JOURNAL OF ENGINEERING annals OF FACULTY OF ENGINEERING HUNEDOARA
Tome V (year 2007), Fascicole 1, (ISSN 1584 – 2665)

LANDFILL BIOGAS FOR DIFFERENT KINDS OF ENERGY MARKETS

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ABSTRACT:
The pre-feasibility study of a landfill gas plant exposed, is an extension of a project on dimensioning a biogas capture-burning mechanism to minimize the GE, proposed by the companies Triple A S.A and MGM international for the CDM. This study contemplates the possibility of having a combined system, which considers the production of EP, NGV, and capture of CO_2 from landfill in order to have a financial and environmental sustainable project. Simulation's results conclude that is possible to generate the EP required and attain incomes from sales of NGV enough to assure the financial sustainability, even without the CDM.

KEY WORDS:
Biogas**,** Greenhouse effect GE, Clean Development Mechanism CDM, Natural Gas Vehicle NGV, Electric Power EP

1. INTRODUCTION

In the city of Barranquilla, Atlantico, located in the north of Colombia, there is a daily production of 1600 tons of rubbish that are dump in a landfill, producing more than 40.000m^3N of biogas per day. Because of the biogas composition based on two greenhouse gases, carbon dioxide and methane, where both have a contribution volumetric of approximately 50%, these biogas emissions are a significant problem that increases the greenhouse effect. Laying emphasis on the decreasing of the global warmth and a sustainable development based on the Clean Development Mechanisms there is a developing project in the mentioned landfill about the biogas seize and burn, to convert it in 100% carbon dioxide. In these way reducing the emissions of a powerful greenhouse gas, methane, which has a GWP (Global Warming Potential) of 21.

Taking as reference the mentioned project and looking for a lucrative alternative that also benefits the environment, is born the idea of the transformation and use of the biogas to obtain a bio carburant such as natural gas from a condensation plant, which will be supply by the electricity generate by the same biogas. In the obtaining of natural gas from biogas by condensation, it is produced another product, liquid carbon dioxide, which can be commercialise in diverse industries, such as the residual water treatment.

The study of the rising project has for purpose to look at the environmental matters not as a problem, but look it as a lucrative opportunity. In this case knowing

the amounts of biogas produce in landfills, specificity the one situated in the city of Barranquilla and the value of such combustible as the natural gas.

2. PROJECT DESCRIPTION

Biogas is a flammable gas produce by an anaerobic decomposition of the organic matter, where three types of bacteria take action. This process has three stages, Hydrolysis/acid genesis, acetogenesis and methanogenesis, in which the organic matter is discompose in smaller particles producing the biogas.

The composition of the biogas is shown in the following chart.

CHART 1. BIOGAS COMPOSITION
REFERENCE: DIFUSIÓN DEL BIOGÁS

COMPONENTE		% VOLUME
Methane	CH4	50
Carbon Dioxide	CO2	48.2
Hidogen	H2	1
Nitrogen	N2	0,5
Carbon monoxide	CO	0,1
Oxigen	O2	0,1
Sulphidric acid	H2SO4	0,1

There are factors such as the pH, the rubbish composition and the temperature that condition the biogas production, being the last factor one of the most important, because this one determines the production time.

Barranquilla has an average temperature of 28ºC, which means that it has the conditions to provide a mesofilic fermentation of the organic matter, with a production time of biogas of 30 to 60 days. This characteristic makes the city a high-quality place for the biogas production.

Nowadays, the landfill has accumulated in his 60000m^2 a total of 7´009.113 tons of rubbish. Where the daily process of receiving and managing the municipal solid waste, consist in covering it with a mantle of approximately one meter of sand, leaving the matter in an anaerobic environment, ideal for the biogas production process.

The landfill also contains a biogas capture system; compose by 76 chimneys around it, allowing the biogas to surge to the atmosphere.

