

Waste to Energy: Plasma Gasification

Maryam (INE) Badr (ELE) Bassam (CVE) Abouelela (MCE) Sul Khan (CHE)

Situation

In recent years UAE has been experiencing high population growth in parallel to its increase in economic status, to the point that each individual on average produced 2.1 kg of waste per capita per day [1]. The consequences of the disposal of garbage are not direct and immediate. Companies in Dubai are charged high prices per ton of unrecycled garbage in order to try to increase the incentive for recycling.

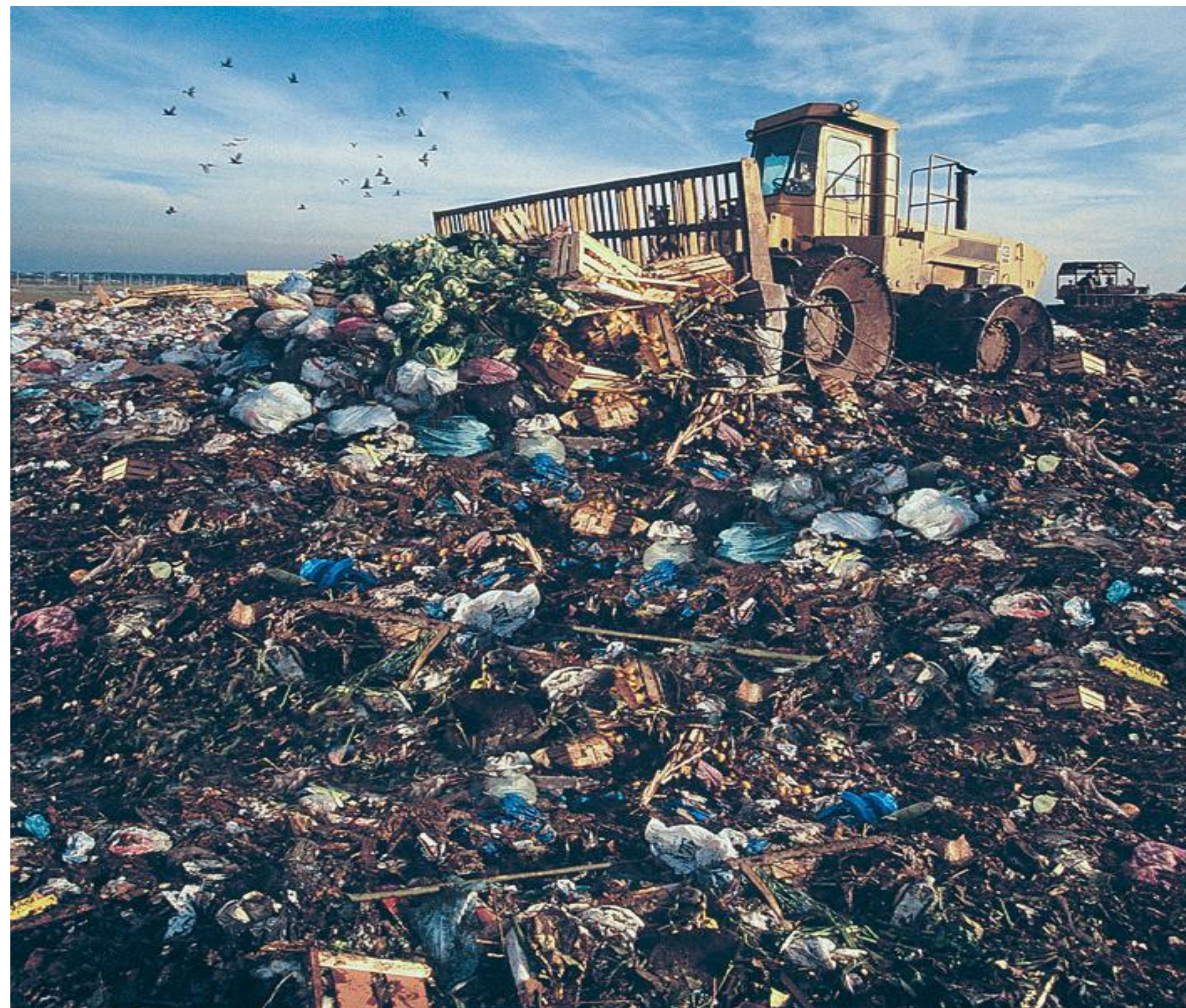


Figure 1: Landfill [2]

