



Plasma Gasification, an Eco-Friendly Solution for Power Generation and MSW Treatment in Kinshasa, DR Congo

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Abstract

Electricity is vital for modern society, powering homes, industries, hospitals, and transportation systems. It is the backbone of our daily lives, enabling convenience, fulfilling human basic needs, and crucial for the development and improvement of socioeconomic conditions. However, the Democratic Republic of the Congo faces a significant challenge with low electrification rates, where less than 10% of the population has access to electricity. Even the capital city, Kinshasa, with 17 million inhabitants, has only about 60% electricity access and struggles with massive municipal solid waste (MSW) generation. To address this issue, a plasma-based gasification technology is proposed as a suitable and eco-friendly solution. This technology involves treating the substantial volume of waste generated in Kinshasa and rural areas to increase power generation. The advanced System of Process Engineering (ASPEN Plus) was used to estimate that 208 tons of MSW as feedstock gasification produced 11.82 MW/h of electricity, significantly improving power access from 678 MW to 961.68 MW. Moreover, implementing plasma technology not only enhances electricity generation but also addresses waste management issues across the country, which are at their lowest point. Furthermore, it is crucial to enhance waste management policies in the DR Congo, particularly promoting different waste-to-energy (WTE) technologies, such as plasma, to fight increasing waste generation and greenhouse gas

emissions.

Subject Areas

Energy Engineering

Keywords

Hybrid Plasma Technology, Waste-To-Energy (WTE), Waste Management, Plasma Technology, Municipal Solid Waste (MSW)

1. Introduction

Energy, particularly electricity, is an indispensable factor for both human and economic development. Its availability is crucial for providing essential services in various sectors, including healthcare, where it powers equipment and illuminates hospitals. Moreover, electricity plays a pivotal role in industry and education by enabling technological advancements in classrooms and households. Additionally, it contributes significantly to food security through refrigeration and fulfills a wide range of fundamental needs such as cooking, sanitation, cleaning, heating, transportation, communication, and entertainment. Furthermore, access to electricity facilitates the utilization of advanced technologies and enhances agricultural and economic productivity. Scholars have emphasized the close relationship between energy consumption and human development, highlighting its profound impact on societal progress [1]. Compared to other human basic requirements, energy has become an essential part of everyday life [2]. Access to electricity is critical for poverty reduction, enabling investments, innovations, and new sectors that drive job creation, inclusive growth, and shared prosperity across entire economies [3].

Despite the critical importance of electricity, the Democratic Republic of the Congo (DR Congo) grapples with one of the lowest electrification rates globally. The country's growing population, urbanization, and modernization have significantly increased the demand for energy. However, the current energy sources are either limited or underutilized due to the substantial investments required; As a result, less than 10% of the Congolese population has access to electricity, as reported by the French embassy [4]. Despite the country's abundant energy potential, DR Congo faces a severe energy deficit problem [5]. The capital city, Kinshasa, with 17 million inhabitants, has only about 60% electricity access, in addition, the service quality remains subpar due to population growth. Consequently, households frequently experience prolonged blackouts lasting from 24 to 72 hours. The demand for electricity throughout the country remains high and continues to rise, due to population increases, as depicted in the energy ministry's 2009 graphic on energy demand scenarios in DR Congo as shown in **Figure 1** [6].

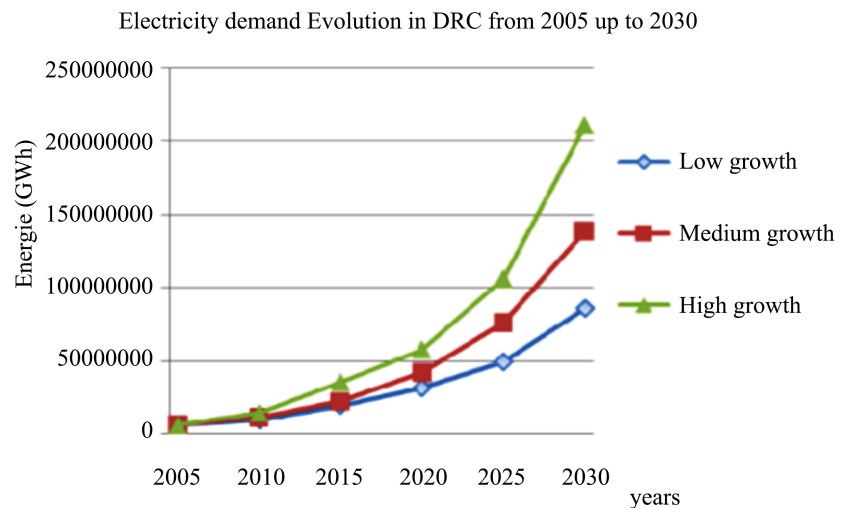


Figure 1. Electricity demand evolution in DRC from now up to 2030. Source: <https://iopscience.iop.org/article/10.1088/1755-1315/249/1/012016/pdf>.

