Team 14

Mag Gas Co

LANDFILL TO GAS BUSINESS PLAN

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EXECUTIVE SUMMARY

This business report determines the feasibility of constructing a landfill gas (LFG) collection plant in the Gauteng province of South Africa and converting LFG to high quality, pipeline natural gas. By establishing MagGas Co., several Millennium Developmental Goals (MDGs) will be addressed whilst simultaneously providing a profitable product that will benefit the city of Johannesburg greatly. By taking municipal solid waste (MSW) and converting it to high quality methane, MagGas Co. is creating a cheap and renewable fuel source, something that is critical in preventing further damage to the current global environment.

BUSINESS BACKGROUND

Solid waste is a huge environmental issue globally. According to (The World Bank, 2012), 1.3 billion tonnes of MSW is dumped per year worldwide, and the trend is worryingly set to increase. MSW is not only unsightly and damaging to the environment, but it is also a breeding ground for many disease-carrying vectors, posing a serious threat to the health of nearby individuals. MSW is also a large contributor to the total global methane emissions because of the ability of methanogenic bacteria to digest MSW in anaerobic conditions, producing methane as a by-product. Given these circumstances, it is obvious that effective management of MSW is crucial to the health of both the environment and humans alike.

The total global methane emissions from human activity alone were estimated at a staggering 6,875 million metric tons (The Global Methane Initiative, 2011). Of this total, landfills accounted for 11% of these emissions (The Global Methane Initiative, 2011), a prime dumping site for MSW. Methane is the second most important greenhouse gas that contributes to global warming, due to its potent ability to be able to trap heat in the atmosphere (The Global Methane Initiative, 2011). However, because of its properties, methane has a high calorific content and burns much cleaner than other fossil fuels; by-products of methane combustion are water and carbon dioxide (Lavelle, 2012). Despite the small production of more carbon dioxide, the ramifications of allowing methane to escape freely into the atmosphere are worse.

Producing methane as a fuel to burn from MSW creates a viable closed loop system. MSW is something that will be produced continuously and unless ways are found to reduce waste levels, recycling MSW is the next best option. By using landfills to create methane, the effects of MSW can be reduced; less environmental methane is released and a cleaner alternative to fossil fuels is created.

South Africa produced 65,311 kilo tonnes of methane in 2010 (The World Bank, 2013) and produced 7.3 million tonnes of MSW in 2012, of which 66% could be used for methane generation (Proparco, 2012). The Gauteng province contributed the most MSW to South Africa's total, with an approximate 5.3 million tonnes being generated per annum (Muzenda, 2012). Not only does South Africa produce large amounts of MSW, but it is also highly dependent on fossil fuels for electricity generation; in 2011, 182,437 tonnes of coal was used in South Africa alone, and yet there were still blackouts and shortages of electricity (Reuters, 2010) (indexmundi, 2013). In addition to this, South Africa only has five LFG to energy projects currently running (Botes, 2012). Given the dire conditions of methane emissions from rising MSW levels, South Africa's dependency on fossil fuels and continual electricity shortages, MagGas Co. seeks to solve these urgent issues by creating an alternative, renewable fuel source that will aid in reducing both MSW levels and environmental methane emissions.

BUSINESS MILLENIUM GOALS

MagGas Co. will address the following UN Millennium Development Goals:

1) Goal 1: Eradicate extreme poverty and hunger:
   - MagGas Co. will greatly benefit the local community of Johannesburg, as many temporary jobs will be created for the construction phase (e.g. the installation of our pipeline will create at least 14 jobs, employ 32-41 people, add more than $US 2.2 million in new project expenditures and increase provincial-wide economic output by ~$US 5.3 million) (United States Environmental Protection Agency, 2010) This directly addresses the UN target of halving the proportion of people whose income is less than $1 a day by creating more jobs, as we will consider any able bodied person that is able to be trained with our programme.
2) Goal 7: Ensuring environmental sustainability
   - MagGas Co. addresses this goal by: Creating the use of a renewable source of energy from waste, reducing the impact MSW has on the environment by harnessing the methane

generation and redirecting it households safely, subsequently integrating South Africa's need for sustainable development.