Problems

Despite the efforts undertaken by the United Arab Emirates Government toward waste management, the UAE is still placed among the top five countries in the world in the accumulation of Municipal Solid Waste (MSW). The UAE MSW figures are 10.69 million tonnes of waste in 2011. [3]

Landfilling

Unsustainable, harmful to the environment and produces pollution due to material decay

Recycling

Not capable of handling the current waste situation
Depends on human integrity

Solution

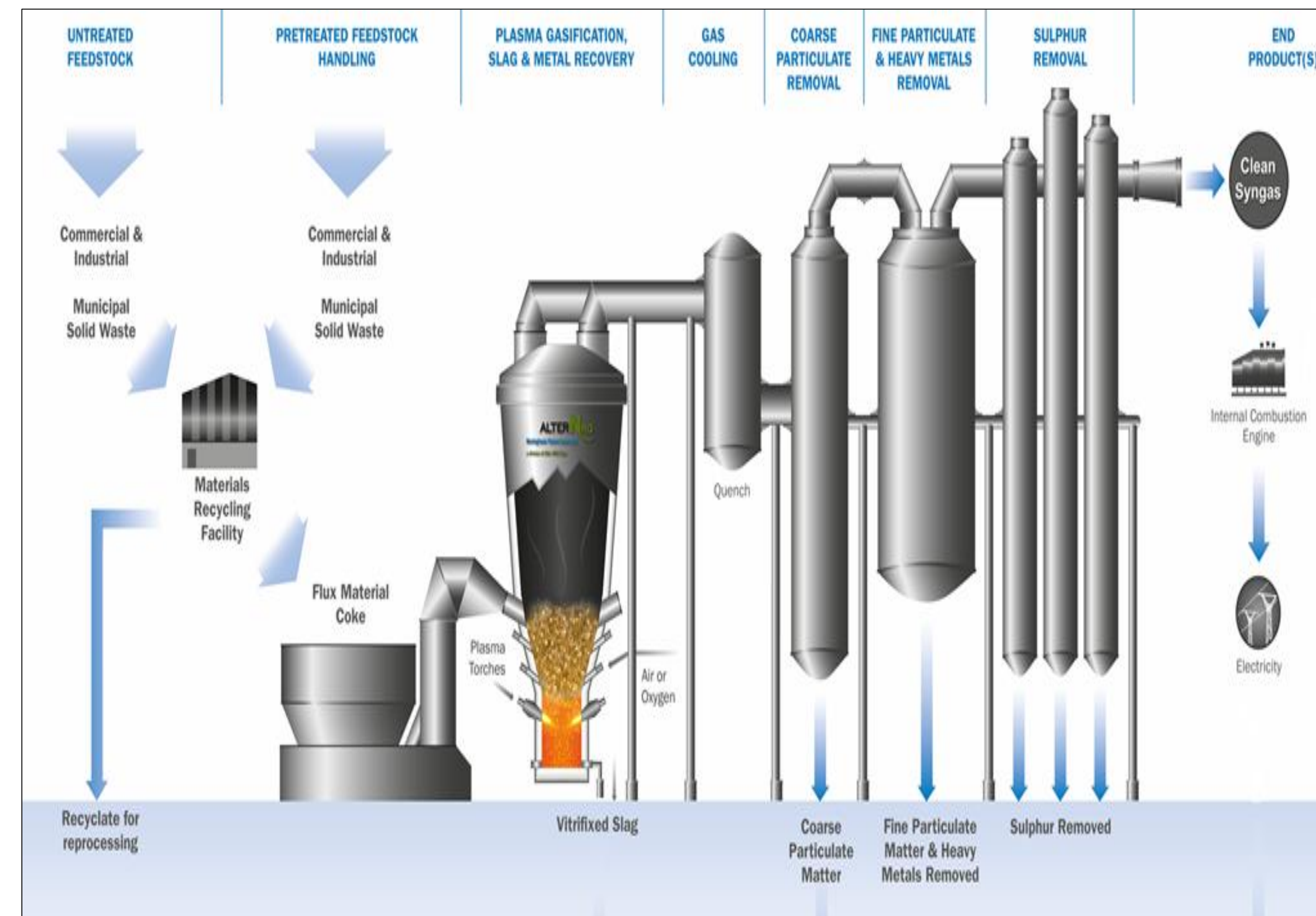


Figure 2: Plasma Gasification Cycle [4]

A plasma gasifier is an oxygen starved vessel where various feedstocks can be gasified using the very high temperatures achievable with plasma

The heat breaks the feedstock down into molecular constituents including hydrogen and carbon monoxide, the two building blocks for syngas

Syngas is cleaned of dust and other undesirable elements