Furthermore, the rapid growth of Kinshasa's population has not only led to increases in energy demand but also to the solid waste generation, in alarming proportion due to economic activities, urban growth, and an increase in the growing population, without a proper management system which has led to an unparalleled accumulation of solid Waste resulting in a slew of urban issues [7] [8]. According to a report published by the International Union for Conservation of Nature in 2010, Kinshasa generates more than 8000 tons of waste per day, or about 3 million tons per year, or more than 260 kilograms per inhabitant per year. Organic matter and plastic are the most generated waste in the capital city.

Scarlet, Motola, Monforti-Ferrario, and Linus argue in their research paper that Waste could be used as a source of energy and that power generation from Waste can play an essential role in reducing the impacts of municipal solid Waste (MSW) on the ecosystem while also providing a local power source [9]. Through a variety of technologies, many different waste types can be converted into either gas or liquid fuels used for energy production [10].

With the increase in human population, particularly in urban areas, Waste generation, and management has become a major issue for both local governments and cities' authorities, and rates are rising. According to the World Bank report on Solid Waste Management published on February 11, 2022, the world's cities generated 2.01 billion tons of solid Waste in 2016 [11], with annual waste generation expected to increase by 70% to 3.40 billion tons in 2050 [12] [13]. However, Reference [14] and [15] noted that due to unsustainable waste disposal and management practices, the amount of garbage is growing, which has a negative impact on the environment, notably in terms of soil, water, and air pollution.

Sub-Saharan Africa generated 125 million tons of municipal solid Waste (MSW) in 2012, with a rate of 0.46 kilogram per habitant and per day [16]. An increase of approximately 174 million tons of waste was observed in 2016 [17]

with studies indicating that this figure will triple by 2025 according to the World Bank.

Less than a decade before the Sustainable Development Goals (SDGs), argue Andrew Ebekoziem *et al.* in their research, there is a potential danger of household waste arising from sub-urban sprawl, particularly in developing countries [18]. Caused by an adverse influence on almost all kinds of human beings on the planet, ranging from contaminating water bodies to clogging and causing flooding, respiratory diseases caused by air pollution as a result of Waste burning, and the breeding of mosquitoes and other insects that cause diseases such as cholera, malaria, and typhoid fever. Waste management is critical for creating livable and sustainable cities, but it continues to challenge so many developing countries and cities. Sustainable Waste management is costly, often accounting for 20% - 50% of municipal budgets. Although municipal solid waste (MSW) poses a potential risk to the ecological environment and human health, it is gradually being considered one of the most renewable resources [19]. Operating this critical municipal service necessitates implementing sustainable, convenient, and socially supported technology solutions. Germany generates the most electricity from Waste in Europe, with 5768 GWh. 2782 GWh for the UK, Italy 2344 GWh, France 1999 GWh, and the Netherlands come in fifth position with 1997 GWh. Throughout the year 2014, the United States implemented 2.5 GW of WtE capacity, which tends to result in electricity generation of 14310.2 GWh [20].

Moreover, the adoption of environmentally friendly energy strategies attempting to enhance its energy mix by establishing a suitable compromise among both environmental protection and energy needs remains a good practice. Waste-to-energy (WtE) is a crucial component of both waste management [20] and renewable energy production [21]. Thereby, technologies that generate energy from Waste are viewed as a solution for sub-Saharan Africa to manage better the region's increasing Waste volume at the same time and meeting the region's growing electricity consumption needs. Furthermore, it is significant to mention that transforming Waste into energy is frequently problematic insofar as many energy recovery solutions, unfortunately, continue to pollute the environment. Moreover, among the various thermochemical conversion processes, pyrolysis has seen widespread use in organic waste valorization [22]. According to Paul, incineration generates very toxic gases, among which are nanoparticles, which is why he suggests combining composting and recycling can reduce global warming gases by about 46 times more than incineration for generating energy [23]. Reference [24] reported that sludge incineration is prohibitively expensive and poses a risk related to the impact of toxic gases, such as dioxin, on the environment. Moreover, Waste management systems that highlight prevention, reuse, and recycling processes, and power generation could play a crucial role in the transition to a circular economy [21].

A comparative study of waste-to-energy technologies was conducted by [25] [26] and concluded that gasification is the most efficient and cleanest approach. In addition, fast and slow pyrolysis, as well as gasification and combustion, are

also investigated as WtE solutions for sewage sludge management with energy recovery [27]. Reference [28] [29] [30] observed that among waste-to-energy technologies including incineration, pyrolysis, and gasification, gasification, particularly using plasma, is the cleanest and most environmentally friendly method. In addition, modern technology based on plasma gasification is the cleanest, most attractive, and environmentally friendly system for solid waste management and energy consumption according to [31]. Given the environmental significance of GHG emissions, research has concentrated on techniques to reduce GHG emissions [32], whereas plasma gasification appears to be a viable strategy in waste treatment.