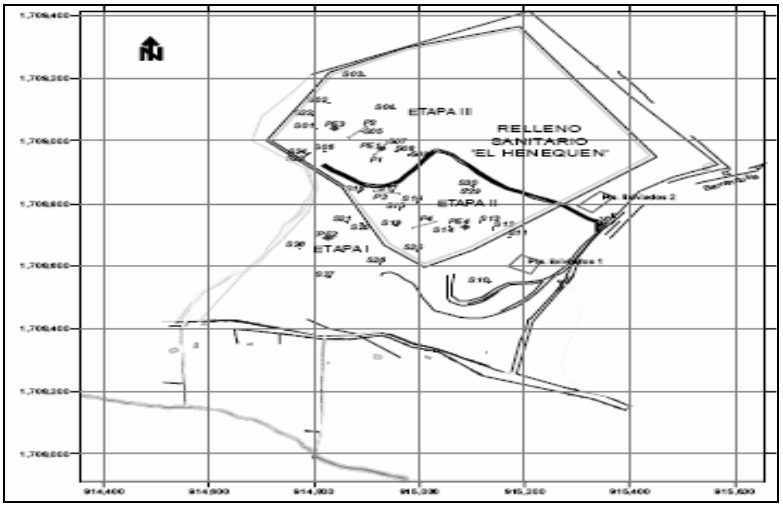

FIGURE 1. EL HENEQUEN LANDFILL
SOURCE. TRIPLE A, PROYECTO CDM EN EL HENEQUEN

Aware of the landfill biogas emissions consequences, it has being develop a project based on the Clean Development Mechanisms with one purpose in mind, minimize the greenhouse gases emissions by the biogas seize, burning and conversion to CO_2.

This project contemplates that the seize biogas in the first year (2006) will be 1683m³N/h, and the amounts of methane eliminated or converted into CO_2 in the first seven years will be of 8.200 tons, which means an annual equivalent reduction of 172.000tons of CO_2 emitted to the atmosphere.

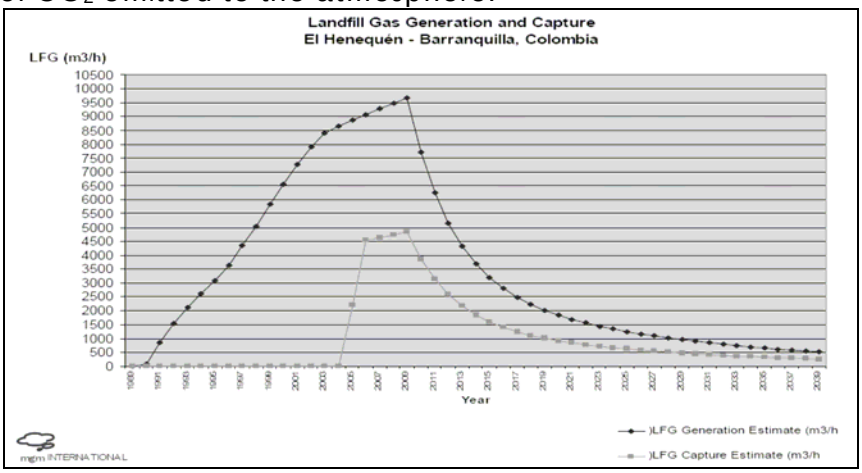

FIGURE 2. PRODUCTION AND CAPTURE OF BIOGAS IN EL HENEQUEN LANDFILL SOURCE, TRIPLE A, PROYECTO CDM EN EL HENEQUEN

In the shown graph, the blue line represents the landfill biogas production with a maximum flow of approximately 10.000m³/h, while the orange line represents the biogas capture that contemplates a maximum flow of 5000 m³/h.

3. RESEARCH'S OBJECTIVE

Taking as a reference the mentioned project was born the research about the methane obtaining from biogas cleaning and condensation, which will be use as a particular vehicles carburant.

The following figure shows the biogas conversion process into methane and liquid CO_2.