Two to five percent of the total energy input is consumed by the plasma torch, and 80% of the total energy input can be recovered in the syngas produced [5]

No greenhouse gasses are emitted in the process

The only by-product is vitrified slag, which can be used in construction materials (asphalt and concrete)

Syngas is used to operate engines and fuel cells and can be converted to biofuel or substitutes for natural gas



Figure 3: Vitrified slag [6]

Evaluation

Advantages

Reduction of exhaust gas flow rate and air emissions
Turbines are fed from a portion of the syngas produced

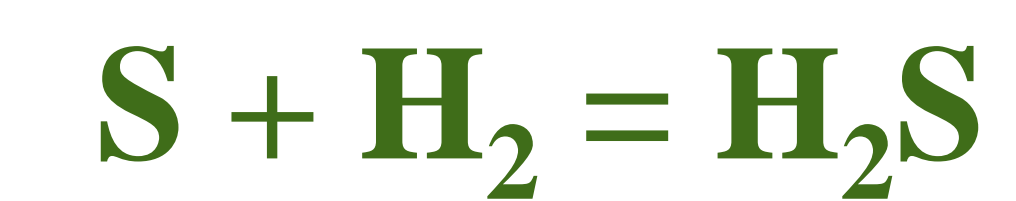


Figure 4: Gasification with Hydrogen

Disadvantages

Capital and maintenance costs of Plasma Gasification plants are higher than traditional waste-to-energy plants
Thermal energy produced from syngas might not have a good use in the UAE due to its climate, as opposed to European countries