According to [33], utilizing waste-to-energy technologies is becoming increasingly important in today's world of limited energy resources. The air study's results of the optimization model indicate that plasma arc gasification and advanced incineration are the most efficient technologies for producing WtE conversion. A case study of a plasma gasification plant that treats 750 tons of municipal solid waste per day was conducted in Greece. The results of this experiment demonstrated that the cost of the plasma gasification process is comparable to that of the commonly used incineration process. That plasma gasification produced a better result [34]. It is widely acknowledged that 70% of medical wastes are hazardous [35]. Nonetheless, plasma gasification can use this type of Waste to generate energy, with energy efficiency and exergy efficiency reaching up to 37.83 percent and 34.91%, respectively, with a total net power of 4.24 MW yielded from medical waste [36]. Reference [37] argues that since gasification is seen as a means of improving the environmental acceptability of coal and increasing the overall efficiency of the conversion of the chemical energy in coal into electricity, electricity generation has emerged as a significant new market concerning coal gasification.

Despite its importance in waste management and clean energy recovery, plasma-based gasification, or hybrid plasma, has received little attention in the entire Democratic Republic of the Congo, although the country is facing a serious problem dealing with solid Waste, which is generated in large portion primarily due to population growth. Furthermore, interest in waste treatment using this type of technology is still very low or nonexistent, and data on the operation and efficacy of plasma technology in cities such as Kinshasa to improve energy supply while treating eco-friendly Waste generated has yet to emerge. Studies on Waste management disregarding the role of plasma technology an issue of debate among scholars. There has not been any relatively published research on Plasma-based-gasification in the study area, so this paper attempts to bridge the gap, primarily by introducing a sustainable technology for solid waste treatment while generating electricity. Implementing the expertise of the technology, as mentioned earlier, would significantly reduce the Waste disposal volume [34], creating interest, knowledge, and awareness in waste management systems, and fill the gap between energy demand and supply. Based on the proposes a cut-

ting-edge technology known as Plasma-based-gasification is as a suitable and environmentally friendly solution for the power crisis and municipal solid waste treatment in Kinshasa, DR Congo.

2. Materials and Methods

2.1. Study Area

Kinshasa as shown in **Figure 2**, formerly known as Léopoldville from 1881 to 1966, is the Democratic Republic of the Congo's capital and largest African city, covering 9965 square kilometers. With a population estimated to be 17 million inhabitants in its metropolitan area in 2021 and should increase to 20 million by 2030, according to the World Bank [38], it is Africa's third most populous city, behind Cairo and Lagos. Also known as the world's largest-speaking French country, surpassing Paris in 2010 and ranking among the world's most populous agglomerations [39].

It is located on the south of the Congo River, at the Pool Malebo, and faces Brazza city, the Congo's capital. The city's boundaries are so broad that more than 90% of its area comprises rural or forest areas; the urbanized rooms are located to the east of the territory. Kinshasa has administrative status and is one of the 26 provinces of the country [40]. The city counts a total urbanized municipality area of approximately 327 km², representing only 3.1% of the total area.



Figure 2. Kinshasa, the capital city of DR Congo [41]. <https://wiki.openstreetmap.org/wiki/Kinshasa#/map/0/13/-4.3637/15.3349>.

2.2. Research Design

A qualitative exploratory case study included both primary and secondary data collection, and an ideal approach for quantitative data, which was used to

achieve the research objectives and provide details concerning data collection and analysis. The scientific curiosity was focused on the current situation on the daily MSW generation quantity and its impact on the environment as well as the population's health, actual trends and management practices, including transportation and treatment, and electricity production capacity to have a holistic overview of the issue of waste management and electricity crisis to solve in the city of Kinshasa in which **Figure 3** shows the pathways specific objectives and goals in the research.