- Reducing South Africa's dependence on fossil fuel by generating an alternative fuel that does not have the same level of detrimental impact on the environment, attempting to offset the loss of environmental resources.
- By using MSW to create methane gas, MagGas Co. does not have the same negative impact on water contamination, waste and pollution as mining shale gas and mining for other fossil fuels

3) Goal 6: Combat HIV/AIDS, malaria and other diseases

- MagGas Co. realises that South Africa has the world's largest HIV burden and wish to contribute to help reduce this burden. MagGas has decided to donate 15% of its profits to the New Start charity, South Africa's largest HIV prevention programme. Once MagGas Co. acquires the ability to form compressed natural gas, we will be able to support the transportation of these workers without damaging the environment.

PRODUCT DESCRIPTION

MagGas Co. produces high-quality pipeline methane gas that will allow people to have a more affordable, clean and powerful alternative energy source to power their homes. MagGas Co. will supply the local Johannesburg gas reticulator, Egoli Gas, our end customer, who will then redistribute our gas.

Compared with traditional energy sources, such as coal, MagGas' Co.'s MSW-generated methane has many benefits. MSW-generated methane can simultaneously reduce the huge amount of MSW levels and supplement green energy to the local community. It has many unique advantages in comparison to the competitive methane market.

- Our generation costs are lower, and therefore the end price is lower, because of the inexpensive raw material required to generate our methane. The current cost of mined natural gas from Sasol is $US 2 per m^3 (Bisseker, 2013); we charge $US0.25 per m^3.
- MagGas Co. has employed the best technology out in the field to ensure that we obtain high quality natural gas consisting of at least 97% methane. MagGas Co. realises that efficient processing technology will yield higher methane concentration results.
- Because we use MSW as our generation source, we are not engaging in any environmentally damaging activities that are involved with the likes of shale gas mining. Therefore our product is superiorly environmentally friendly by not adding to the environment's burden.
- It can improve the overall health and safety standards in the Johannesburg area by containing the disease-ridden waste within secure boundaries.
- Not only can our product be used to provide energy to homes, but our product can be used to operate vehicles and machinery, and for power generation and manufacturing processes; the scope is enormous. MagGas Co. will continually seek new ways to expand our supply of MSW-generated methane gas as the opportunities arise.

MARKETS AND MARKETING

Natural gas has been a steady source of energy for the human population, but has only been increasing in popularity over the past 50-60 years (Ernst & Young, 2012). This is due to the steady decline in availability in other fossil fuels, such as oil and coal. South Africa's natural gas consumption has gone from 3203 million cubic meters in 2006 to an estimated 5073 million cubic meters in 2012 (Energy Delta Institute|Energy Business School, 2012). Solid biomass/waste provided 10% of this in 2010, with numbers set to increase. South Africa only has five landfill-to-energy projects currently running nationwide (Botes, 2012), so there is scope for more expansion. Unfortunately, the distribution network for gas supply is currently limited to the high-income areas, but South Africa is looking to develop its gas network over the next decade so that gas will become readily available to the lower-income groups also. There is an economic viability switching from fossil fuel-generated electricity to using natural gas as an energy source; households are able to save up to 27% per month on energy costs if they use natural gas as opposed to electricity. In addition to growing electricity demand and the struggling suppliers, electricity supply has become a lot more unreliable and more expensive over time. These factors are helping to drive the demand for natural gas up as an alternative source of energy.

Future Prospects of the methane market:

Research has found that unconventional supplies of natural gas (such as shale gas, tight gas and coal seam gas) amount to a phenomenal 752 trillion cubic meters, of which 44% or 331 trillion cubic meters is readily recoverable (Ernst & Young, 2012). Estimates say that if this supply of gas were

harvested, the world would have enough energy to last more than 200 years (Ernst & Young, 2012). With the International Energy Agency (IEA) forecasting an increase in the natural gas share of the world's energy mix, from 21% in 2010 to 25% in 2035, natural gas market is set to boom (International Energy Agency, 2012). South Africa has a potential 485 trillion cubic feet of technically available natural gas, the majority of which lies in the Karoo Basin (U.S. Energy Information Administration, 2011).