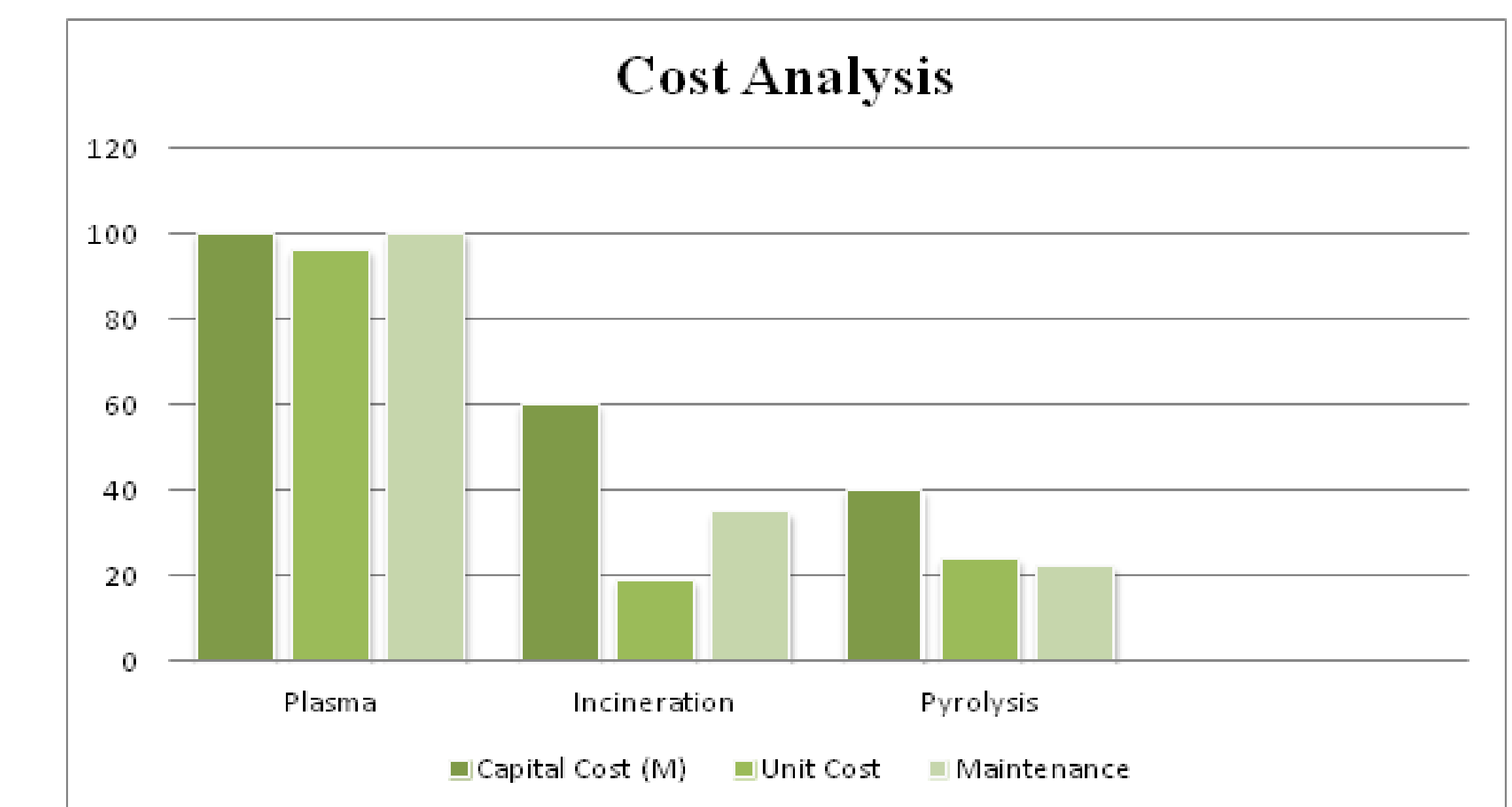


Figure 5: Cost Analysis

References

- [1] "Waste-to-energy: An opportunity for a new industrial typology in Abu Dhabi," Renewable and Sustainable Energy Reviews, vol. 55, pp. 1260–1266, 2016.
- [2] Available: <https://www.pinterest.com/pin/573857177491947818/>.
- [3] "Towards Waste Management in Abu Dhabi," Oct. 3, 2013. [Online]. Available: <https://www.ead.ae/Documents/PDF-Files/Waste-PB-Eng.pdf>
- [4] "Typical Plasma Facility," Alter NRG Corp, 2016. [Online]. Available: http://www.alternrg.com/waste_to_energy/typical_plasma_facility/.
- [5] "westinghouse | netl.doe.gov", Netl.doe.gov, 2016. [Online]. Available: <http://www.netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/westinghouse>.
- [6] "Mülldeponien als Bodenschätze entdeckt!," Die reale Welt Stiftung, 2015. [Online]. Available: <https://www.die-reale-welt.de/technisch/alternative-zur-muellverbrennung/>.