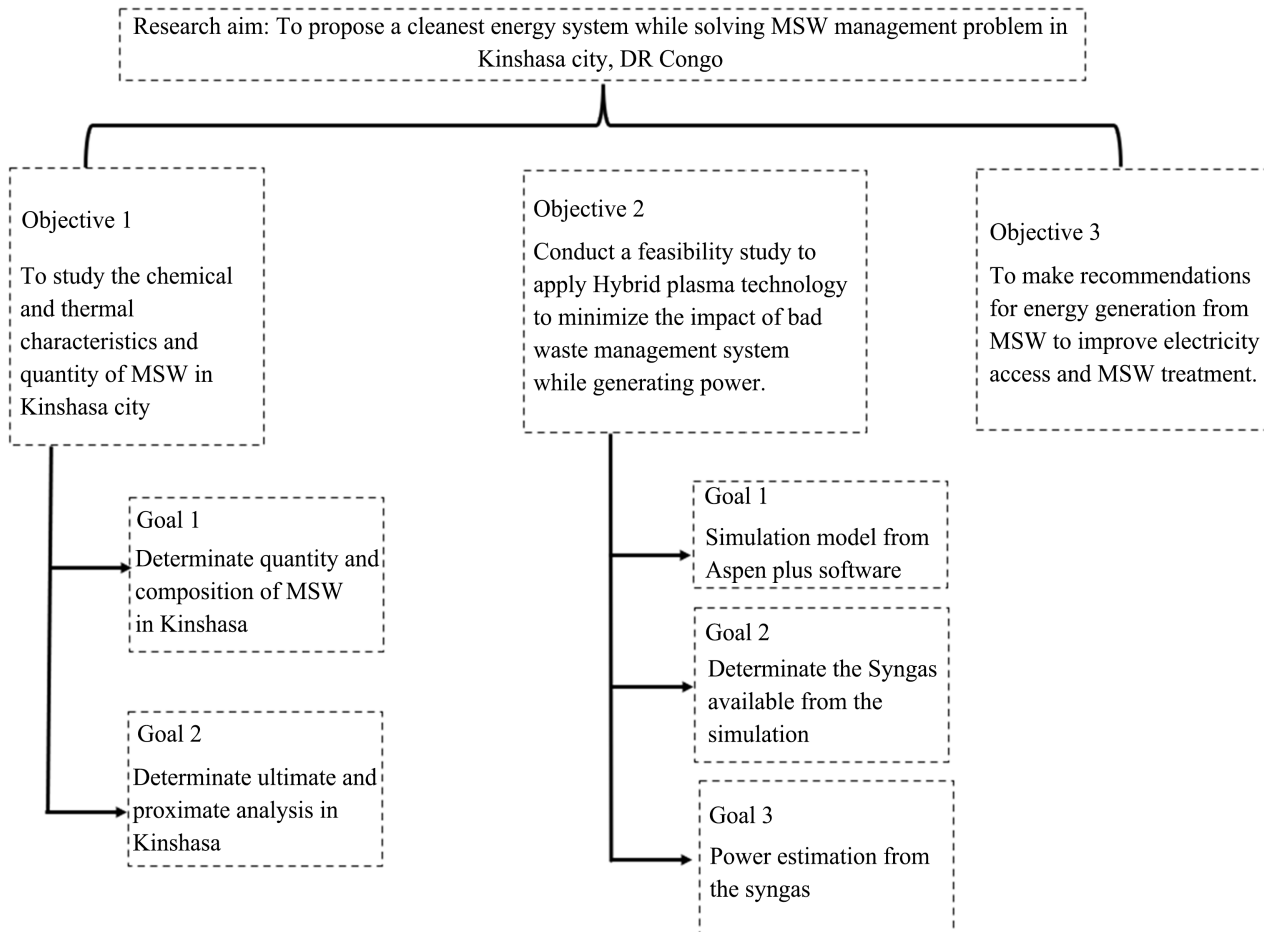


Figure 3. Pathways specific objectives and goals in this research.

2.3. Proposed Energy Generation and Distribution System

The proposed method generates and distributes energy, as shown in **Figure 4**, which emphasizes the overall design and operation of the system. The MSW are first collected and sorted. The microwave plasma gasification is then fed. After applying plasma energy to MSW, syngas is produced, which one used to generate electricity via the combined cycle's steam turbine and gas engine. Furthermore, the smart grid based on the machine learning model employing the LSTM algorithm and IoT sensors would enable intelligent energy distribution across many lines.

