the second groups were to respondents that were identified as key informants.

1	How long have you been working for your current company?	Years ☐ Months ☐
2	How long have you been managing waste disposal facilities?	Years ☐ Months ☐
3	Have you seen any changes in waste disposal facilities management over the past few years?	Yes ☐ No ☐
4	Has the volumes of waste entering the waste disposal facility increased over the past 12 months?	Yes ☐ No ☐
5	What volumes of waste do you manage on a monthly basis?	< 5 000 tons ☐ > 5 000 < 10 000 ☐ > 10 000 < 20 000 ☐ > 20 000 ☐
6	Does your waste disposal facility cater for on site waste separation?	Yes ☐ No ☐
7	Do you believe that all waste disposal facilities should be permitted?	Yes ☐ No ☐
8	Do you believe that local authorities and government is doing enough to ensure that waste to disposal facilities is minimised?	Yes ☐ No ☐
9	Do you believe the Materials Recovery Facilities (MRF's) on waste disposal facilities will impact in the way in which you manage your facility?	Yes ☐ No ☐

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10	Do you believe tha ensure that the life span of the facility is prolonged beyond its original expectancy?	Yes ☐ No ☐
11	What do you know about the extraction of methane gas from a waste disposal facility?	Nothing ☐ Limited ☐ Can be done ☐
12	Do you believe that the way your current facility is being managed, is the most cost effective way?	Yes ☐ No ☐
13	The National Waste Management Strategy has set certain targets. Do you believe these targets are attainable and are you doing what is required to attain those targets?	Yes ☐ No ☐

Survey questionnaires sent to respondents identified as key informants

1	Years of experience • 0 – 5 years • 5 – 10 years • 10 – 15 years • More than 15 years	
2	Line of business (select one or more) • Landfill Management • Stakeholder • Government • Local Government • Industry	
3	Are you familiar with any of the following terms? • Gas extraction • Waste to energy • MRF • Bioreactors	
4	What is your opinion of the aforementioned?	

5	What is your o state of affairs of waste disposal facilities management in South Africa?	
6	Do you believe that where waste disposal facility gas is extracted, it is done effectively, and can it contribute to the energy crisis in South Africa?	
7	Please elaborate on your answer at number 6	
8	How can waste disposal facilities in South Africa be optimised to produce energy?	
9	Will it be cost effective to develop future waste disposal facilities as bioreactors?	
10	Please elaborate what you see the purpose of waste disposal facilities as bioreactors will have?	
11	Do you believe that a waste disposal facility should be designed from inception to cater for gas extraction?	
12	What benefits will this have in the way that the waste disposal facilities are being managed?	
13	What benefit will this have for the environment?	
14	Will this be cost effective to construct a waste disposal facility in this manner?	
15	Do you believe that waste disposal facilities management costs in South Africa are cost effective in comparison to the rest of the world?	

16	What positive e[illegible] extraction of methane gas have on the environment?	
17	Are there any other waste disposal solutions to be considered in South Africa?	
18	What do you think will the value be if: • Waste is sorted before it is accepted into a landfill facility • Scrap metal is removed • Organic matter is removed from the waste stream	
19	Do you believe that waste disposal facilities management in its current state is viable in South Africa?	
20	Do you believe that waste disposal facilities management is monitored effectively?	
21	If yes, what do you believe are being done that adds value?	
22	If no, what can be done to ensure that waste disposal facilities are managed effectively?	
23	Do you believe that Government is doing enough to ensure that waste disposal facilities management is done effectively?	