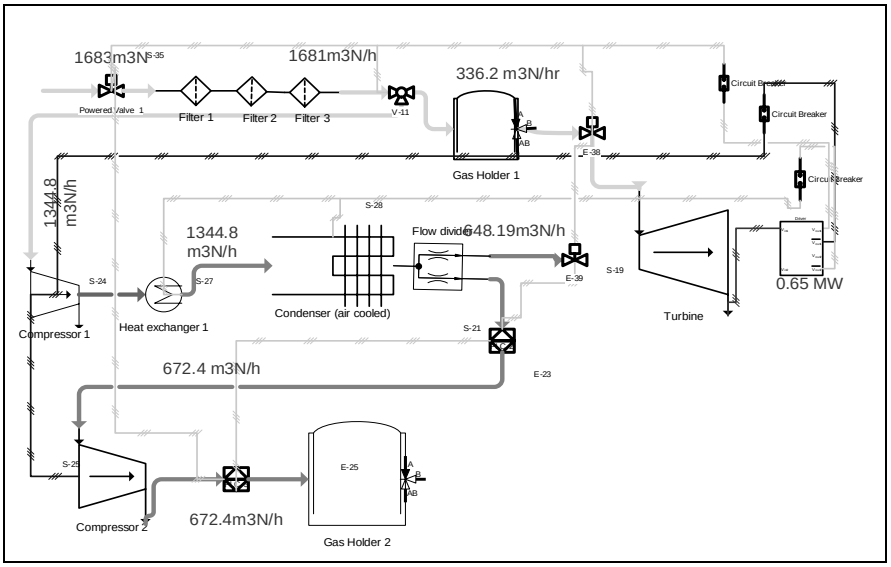

FIGURE 3. METHANE AND ELECTRICITY GENERATION PROCESS

The seize biogas enters to a cleaning system where the sulphuric acid is removed, because of his corrosive characteristics that could damage the equipment. When the H_2SO_4 is removed, one portion of the clean biogas is transfer to the generator that will provide electricity to the plant. The remaining portion will be use for the methane and carbon dioxide obtaining, where the last one is emitted to the atmosphere. The obtain methane is compress and store to be commercialize as fuel as it was mentioned before. Although the CO_2 will be evacuated to the atmosphere it has a vast market, such as the paper industry, the leather industry, metallurgical and petrochemical industries.

4. RESEARCH DEVELOPMENT PROCESS

To determine the biogas portion that will be use in the electricity generation to provide the plant, it was use the software HYSYS 3.2, where it was calculated the plant electricity consumption based on the flow to be convert. (see figure 5)

In the next chart and figure is shown the plant consumption or demand of electricity based on the simulation for the different flows to be capture through the years.