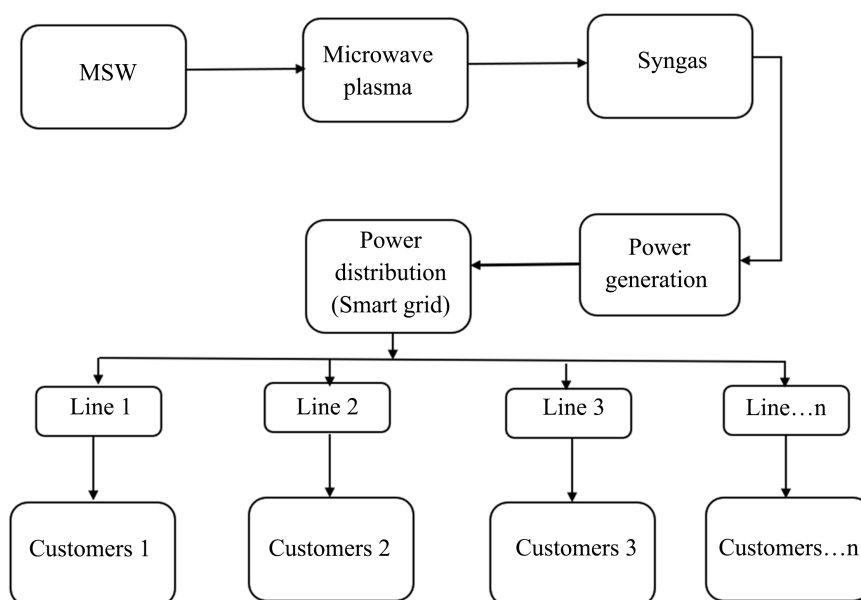


Figure 4. Proposed system architecture.

3. Result

3.1. Study of Chemical and Thermal Characteristics and Quantity of MSW and Current Energy Distribution System Analysis in Kinshasa City (Objective 1)

3.1.1. The Physical Composition of Waste Determination in Kinshasa (Goal 1)

The classification of municipal solid waste is critical in the design of waste management and waste-to-energy systems. As a result, estimating MSW from Kinshasa city is the first and most crucial step in PE-IGCC design. African Clean Cities estimated throughout their report that about 0.7 kg of Waste is generated per inhabitant in the city province of Kinshasa. In 2017, in its Master project plan for Urban transportation in Kinshasa [42], JICA estimated the population at 12 million [43], and waste generation per day was 8,400 tons. In 2020, with the growth of population in Kinshasa due to urbanization which reached 17 million inhabitants by considering the estimation of 0.7 kg as the amount of Waste generated per person/day, the total quantity of MSW produced throughout the city province of Kinshasa daily would be 11,900 tons. This value is supported by the article on Makanisi by Professor Mangenda [44]. **Figure 5** shows the Combined material balance generated considering the total MSW estimated daily.

According to several studies conducted in the environment, the physical composition of municipal solid waste in Kinshasa city is composed of various types. Depending on their classification, these waste types are generated in different households, including food scraps, plastics, paper and cardboard, glasses, metals, and other materials. Most of the researchers are presenting MSW composition by township [45] [46] [47], however, the research that shows MSW characterization globally for the entire of Kinshasa is from African Clean Cities [48] summarized in **Table 1**.

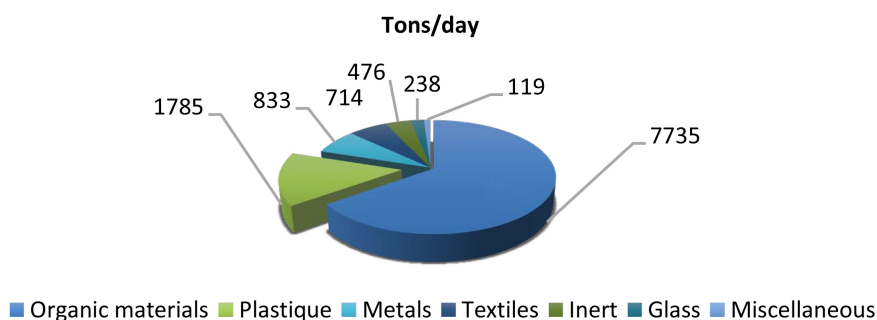


Figure 5. Physical composition of MSW in Kinshasa.

Table 1. Total percentage of MSW composition in Kinshasa.

N°	MSW Characterization	Mass (%)	Weight (tons)	Moisture Content	Dry Weight (%)
1	Organic materials	65	7735	73	17.55
2	Plastics	15	1785	2	14.7
3	Metals	3	357	2	2.94
4	Textiles	6	714	8	5.52
5	Inert	4	476	7	3.72
6	Glass	2	238	2	1.96
7	Miscellaneous	5	595	6	4.7
	TOTAL	100	11,900	100	51.09

After getting this data about waste generation in Kinshasa, pre-processing was done to remove all waste that cannot be applied for Syngas production from the feedstock, such as Glass and Metal. Although the quantity in tons and percentage of all types of waste collected daily is presented as an estimation of all townships, which are 24 in total, this research considered only one township at a time. Thereby, by removing from the feedstock all compositions that cannot be handled for plasma gasification purposes, and considering only the quantity of Municipal Solid Waste from one township of the city of Kinshasa, the percentage and weight composition of MSW as shown in **Table 2**.

