**Waste to energy**

# Incineration

Incineration is an attractive technological option for waste management and energy production. Incineration technology consists in a controlled combustion that uses waste as a principal fuel to produce steam in order to produce power trough steam turbines.



Figure : Inceniration plant in Malmo, Sweden

## Health impacts

Waste incineration systems produce a wide variety of pollutants which are detrimental to human health. There are systems that minimize the effect of the emissions from chemicals used on the incinerators, but those systems are expensive and doesn’t eliminate or adequately control.

Even the most recent incinerators release toxic metals, dioxins and acid gases. The Dioxins, which are considered by the WHO (World Health Organization) compounds that are persistent environmental pollutants have irreparable environmental health consequences. People may be exposed to these compounds in various ways such as breading the air near the plant, eating locally produced foods or water that have been contaminated by air pollutants from the incinerator or by eating fish or wildlife that have been contaminated by the air emissions.

## Environmental impacts

The most relevant positive environmental impacts are related to positive effects on water, soil, air, fauna, flora and landscape resultant by not disposing the garbage on the soil.

The incinerators may have the need to use natural resources such as natural gas due to his process that has proved to be very unstable with many stops, which lead to high consumption of natural gas at start-up or to maintain the temperature inside the combustion chamber, until waste is introduced or the optimum conditions are restored to start the incineration process.

The risk of an eventual environmental accident that effects the facility could culminate into emissions to the atmosphere, spills of chemicals and waste or raw materials such as ammonia, as well as the lack of maintenance of some equipment, which could potentially jeopardize safety, causing fires or explosions.

## Properties of some types of waste

In the following table are shown some calorific values for the most common types of garbage that we can find in municipal waste.

Tabel

|  |  |
| --- | --- |
| **Type of waste** | **Calorific Value [MJ/Kg]** |
| WOOD (Wet/Dry/Average) | 12/19/15 |
| PLASTIC | 24 |
| PAPER AND CARDBOARD | 13 |
| TEXTIES | 14 |

The average values for calorific values of the plastic garbage container for cities and village are 17 [MJ/kg] and 18 [MJ/kg] respectively.

## Energy production (Example)

**Assumptions:**- We have 50 000 [habitants];  
- Each habitant produces 300 [kg of waste/year];  
- We can burn about 35% of the produced waste;  
- Electrical capacity of the plant is 214 [kWelectrical];  
- Thermal capacity of the plant is 500 [kWthermal];

To calculate power, we used a linear function based on these values:

|  |  |  |
| --- | --- | --- |
| **Weight [ton]** | **Eletric energy [MWh]** | **Heat energy [MWh]** |
| 120000 | 43000 | 100080 |

So, our combined heat and power plant is able to produce around 1881MWh/year (electricity) and 4378MWh/year (thermal), that means a capacity of 214kW (electricity) and 500kW (thermal).

# Production of biogas

Biogas is a gas resulting from the processing of organic compounds contained in biomass. Is a secondary source resulting from the processing of biomass/animal excrements using various processes. The most common technique for producing biogas is methane fermentation, where under anaerobic conditions, physic-chemical processes supported by methane bacteria break down the organic mass into gaseous form. Biogas is a useful hybrid fuel because it can be used in heating, electricity production and in engines.

Uma imagem com alimentação

Descrição gerada automaticamente

Figure : Biogas production scheme

## Health impacts

The usage of biogas has a positive effect in people that use wood and plantal wastes in combustion systems without chimney which are affected by respiratory diseases, because using biogas eliminates these problems.

Animal producers are kept under pressure by local residents because of the odor that comes the animal droppings, the source of the odor usually are nitrogen and sulfur and the removal of these animal wastes can be considered a positive impact because of the reduction of these compounds on the atmosphere.

## Environmental impacts

The methane and the ammonia emissions occur mainly during storage of animal waste

## Biogas Plant

The biogas plant is a facility where the biogas is produced from biomass, animal manure, organic waste (e.g from the food industry), slaughter waste or biological sludge from sewage.

This installation has the following stages:

* Preliminary tank;
* The dosing system;
* Fermentation chamber (fermenter);
* Storage tank for the fermented substrate;
* Biogas tank;
* Power generator or cogeneration unit;

It is worth considering the construction of a biogas plant near an existing animal farm, so that the transport of biogas substrates, i.e. slurry and biomass, will be easier. Natural fertilizers, especially slurry have low efficiency in terms of biogas efficiency. This is due to, among others from their significant hydration. Therefore, transporting them over long distances to biogas plants is not cost-effective.

For this facility we chose the co-generator agenitor 404b from 2G Energy that has capacity of 100 kW, which is in the following image.