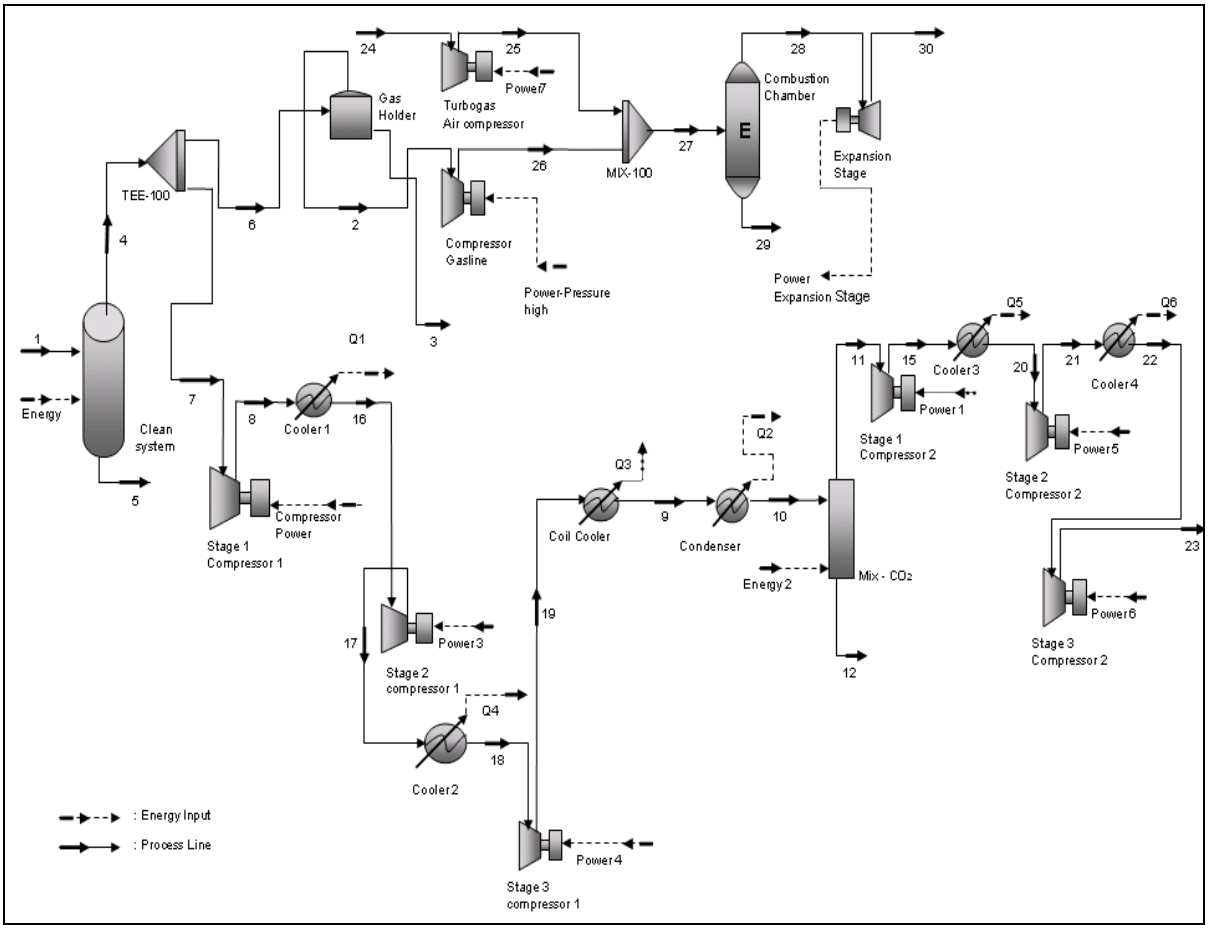

FIGURE 5. PROCESS SIMULATION USING HYSYS 3.2

Based on the data from the simulation, the biogas portion to be use for electricity generation to provide the plant is the 20%, and the 80% will be for condensation. With the 20% of the biogas for electricity and the 80% for methane obtain there will be an average generation of both of 6.711.074 KW/year and 8.174.640 m3N/year through the lifetime of the project. In the next chart is illustrated the methane and electricity production per year.

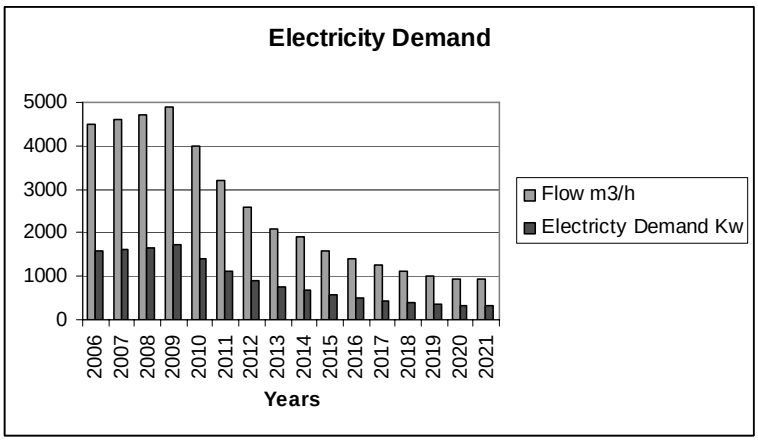

FIGURE 6. ELECTRICITY DEMAND

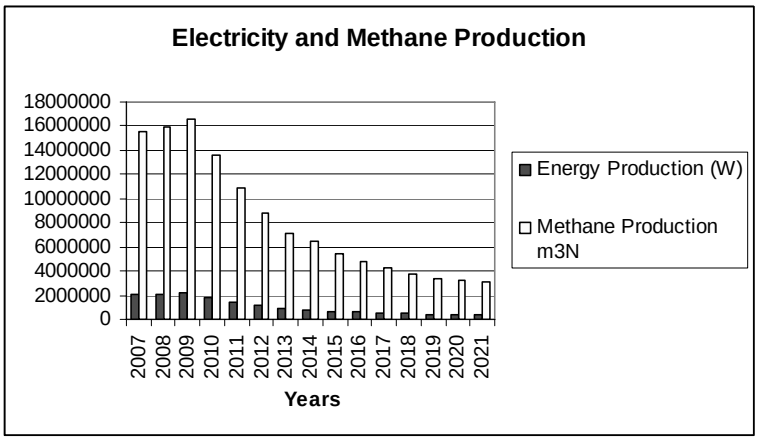

FIGURE 7. ELECTRICITY AND METHANE PRODUCTION

In Colombia, specifically in Barranquilla natural gas for vehicles has a higher price of US $0.33/m^{3}N approximately.

The study target is the natural gas converted taxicabs market in Barranquilla, where exist approximately 10.000 of them with a daily demand of 28m^{3}N each, which indicate that the market size for compress natural gas is 100.800.000m^3/year. These numbers shows that in Barranquilla there is enough market to sell the methane that will be produced and it could have the 15.44% of it.