3.1.2. Proximate and Ultimate Analysis in Kinshasa City (Goal 2)

In contrast to an ultimate analysis, which is used to determine the chemical makeup of MSW, the proximate study examines MSW moisture content, ash content, and fixed carbon. The proximate analysis technique involves determining the different compounds present in a mixture in another world, the percentage of a fuel that burns in a gaseous state (volatile matter), a solid state (fixed carbon), and an inorganic waste material (ash) are being provided by proximate analysis of a fuel, which is crucial for the use of biomass as energy [49]. At the same time, ultimate analysis entails determining the number and types of different chemical elements present in a specific compound [50]. Nevertheless,

these two techniques are linked and are used to simulate the gasification process. The proximate and ultimate analysis must give 100% for a good quality of MSW in the case of energy production shown in **Table 3** and **Table 4**, respectively Proximate and Ultimate analysis conducted.

$$\text{Moisture}(\%) + \text{Ash}(\%) + \text{FixedCarbon}(\%) = 100\% \quad (1)$$

And

$$\text{C} + \text{O} + \text{N} + \text{H} + \text{Moisture} = 100\% \quad (2)$$

By calculating the Proximate analysis value in “Equation (1)”, the result gives 100% and the Ultimate analysis value in “Equation (2)” gives 100% too showing how good is the quality of MSW generated in the city of Kinshasa.

Table 2. Percentage of MSW Composition in Kinshasa.

N°	MSW Characterization	Mass (%)	Weight (tons)	Moisture Content	Dry Weight (%)	Dry Weight (kg/hr)	Dry Weight (tons)
1	Organic materials	65	308.72	73	17.55	3299.5	79.187
2	Plastics	15	71.243	2	14.7	2763.7	66.328
3	Textiles	6	28.497	8	5.52	1037.8	24.907
4	Inert	4	18.998	7	3.72	699.37	16.785
5	Miscellaneous	5	23.748	6	4.7	883.62	21.207
	TOTAL	95	95	451.21	96	46.19	8683.9

Table 3. Proximate analysis.

Proximate Analysis	
Element	Value (%)
Moisture	10.11
Volatile matter	62.1
Ash	18.29
Fixed Carbon	9.5

Table 4. Ultimate analysis.

Ultimate Analysis	
Elements	Value (%)
Hydrogen [H]	5.84
Oxygen [O]	27.52
Carbon [C]	46.56
Nitrogen [N]	1.6
Sulphur [S]	0.19

3.2. Feasibility Study to Apply Hybrid Plasma Technology to Minimize the Impact of Bad Waste Management System While Generating Power. (Objective 2)

3.2.1. Simulation Model Using Aspen Plus Software (Goal 1)

Aspen Plus (AP) is the industry's leading Chemical Process Simulator, allowing users to create a process model and then simulate it. It uses complex calculations (models, equations, math calculations, regressions, etc.) [51] and consists of many databases collecting physical, chemical, and thermodynamic data for an extensive range of chemical substances, as well as a set of thermodynamic models needed to accurately simulate any chemical system [52].

Figure 6 below depicts the Aspen plus simulation flowsheet, which includes all steps from feedstock supply, Waste drying, pyrolysis, combustion, and gasification, until syngas extraction as a fixed bed gasifier model. The MSW gasification models focuses on mass-energy equilibrium, which focuses on mass-energy and chemical equilibrium across all processes.

