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# Economic Conversion of Agricultural and Solid Wastes to Energy: Possible Exploration of Farm and Solid Waste Products

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# ECONOMIC CONVERSION OF AGRICULTURAL AND SOLID WASTES TO ENERGY: Possible Exploration of Farm and Solid Waste Products

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***Abstract***
*The quest of living in a healthy environment and exploring a sustainable diverse energy-use toward improve economy has brought the continuous research to convert farm and municipal solid wastes (MSW) to useful energy. This study presents a case scenario on agricultural and solid waste generation, material recovery and the recycling potential of MSW in Maiduguri, Nigeria. The weights of the farm and MSW generation were estimated, while the energy and power potentials were estimated using thermo-chemical conversion model, from selected locations and tested within five planned areas; which are the General hospital, Gomshey dumping spot, State secretariat, University of Maiduguri campus, and University farms area of the Maiduguri metropolis. The mathematical model predicted 18702.87 kW/h of the energy potential and 779.29 kW/h of the power generation potential, these are appreciating values of energy potential and power generation potential found to be generated within the area studied. In summary, the study was concluded on possible investment opportunities to enhance the state resources utilization for energy purpose, increase in gross domestic project (GDP) and employment opportunity.*

**Keywords:** *Wastes, environment, health, GDP, sustainable economy*

## 1.0 INTRODUCTION

Globalization of modern economy, technologies and other human related activities has been attributed to the dynamic and sophisticated nature of modern electricity supply structures. The rapidly changing structure of these phenomena is responsible for the tremendous increase in the level of energy demand around the globe. There have been rigorous efforts to meet the global energy demand challenges, but relying on the traditional fossil fuels alone is synonymous to taken a great risk of backward trend in modern developmental strategies. The main reason behind this assertion is that fossil fuels and other conventional energy resources are not only limited, but their

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global reserves is declining as each day closes while the prices are on the increase geometrically. Excessive combustion of fossil fuel for

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energy has potential contribution to negative environmental consequences such as global warming or greenhouse effects (GHE). Therefore, renewable energy has attracted a very realistic global interest being the only viable option available to man for providing solution to energy. Development of renewable energy from biomass is one of the major promising alternative energy resources because of its presence in almost every part of the world Idris and Ibrahim (2018). The aim of this study is focused on the execution of dynamic and sustainable waste management through reduction, reuse, recycling, composting as well as waste to health and waste energy activities. This study is limited to most of the dumping sites as infill, adequate schedule for evacuating of waste in the metropolis, lack of trained personal that will make explanation and problem of insecurity in the state.

There is increasing interest in electric power generation from MSW throughout the world. Power generation from MSW is one of the stringent measures adopted by international communities to prevent escalation of harsh environmental conditions. Application of bio-waste resources for electricity has positive mitigation impact on atmospheric pollutions. Overdependence on fossil fuels combustion for energy raised serious concerns about the health of living organisms and their immediate environment. Moreover, Nigeria is largely accustomed to power generation from gas-fired power plant due to the country's natural gas resources potential. The national power generation mix comprises hydro- and gas-fired power plant, but predominantly natural gas power plant. Besides, there has been a situation in the Nigeria power sector where the current power system infrastructures can no longer deliver half of the total national power demand. The total installed capacity of the country is over 8000MW, but available capacity has never reach 4000MW at any time in the history of the nation's power sector. Phenomenon of sporadic power failures and energy crisis has prevailed over efforts to bridge the gap between power demand and supply scenario. This ugly development is not peculiar to Nigeria alone.

Energy reform led to the establishment of a statutory regulatory commission, Nigerian Electricity Regulatory Commission (NERC) entrusted with the mandate to monitor all power generation, transmission and distribution related activities in the nation's power sector. Since 2007 to date, the Independent Power Producer (IPP) participation was supported as part of the reform measures. The reform also endeavours to segregate the entire power system operations into three independent companies comprising six generation, one transmission and eleven distribution companies implemented and now under the Power Holding Company of Nigeria (PHCN). The reforms are yet to bring any fruitful changes to the situation in the energy sector of the country.

## 2.0 BACKGROUND LITERATURES

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Historically human progress has been intrinsically tied to the management of waste due to its effect on public and environmental health. Waste management has affected human history in many ways just as it will in the future. The modern waste management industry has become far and with recycling and other advance. Ancient history as far back as 10,000 BC to 400 AD, waste was mainly composed of ash from fire, woods, bones, and vegetable waste. The edible matter was disposed to feed animals and what remained was disposed of in the ground where it would decomposed, as city population grew, waste management systems became necessary to handle the waste stream. Crete, Athens and Rome are example of ancient civilization that began to establish rudimentary waste management systems (Pitchtel, 2014). Table 1 is a summary version of reviewed investigations. The process representation in Figure 1 depicts the flow scheme of solid waste management (SWM) to energy generation.