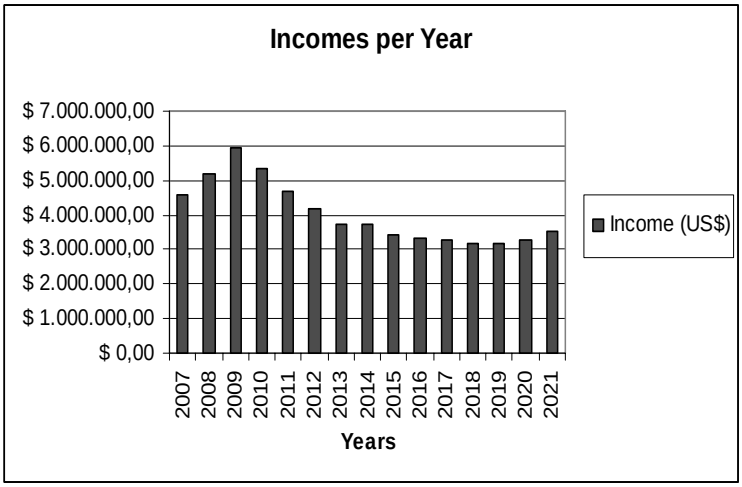

FIGURE 8. INCOMES PER YEAR

Knowing that the higher price for the natural gas is \$0.33/m³N, the calculations of the incomes were based on the strategy of selling the m³N at US \$0.29/m³N with an annual increase of 10%, proportional to that of traditional fuel.

The cost for a project of this magnitude is described as follows:

CHART 5. INVESTMENT

Investment	
TOTAL	\$ 4.480.809

The project estimated operational costs are represented by manual labour, public services, raw materials (biogas) and maintenance. It is important to highlight that the investment on the previous phase (seize and burning of the biogas) of the studied project is above three million dollars. Based on this invest it was calculated the cost of the m³N of biogas, which is U.S\$0,031.

5. CONCLUTION

Taking into account that the net present value NPV is positive and the internal rate of return IRR are above the opportunity cost of the money (which is currently 18%), it could be stated that the project is economically and financial feasible and that the initial investment can be recovered in less than a year.

The graphs shown next describe the behaviour of the incomes and costs, and benefits through the years.

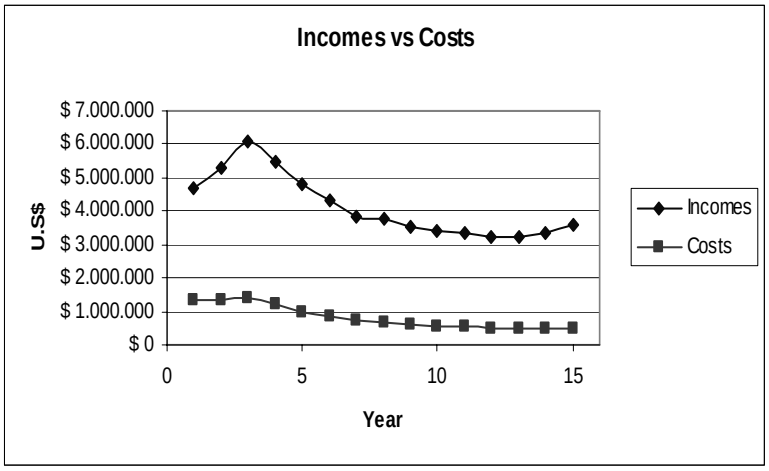

FIGURE 10. INCOMES VS COSTS

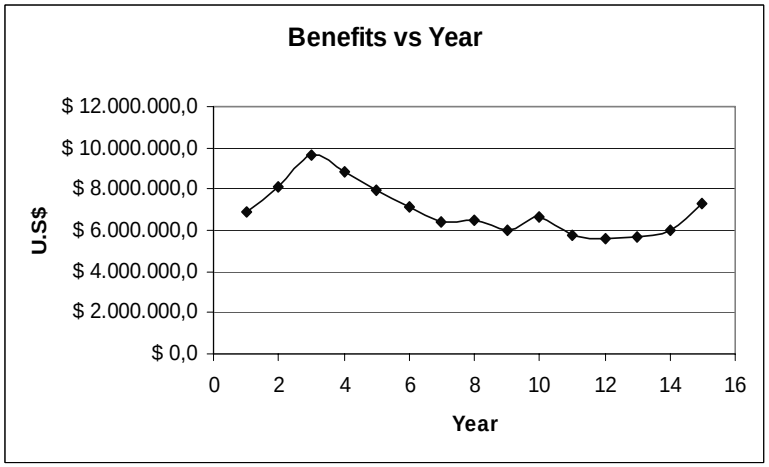

FIGURE 12. BENEFITS VS YEAR

In the incomes vs. costs graph it can be perceive that through the years both have a negative tendency, which has for reason the landfill biogas flow production decrease. Such behaviour happens in the graph of benefits vs. years, indicating that there is a proportional significance between the production and the benefits.

With the technical and financial results obtain from this study can be conclude that these kind of projects are an excellent choice to support the sustainable development, where the incomes for the selling of the CO_2 bonds will be a bonus and the relevant benefits will be given by the methane and CO_2 sells.

It is important to notice that these kind of projects will only be financial feasible for huge productions of biogas, such as one the one illustrated in the city of Barranquilla, because the investment in equipment is representative.

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