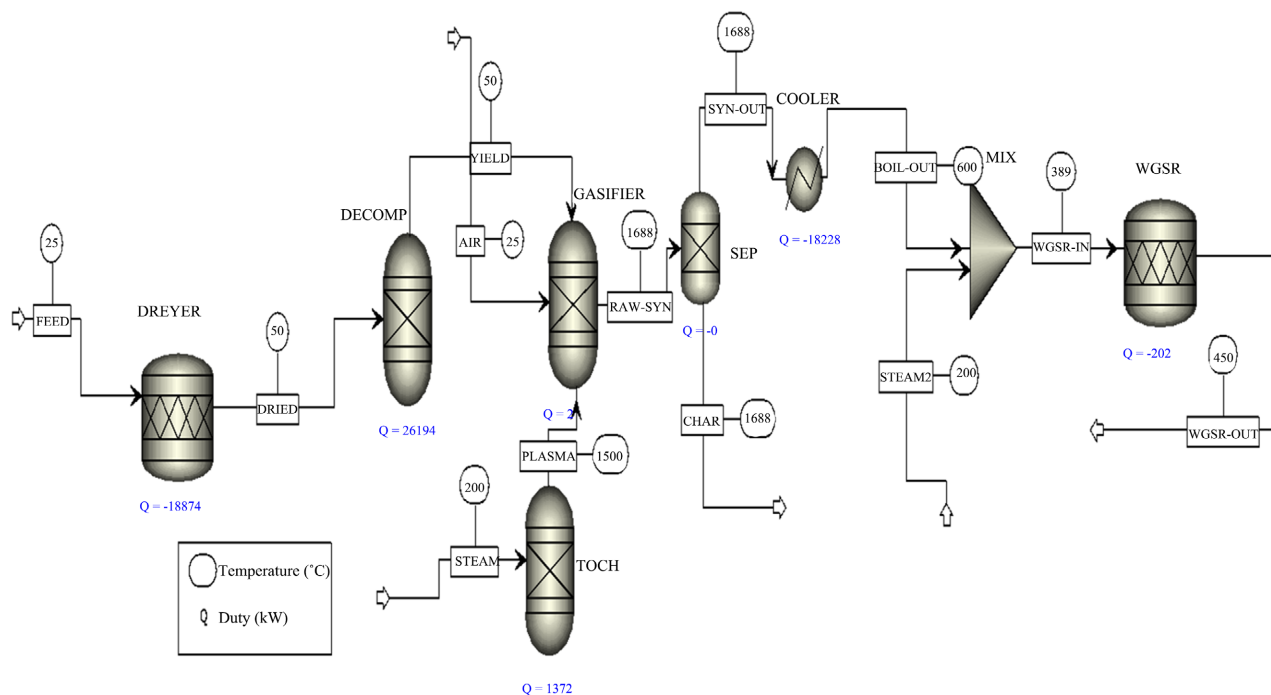


Figure 6. Flowsheet model applied to the MSW gasification simulation.

3.2.2. Determination of the Syngas Available from the Aspen Plus Gasification Simulation (Goal 2)

The finding from Aspen plus simulation after running the above model is in Figure 7 below, in which Syngas's model fraction composition is present. The total estimated amount of energy to be produced from these compositions will be determinate in the next section.

Syngas composition from the simulation shown throughout the above graphic reveals 19% of hydrogen generated, 60% of Nitrogen, 1% of Carbon monoxide (CO), about 20% of Carbon dioxide (CO₂), and 0.312% of Methane.

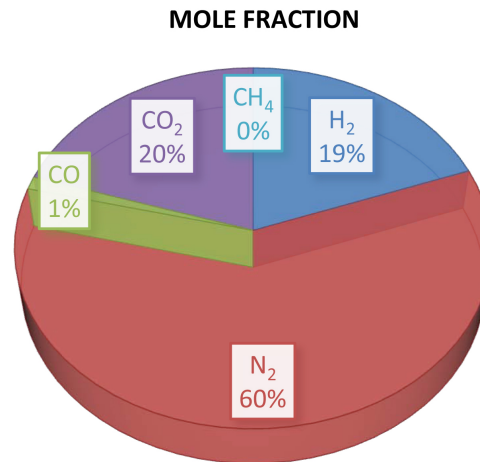


Figure 7. Syngas composition results.

3.2.3. Estimation of Energy Production

The coal gasification process can produce various products, including power (Electricity), chemicals, natural gas substitutes, and transportation fuels. The ratio between the energy content of the product gas or in useful after gasification and the energy content of the energy carrier before gasification in the raw state is known as cold gas efficiency (CGE in %) [37]. Its formula was used to determine the amount of energy produced and can be calculated as follows:

$$CGE = \frac{\left[HV \frac{mj}{kg} \right] * GAS/kg * 22.4}{\left[MSW \frac{mj}{kg} \right]} \quad (3)$$

where HV is the heating value of Gas, Gas/kg is Gas amount per kg of MSW, 22.4 is the volume of any gas ^{^3} and MSW is the MSW mas flow rate in MJ/Kg.

1) The heating value of Gas determination

There are two heating values to be determined, High (HHV) and Low (LHV) and for the computation of Cold Gas Efficiency, the higher heating value is used.

$$HHV \left(\frac{MJ}{N \cdot m^3} \right) = [(12.63 * Co \text{ mole}\%) + (12.74 * H_2 \text{ mole}\%) + (39.82 * CH_4 \text{ mole}\%)] \quad (4)$$

$$HHV \left(\frac{MJ}{N \cdot m^3} \right) = [(12.63 * 0.093) + (12.74 * 0.054) + (39.82 * 0.312)] = 14.288 \quad (5)$$

$$LHV \left(\frac{MJ}{N \cdot m^3} \right) = [(12.63 * Co \text{ mole}\%) + (10.78 * H_2 \text{ mole}\%) + (35.88 * CH_4 \text{ mole}\%)] \quad (6)$$

$$LHV \left(\frac{MJ}{N \cdot m^3} \right) = [(12.63 * 0.093) + (10.78 * 0.054) + (35.88 * 0.312)] = 12.95127 \quad (7)$$

2) Cold Gas Efficiency determination

The “Equation (3)” is used to compute the Cold Gas Efficiency after Heating value and the highest value is selected.

$$CGE = \frac{14.288 * 0.080 * 22.4}{29.5479} = 0.8665 \approx 86.65\% \quad (8)$$