Potential Customer:

The potential customer or MagGas Co. is Egoli Gas (Pty) Ltd., which is a natural gas reticulator based in Johannesburg and servicing more than 7500 domestic, central water heating, commercial and industrial businesses in the greater Johannesburg (largest city in South Africa) metropolitan area (Egoli Gas (Pty) Ltd., 2013). Since Egoli Gas has already built their pipeline system to transfer the gas to the customers, MagGas Co. will build a pipeline that will transfer our MSW-generated methane gas to the Egoli Gas pipeline system. This is because no technology is currently available in transferring a large amount of methane gas, except for a pipeline system. Egoli Gas will be willing to switch to a new supplier if our company can sell the gas with a lower price than their current supplier, as Egoli Gas will make a profit if the company is paying less for the gas supply.

Competitors:

Sasol, the largest synthetic fuel facility in the world is our main competitor. Sasol has a plant at Secunda that produces gas and oil from coal (SouthAfrica.info, 2013). This company is also the supplier for our potential customer, i.e. Egoli Gas. Sasol has a competitive advantage in terms of their plant's size and the quantity of oil and gas that they are able to produce from using coal. They are able to produce significantly higher quantities than MagGas Co. The second main competitor is iGas, which is a South African Gas Development Company. iGas is mandated by the government of South Africa to develop the gas industry in South Africa (CEF Group of Companies, n.d.). iGas is also one of the companies that mainly extract natural gas or methane from coal beds. MagGas Co. may not initially be able to compete with them on size and quantity of supply, but MagGas Co. has a strong competitive advantage in that we are producing natural gas in an environmentally friendly way. The effects of shale gas and coal bed mining on the environment are dire. There are many detrimental impacts, such as, additional methane leaks from the mining sites, increased earthquake susceptibility, waste-water disposal, ground-water contamination and water supply (Ernst & Young, 2012). Because MagGas Co. uses MSW to generate natural gas, our impact on the environment is severely reduced.

Marketing Strategy:

Our company is not producing consumer goods, so there will be no specific marketing strategies to promote our product. Our company will setup an official website (www.maggas.co.za) and advertise in business magazines to create awareness in South Africa. A fund will be setup under the name of MagGas Co. for corporate social responsibility and 15% of the company profit will be donated to this fund to help prevent HIV transmission and contraction, by supplying financial aid to the New Start NPO.

MANUFACTURING PROCESS

Landfill Selection:

In order for a landfill to be recognised as a potential source of natural gas, the following criteria must be satisfied:

- Produce at least 1 million tonnes of MSW
- Be at least 15m deep
- Receive at least 635 mm of precipitation annually (United States Environmental Protection Agency, 2010)

Gauteng produces the highest amount of waste by province in South Africa, possesses the greatest number of landfills and has an average annual rainfall of 700mm (Dyson, 2009). These factors led to the decision of choosing the Greater Johannesburg Metropolitan City to base our plant in, as it produces four million tonnes of waste in total, of which almost half can be recycled (1934400 tonnes of MSW) (Muzenda, 2012). The municipal landfill site Marie Louise, situated in Roodeport, Johannesburg has an area of 45 acres approximately and satisfies the requirements for successful LFG production (Muzenda, Ntuli, & Pilusa, 2012).

Production:

In order for methanogenic bacteria to be able to decompose the MSW, the environment must be anaerobic (i.e. no oxygen present). This is created by placing a layer over the MSW, preventing the entrance of oxygen. The contraption is referred to as a 'cell'. The cell is then closed off to further

waste addition. A new cell must be created once the previous cell stops producing methane, which tends to occur after 20-30 years (United States Environmental Protection Agency, 2010).

Collection:

Once the right conditions have been reached, after a year the MSW will start decomposing and produce LFG. This collection has three main parts; collection wells, a condensate collection and treatment system and a blower (which pulls the gas from the collection wells and conveys the gas to downstream processing). The collected LFG then flows to the plant for further processing (United States Environmental Protection Agency, 2010).

Treatment:

The collected gas must be then treated to remove the impurities, as they could potentially damage downstream equipment. This involves a primary and secondary treatment. The LFG produced from this plant undergoes three stages of treatment to produce high pipeline quality gas (i.e. natural gas), which has a concentration of 97% methane.

Distribution:

Using the pre-established pipeline networks Egoli has developed, MagGas Co. will build a connecting pipeline that will deliver our gas into the main system.

