UNIVERSIDADE DE LISBOA

FACULDADE DE CIÊNCIAS

Departamento de Engenharia Geográfica, Geofísica e energia

Carlos Churro, nº49713

João Pedro Santos, nº 55144

Diogo Pestana, nº47241

SISTEMAS DE ENERGIA

WASTE

There is a large necessity for the production of electrical energy because the world consumption is growing at an exponential rate, therefore the is also the necessity to look for new types of energy resources.Three of these ways come from using the waste residues produced by overall people, waste-to-energy incineration, producing biogas from landfills and also harvesting biogas and then storing it in tanks and transporting it to the homes of residents.

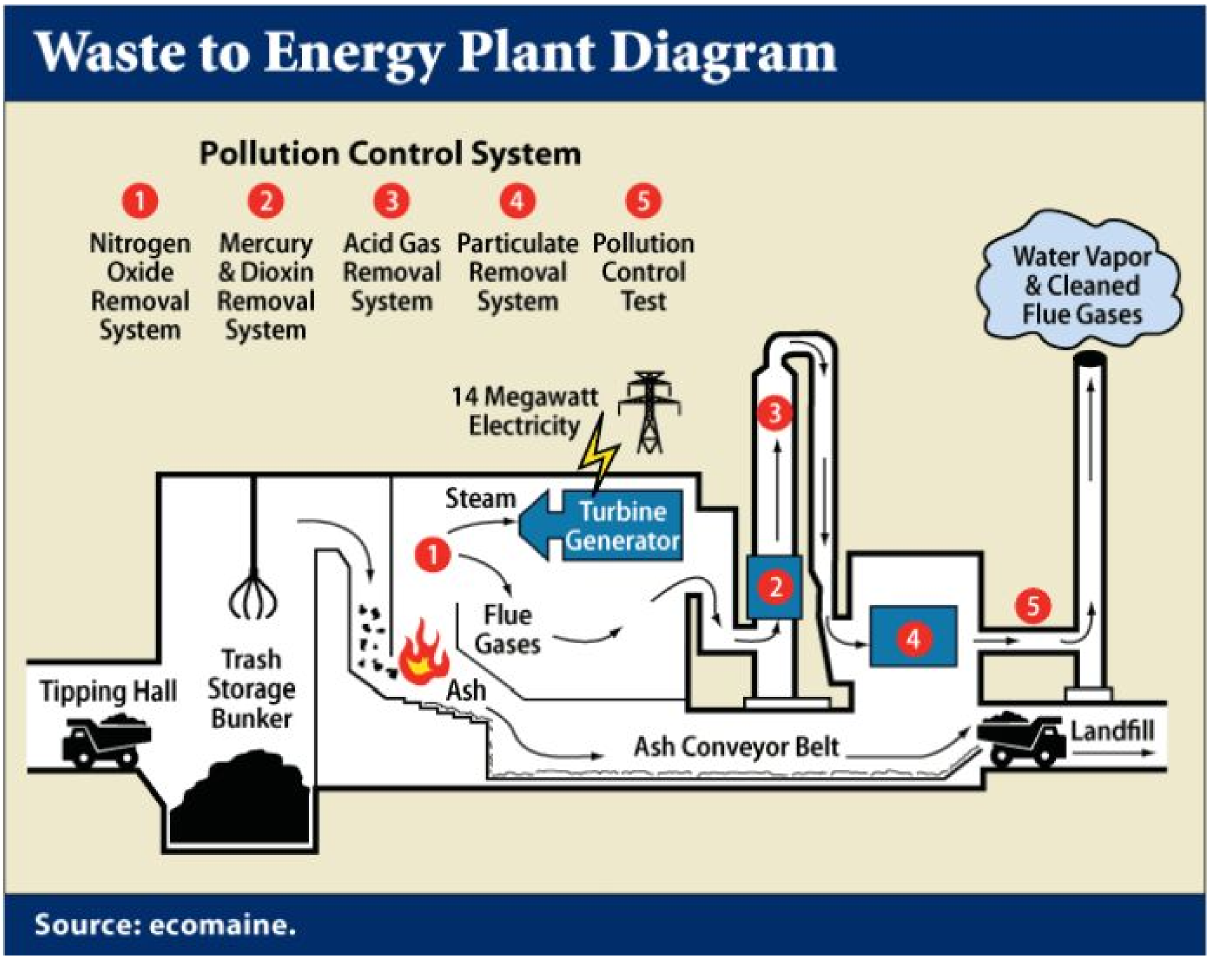
The impacts associated with using these three technologies are for example the reduction of the landfill needs, the fact that it is a reduced area need comparing it to normal landfill for the waste incinerator and for biogas production, it reduces the CO2 emissions and other pollutants generated at landfills, also its a renewable source and easy to get resource,it uses the waste as fuel so it is a smart way to utilize this resource, biofertilizer is a byproduct from the production of biogas and can be used on agriculture, also is a good way to change the current paradigm on fossil fuels as it is a dispatchable energy.