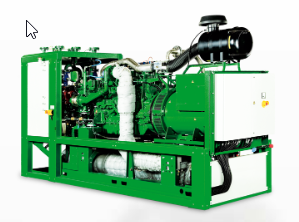


Figure : Cogenerator, agenitor 404b 2G Energy

The technical details of this engine are in the following table:

Tabele : Technical details of the coogenerator

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Agenitor 404b** | **Output** | | **Efficiency** | |
| Electrical [kW] | Thermal [MBTU] | Electrical [%] | Thermal [%] |
| 100 | 406 | 37 | 44 |

## Costs of the plant installation and operation

We found in literature that the installation of this plant would cost about 464 000 euros

## Energy production (Example)

For the production of the biogas we assumed that as a principal source we need 70% of animal waste and 30% of biomass. We chose cow’s waste and corn because by in the following calculus those the more efficient for this type of process.

**Assumptions:**

- Substrates in a ratio of 70% A (animal wastes 🡪 cow), 30% B (biomass 🡪 maize silage)

- Capacity 100 kW

- 8000 hours/year of work

**Biogas demand (*data from producer website*):**

|  |  |  |
| --- | --- | --- |
| **Electric Power** | **Thermal Power** | **Efficiency** |
| 100 kW | 118 kW | 81% |

We can calculate gas flow with formula:

Q – capacity of system, 100 kW

η – efficiency, 81%

W – caloric value, 21 MJ/kg (assumed value)

|  |  |  |
| --- | --- | --- |
| **Capacity** | **Gas Flow** | **Annual Biogas Demand** |
| 100 kW | 21,2 m3/h | 169 600 m3 |

The average dry biomass content and average biogas yield were used for the calculations:

|  |  |  |
| --- | --- | --- |
|  | **Dry biomass content [%]** | **Production of biogas [m3/t.d.b.c.]** |
| Cow wastes | 78 | 350 |
| Maize silage | 90 | 575 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Capacity [kW]** | **Annual demand [m3]** | **Substrat A [m3]** | **Substrat B [m3]** | **Mass of A [t]** | **Mass of B [t]** |
| 100 | 169 600 | 118 720 | 50 880 | 339,2 | 88,5 |

We know that 70% of all needed biogas is animal wastes and 30% is maize silage. So we know how many m3 we need. 1 tone of dry biomass can generate 350 m3 of biogas (literature). So:

339,2 tons of cow wastes we need

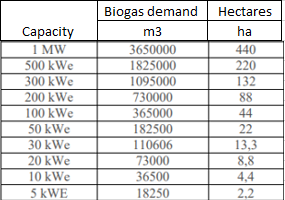
**Required quantity of cows:**

The data found on internet shows that one cow produces 20 m3 of liquid wastes a year, with an average density of 1,3 t/m3, which gives 26 tons of liquid wastes (manure) per year.

So:

We need 14 cows.

**Biomass:**



*Table 3*. *Hectares depends on capacity and biogas demand.*

Function is linear. We need only 50 880 m3 of biogas from maize, so:

|  |  |  |
| --- | --- | --- |
| 100 kWe | 50 880 m3 | 7 ha |

We need 7 hectares.

**Energy:**

|  |  |  |  |
| --- | --- | --- | --- |
| Capacity [kWe] | Electric Energy [kWh] | Capacity [kWth] | Thermal Energy [kWh] |
| 100 | 304 000 | 118 | 405 920 |

Assumption:

Power plant life: 43 years

Cost of plant: 464 000 euro

**Cost of energy:**

|  |  |
| --- | --- |
| **ELECTRICITY:** | EURO |
| 1 ha | 1241 |
| 7 ha | 8687,0 |
| Annual, service costs | 10870 |
| Cost of plant/year | 10 790,7 |
| SUM OF COSTS | 30 347,7 |
|  | |
| Energy [kWh] | 30 4000 |
| **Cost of energy [EURO/kWh]** | **0,10** |
|  | |
| **THERMAL:** |  |
| Energy [kWh] | 405 920 |
| **Cost of energy [EURO/kWh]** | **0,07** |

## Conclusions

For the energy production by using incineration we didn’t found on literature any plant that uses such a small amount of waste per year so we’ve considered that for using this technology we would have to add biomass in order to fill the production needs of the plant.

The incineration plants have small positive impacts comparing to the negative impacts in terms of the environment and health so we considered that it wouldn’t be a wise choice to use on this island.

# Bibliography

<https://www.sciencedirect.com/science/article/pii/S1876610217352001>

<https://www.researchgate.net/publication/317596745_Negative_impacts_of_MSW_Incineration>

<https://dergipark.org.tr/en/download/article-file/118842>

<https://spalarnie-odpadow.pl/ile-energii-rocznie-wytwarzaja-spalarnie-odpadow-w-polsce/?fbclid=IwAR2ejv44fTo7lpHN2W7nvud9BeKWG63ZYjNVU7FETsa526A7Vr06cPeJLHk>

<https://cdr.gov.pl/pol/OZE/substraty.pdf?fbclid=IwAR2LREQXXzIV_PzXjVd0OxYJAErOY5sS74UfgeLG3at7UFIbruwSPcRFi-8>

<http://www.2g-energy.com/products/biogas-product-line/#agenitor>