Gas Quantification:

We propose to collect the MSW for the GJM City, of which 1,934,440 tonnes will be used for our plant. Using the LandGEM (Landfill Gas Emissions) model generated by the EPA (United States Environmental Protection Agency, 2013), we calculated that our plant would generate 10,730 tonnes of methane per year, or 16,080,000 cubic meters per year or 1095 cubic feet per minute.

Expansion plans:

MagGas Co. will have the financial capability to expand after Year 6. There are many plans in the pipeline, such as constructing another plant within the Gauteng province, extending our services to generate electricity, providing natural gas to Eskom's power plants that are looking to convert their coal-fired plants to natural gas. Also continually looking out for more efficient, cheaper technology, i.e. liquefied natural gas technology is too expensive currently, but with investments into R&D, cheaper options will hopefully become available, which MagGas Co. will capitalise on.

OPERATIONAL MANAGEMENT

Employment:

The unemployment rate in Gauteng, South Africa was recorded at 23.7% in year 2012 (Independent Online, 2013). Potential in-country employees will be hired for this plant to operate for two reasons; firstly, to create more job opportunities that could decrease the unemployment rate in Gauteng and secondly, in-country employees are more familiar with the culture in the country.

Training:

Regular training for operations and management, health and safety concern, and self-enhancement will be provided for the first week of working and every half a year to ensure employees are filled with knowledge and up-to-date information to operate MagGas Co. safely, efficiently, and effectively.

Monitoring and Adjustments:

Routine and scheduled monitoring on LFG collection is required to ensure the effectiveness of the collection system in response to varying LFG generation rates and adjustments are to be made to ensure a balanced collection system is being implemented. The collection system has to be operated to match the landfill site's uncertainty LFG generation potential and adjustment of valve settings is done to reduce or increase LFG flows from low to high generation areas of the landfill in which under or over-drawing does no good in conjunction of efficient and effective collection system.

Health, Safety and Environmental Concern Plan:

The possible health, safety and environmental risks will be groundwater contamination, subsurface migration and uncontrolled surface emissions of LFG into the air that contains hazardous air pollutant (HAP) and odour nuisance. The strong and sharp unpleasant odour could transmit to nearby homes or businesses that causes a decrease in local property values and quality of life. HAP's exposure could possibly cause health problems such as cancerous illnesses, respiratory irritation, and central nervous system damage (United States Environmental Protection Agency, 2011). Precaution steps must be taken such as the landfills must be lined on the bottom and sides before depositing the waste and a final cap must be placed over the surface in order to reduce the potential risks. Free health check-ups will be provided for all employees, to ensure that the employees' health is maintained on a regular basis. The LFG movement has to be well monitored as well with comprehensive LFG control measures to meet Environmental Protection Act (EPA) standards.

FINANCIAL INFORMATION

All figures used have been calculated using $US, as this currency is often used as the global currency, and is easily converted into any currency around the world.

Financing MagGas Co.:

The company 'Business Partners Limited', (businesspartners.co.za, 2012) based in South Africa provides small to medium sized firms with finance to cover start-up costs and advice about entering new markets in particular industries. We are confident that the company would be willing to invest in MagGas Co., and cover our main expenses of the initial plant construction, and the pipeline installation. The total figure that would be borrowed is $5,280,000. The terms of the loan can be seen below:

Loan Financing	
Initial Loan	$5,280,000
Interest Payable Per Annum	10%
Loan Period	10 Years
Total Annual Repayment	$837,300

Biogas pricing:

Based on current U.S. stock prices (United States Environmental Protection Agency, 2010) (Renewable Energy Agency, Ukraine, 2011), MagGas Co. has decided to charge $0.25 per m^3, giving MagGas. Co. a potential earning of 16,080,000m^3 x $0.25 = $4,020,000 per year.

Initial setup costs and Installations:

After extensive research the landfill site in Roodeport, Johannesburg, South Africa, was selected due to the densely populated area and transport links readily available. The site itself would cover 45 acres within the landfill zone. Each acre of land would contain 1 biogas well per cell. Each well contains 1 blower to extract the produced gases and 1 flare to ensure the safety of the project. The total cost therefore per acre of land was agreed at $24,000, based on figures sourced from the EPA (United States Environmental Protection Agency, 2010) and previous landfill-to-energy projects (Renewable Energy Agency, Ukraine, 2011). Therefore $24,000 x 45 acres = $1,080,000. Pipeline costs were estimated at $300,000 per mile (we needed 14 miles to connect to the Egoli Gas pipeline) (United States Environmental Protection Agency, 2010).