Technologies

Waste Incineration

Waste-to-Energy or energy-from-waste is the process of generating energy in the form of electricity and/or heat from the incineration of waste. Combustion reduces the volume of material by about 90 percent and its weight by 75 percent. The heat generated by burning wastes has other uses, as well, as it can be used directly for heating, to produce steam or to generate electricity.

In the image below we can see the whole process of the waste incineration plant excluding the transport process.



For this specific case of the island we first searched for the amount of waste produced per person each day

organic material	0,80 kg
plastics	0,23 kg
paper	0,15 kg
other	0,17 kg
Total	1,38 kg

Table 1 - Amount of waste produced each day per capita

With the daily waste produced per person we can now predict the total daily production for 50000 people

organic material	39,9 tons
plastics	11,6 tons

paper	7,65 tons
other	8,58 tons
Total	67,7 tons

Table 2 - Amount of wasted produced by 50000 people each day

Below are the calculated lower calorific value (LCV) of each of the components of waste.

organic material	1,22 kWh/m3
plastics	1,70 kWh/m3
paper	0,72 kWh/m3
other	0,82 kW/m3
Total	4,45 kWh/m3

Table 3 - The values of the lower calorific value(LCV) of the different components of the waste

With the values from *Table 3* we can calculate the energy expenditure from the powerplant

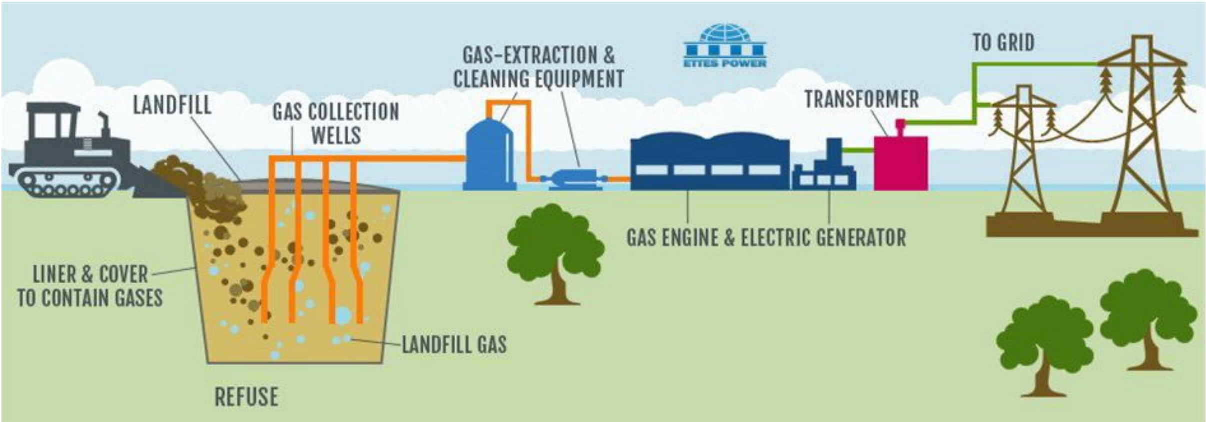
Daily energy per capita	1.81 kWh
Yearly energy per capita	660.65 kWh
Yearly energy output	33.0325 GWh

Table 4 - Energy outputs for daily and yearly per capita by the incineration plant also the overall energy for 50000 people per year

Biogas incineration

Anaerobic digestion is a natural process in which bacteria convert organic materials into biogas. It occurs in marshes and wetlands, and in the digestive tract of ruminants. The bacteria are also active in landfills where they are the principal process degrading landfilled food wastes and other biomass. Biogas can be collected and used as a potential energy resource. The process occurs in an oxygen-free environment through the activities of acidand methane-forming bacteria that break down the organic material and produce methane (CH4) and carbon dioxide (CO2) in a gaseous form known as biogas.