3) Power computation

Power in MW/h is computed from Heating value, Gas flow (GF) and turbine efficiency (GTE) in %. The Gas turbine efficiency is in the range of 33% to 40%. In the case of this research, Gas turbine efficiency is 40% for both Higher and Lower Heating values (HHV and LHV).

$$\text{Power (MW)} = \frac{HV}{3600} * GF (\text{N} \cdot \text{m}^3/\text{hour}) * \text{GTE} (\%) \quad (9)$$

The High Heating Value produced 11.82 MW while Low Heating Value could only produce 8.83 MW after the computation of both factors. Based on the Higher Heating Value result, the total energy that can be produced is 11.82 MW/h. Consequently, the power plant design for the Kinshasa metropolitan area would have an installed generating capacity of **11.82 MW/h**.

3.3. Energy Generation from MSW for Kinshasa’s Electricity Improvement Recommendations (Objective 3)

Waste-to-energy technologies, especially plasma-based gasification is an alternative technology for energy improvement in DR Congo, particularly in Kinshasa city for the sake of a sustainable environment and economic growth. In addition, to maintain the economic, social, and environmental benefits of energy generation from solid municipal water [53], the adopting of relevant strategies for energy generation enhancement must be adopted as follows:

- Improving electrification access in DR Congo, especially in Kinshasa, is relevant due to the between energy supply and demand. Providing a suitable waste treatment system and appropriate. Therefore, there is a need to provide adequate advanced technology to enhance the conversion of WTE. Furthermore, plasma-based gasification technology will play a vital role in improving energy generation from MSW in DR Congo.
- Kinshasa needs adequate enforcement of solid waste management policy. It is essential to provide separate trash cans for various types of solid Waste to encourage segregation. Thus, using this method, authorities can reduce the harmful effects of improper primary waste disposal on the environment and advocate for implementing waste segregation and disposal policies.
- The impact of neglect includes augmenting the flooding risk, soil fertility, infrastructural disruption, air pollution, and health issues. It is essential to maintain and enforce an adequate Waste management policy. Therefore, Government policies and regulations, such as fines, should be imposed to hold residents accountable for properly disposing of the waste they generate. Furthermore, the researcher suggests that Waste be separated from the

source of production first and by the service in charge for easy management of solid waste that might serve as a suitable feedstock into plasma gasifier plants for energy recovery.

- The study observes a limitation and inconsistency in information on data about waste management in Kinshasa among scholars which is not helping research. Thus, the Department of Environment of universities in the country must be supported by the government to enhance research for more information sharing.
- Environmental awareness promotion must be done and argued that environmental and ecological awareness is a strategic way to disseminate the significance of waste management. Although it is not enough for people to be aware of the need for MSW management, however, there is a need to educate the public on how to convert these MSW to energy or new products as these are sustainable solutions for curbing waste generation.

4. Conclusions

This research proposes an environmentally friendly system for treating municipal solid waste (MSW) while generating electricity in Kinshasa, to address both the increased demand for electricity on one hand and the issues of waste mismanagement on the other.

A comprehensive review of relevant literature and data reveals that DR Congo possesses a substantial amount of waste, with approximately 11,900 tons of solid waste generated daily. This figure is expected to rise due to urbanization and population growth. Door-to-door collection accounts for only 25% of the waste collected. Proximate and ultimate analysis of the waste indicates important properties such as moisture content, ash, volatile matter, and fixed carbon, which serve as key indicators for energy generation. Mass balances for the chemical and thermal processes also yield valuable insights. Using Aspen Plus software, a simulation was conducted based on hybrid plasma gasification, incorporating a combination of different reactors, steam turbines, and gas engines in a combined cycle for efficient power conversion from syngas.

The study highlights the importance of carbon monoxide (CO) over carbon dioxide (CO₂) for electricity production from waste. The combustion process's temperature plays a crucial role, as very high temperatures result in increased CO₂ production, while excessively low temperatures are not recommended. Through the research's simulation, a specific temperature was determined, along with appropriate chemical reactions, resulting in an estimated electricity generation of 11.82 MW/h.

Out of the total electricity consumption of 1130 megawatts in certain parts of the DRC, 60% is allocated to Kinshasa. By implementing the proposed system, an additional 283.68 megawatts will be generated, augmenting the existing 678 megawatts used in Kinshasa. This would significantly improve the power access, totaling 961.68 megawatts in Kinshasa. Additionally, aside from power genera-

tion, hybrid plasma technology will play a crucial role in eco-friendly waste management.

The introduction of plasma technology for waste treatment in Kinshasa presents an opportunity and offers promising results to address waste management challenges, generate electricity in order to fulfill the gap of energy deficit all over the country in general, especially in Kinshasa city.

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Conflicts of Interest

The authors declare no conflicts of interest.

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