Operational costs and Maintenance (O&M):

The final calculations for running the plant are: O&M for each well per annum would be $2,250 (x45 = $101,250 total per annum) (United States Environmental Protection Agency, 2010). O&M for each Flare would be $4,500 (x45 = $202,500 total per annum) (United States Environmental Protection Agency, 2010). O&M for the treatment of LFG would total $250,000 per annum. And finally the electricity costs for the blower would total $44,500 per annum (United States Environmental Protection Agency, 2010). This gave a total expense for O&M of $598,250.

Wages:

It was assumed 20 workers would be needed in total to run the plant. 3 Managers would control different sections of the project while 17 workers would be trained to be able to carry out a number of different tasks around the site. Subordinate workers would be paid $25,000 a year and managers $60,000. Total cost, $605,000 per annum.

Donation to Community Projects:

MagGas Co. corporate social responsibility lies within aiding South Africa's burden of HIV, by donating 15% from our total profit to the New Start Organisation.

10 Year Forecast Budget for MagGas from 2013

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue										
Biogas production	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000	$4,020,000
Total Revenue	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**	**$4,020,000**
Expenses										
Plant cost	$1,080,000	-	-	-	-	-	-	-	-	-
Pipeline Installation	$4,200,000	-	-	-	-	-	-	-	-	-
Pipeline maintenance	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
O&M	$598,250	$598,250	$598,250	$598,250	$598,250	$598,250	$598,250	$598,250	$598,250	$598,250
Pre processing	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Consultancy fees	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000
Wages	$605,000	$605,000	$605,000	$605,000	$605,000	$605,000	$605,000	$605,000	$605,000	$605,000
Contingencies	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Collection system	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Land Lease	$20,000	$20,500	$21,000	$21,500	$22,000	$22,500	$23,000	$23,500	$24,000	$24,500
Loan Repayments	$837,300	$837,300	$837,300	$837,300	$837,300	$837,300	$837,300	$837,300	$837,300	$837,300
Total Expenses	**$7,955,550**	**$2,676,050**	**$2,676,550**	**$2,677,050**	**$2,677,550**	**$2,678,050**	**$2,678,550**	**$2,679,050**	**$2,679,550**	**$2,680,050**
Gross Profit	-$3,935,550	$1,343,950	$1,343,450	$1,342,950	$1,342,450	$1,341,950	$1,341,450	$1,340,950	$1,340,450	$1,339,950
Profit after 15% Donation	**-$3,935,550**	**$1,142,358**	**$1,141,933**	**$1,141,508**	**$1,141,083**	**$1,140,658**	**$1,140,233**	**$1,139,808**	**$1,139,383**	**$1,138,958**
Accumulated Profits	-$3,935,550	-$2,793,193	-$1,651,260	-$509,753	$631,330	$1,771,988	$2,912,220	$4,052,028	$5,191,410	$6,330,368

RISK FACTORS:

Despite the appealing concept of converting waste to a renewable source, there are a few major pitfalls and risks associated with a venture such as this.

1. The collection systems have to ensure that at least 1m tonnes are collected per year in order for our plant to remain viable. If the future manages to significantly reduce MSW levels, then that could impact greatly on our business (however it would be for the best). For the meantime, because Marie Louise is a municipally owned site, MagGas Co. will contribute to the established collecting system costs and are aware that methane is still produced 30 years on from initial dumping.

2. High initial capital costs

3. Unpredictability in methane production - As methane production is dependent on precipitation levels and the quality of the MSW, MagGas Co. will attempt quality control by ensuring we have the best technology available to remain efficient.

4. Inconsistencies in the quality of methane - This will be managed by ensuring workers are performing the procedures correctly, procedures are operating efficiently and the technology is maintained to a high standard.

5. The high competition from larger producing companies - Sasol has an incredibly domineering presence, not only on the South African market, but also internationally. MagGas Co. realises that whilst Sasol has the quantity and high revenue advantage, MagGas Co. will be able to compete to some extent on reasons listed previously.

MagGas Co. ***"Working for a sustainable tomorrow"***

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