Biogas can be used as fuel for combustion engines, which convert it to mechanical energy, powering an electric generator to produce electricity.the heat produced in this process can also be used to generate electricity.



With the daily waste production calculated we can calculate the production of biogas on the island

Biogas per ton of waste	1,3 m3
Biogas daily production per capita	0.10 m3
Biogas LCV	11.1 kWh/ m3
Biogas daily energy per capita	1.15 kWh

Table 5 - Parameters relative to biogas including the lower calorific value (LCV)

We can now calculate the total amount of energy produced by the incineration of biogas plant, with the special attention that the daily energy per capita value of biogas on *Table 5* is only for heating water or food to calculate the production of energy it must be calculated using an efficiency of 50 to 55%

Biogas daily electrical energy per capita	0,575 kWh
Biogas yearly electrical energy per capita	209,9 kWh
Biogas yearly electrical energy output	10,49 GWh

Table 6 - Electrical energy production using incineration of biogas

Biogas residential homes

The same biogas produced by the anaerobic digestion can also be stored and transported directly to residential homes.Mostly to be used by the gas stove and water heater. This way although it loses some efficiency by transporting the produced biogas it has a more direct use in terms of everyday heating problems as it is more efficient than electrical energy to heat water and food.

Biogas daily energy per capita	1.15 kWh
Biogas daily energy use per house	2,88 kWh
Biogas yearly energy use per house	1049,4 kWh
Biogas yearly energy use total	52,468GWh

Table 7- Energy use of biogas fuel for heating water and food

Economics Analysis

All types of economic analysis were made assumptions that helped us to give a proper answer, which are: life time period of 25 years, yearly maintenance equal to 5% of initial investment and discount rate of 5%.

Were also made specific assumptions for each project.

For the direct waste incineration were made 2 different analyses, all waste incineration and the waste without the organic material. The values obtained are:

I - Investment (€)
LCOE - Levelized cost of energy (€/kWh)
NPV - Net Present Value (present value costs) (€)
SIR - Saving to Investment ration

All waste incineration

I	LCOE	NVP	Payback	SIR
2,82E+07	0,20	1,66E+07	12 to 13 yr	1,59

Parcial waste incineration

I	LCOE	NVP	Payback	SIR
1,42E+07	0,14	2,29E+07	6 to 7 yr	2,62

In the biogas projects were not considered the investment of the waste conversion to biogas i.e, no costs for landfills or any technology to convert waste to biogas.

The results obtained are:

Biogas thermoelectric power plant

I	LCOE	NPV	Payback	SIR
5,72E+06	0,11	1,33E+07	4 to 5 yr	3,33

Biogas distribution by pipelines

I	LCOE	NPV	Payback	SIR
1,50E+06	0,011	1,50E+07	1 to 2 yr	11,0

Biogas distribution by trucks

I	LCOE	NPV	Payback	SIR
1,00E+05	0,0029	1,62E+07	0 to 1 yr	137

In the biogas distribution by pipelines where considered that on the island are needed 15km of pipelines, the installation price of pipelines are 100€/m and the maintenance annual cost is 1% of the initial investment instead of 5%.

In the biogas distribution by trucks, it was considered that are needed tow trucks worth of 50000€ as new, the life time period for each truck is 10 years, the distance ride in a day is 100 km, with 60L a truck can ride for 350km and in the end of each life time period a truck can be sold for 7500€. The calculations were made for a 25 year project.

Recommendation

Based on the numbers the recommended course of action would be to use all but the organic waste to incinerate and the organic matter to produce biogas. The produced biogas can be used for both a complement on a CHP central or to residential.

With this choice based on the economic analysis we recommend using biogas for residential use, with trucks and bottles as the means of transportation.

Based on an usual electric bill we determined that biogas alone could handle around 46% of residential uses (both heating water and cooking achieved by biogas), as a cheap solution.

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