**Table 1** Summarised version of reviewed investigations

| Author(s) | Research Investigation | Research Benefits | Remarks |
|---|---|---|---|
| *Dauda et al (2003)* | Findings revealed that all 25% of solid waste generated in Maiduguri was biodegradable materials, and were composted of fertilizer, while 22.6% and 13.8% of the waste were polythene bags and table water sachets respectively. | Both the biodegradable and polythenes materials can be reduced, reused or recycled. | A need for further investigation on solid wastes |
| *Susu et al (2003)* | Proclaimed that many techniques especially landfill are used in environmental waste management in Nigeria but there still exist a need for effective waste control to provide a platform for sustainable development. | Landfilling of waste management strategy also has associated space allocation challenges as reported in several major cities of the world. | Some designated areas for landfill have run short of accommodating space. |
| *Pitchel (2014)* | Rapid developing in product innovation, machinery development and trade; these advances were stimulated by the availability of raw materials and rank of labourers. | This time of growth also created significant greater amount of waste. | Government official and public alike were concerned |
| *Idris and Ibrahim (2018)* | Studies on some selected locations to analyse the biomass wastes (both agriculture and municipal waste) | Analysed the waste capacity of MSW from the various locations and validate the technology to | An excellent renewable energy technology which our governments should key-into for |

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| | | |
|---|---|---|
| | transform it into valuable energy. | social and economic development |

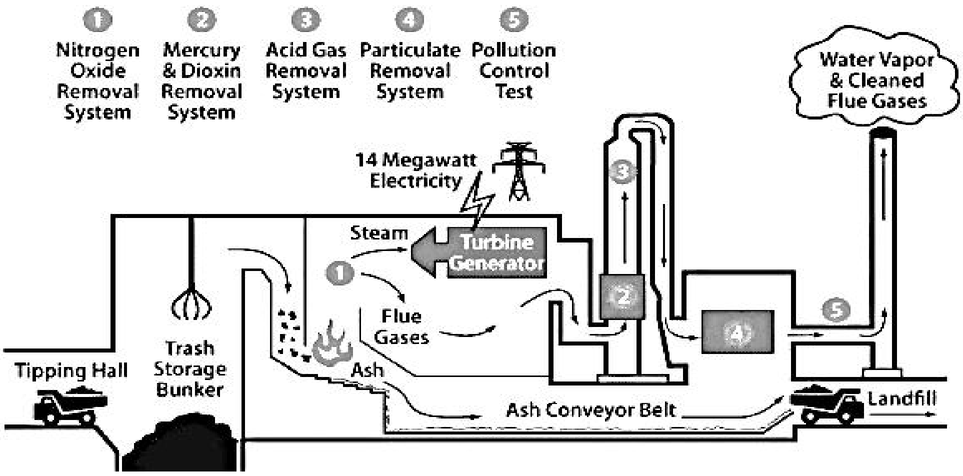


**Figure 1** Typical process flow scheme of waste to energy generation.
**Source:** Aqua Horizon Technologies, (AHT, 2022)

## 2.1 Waste Collection and Transportation System

Nigeria is a developing country with inadequate technologies of waste management. The recycling and reuse potential of the country is underdeveloped and limited. Waste collection and transportation play a very significant role in any complete waste management practice. Efforts to stimulate effective collection of waste were favourably channelled towards the establishment of multiple collection strategies in Maiduguri metropolis. Quality management of wastes is still required using the methods are house-to-house, communal depots, curb-side bin, bulk loading and industrial collection system. The Lagos State Waste Management Authority (LAWMA) collects from commercial and industrial centers while private sector participation (PSP) is actively involved in domestic wastes collection. However, the capital city of Abuja has a comprehensive waste management system (WMS), but a room for better improvement and operations are still required.

## 2.2 Process Operation of Waste to Energy Generation

In advance nations, waste management is basically by land filling and combustion for energy in modern incineration or gasification systems. In landfill areas, there is greater possibility of methane formation by spontaneous reactions. Excessive release of methane gas and other hazardous gases such hydrogen sulphide ($H_2S$), ammonia ($NH_3$), and oxides of sulphur and carbon has greater environmental consequences which may not be immediate. Methane and carbon dioxide are the most important gases that can rapidly influence the phenomenon of global warming, as seen in Figure 1.

## 2.3 Technological Approach to Electric Power Generation from MSW

Base on general perspective, the technologies are categorized into thermo-chemical and bio-chemical conversion. In ideal situation, the choice of technology depends on economic viability and technical know-how. Different bioenergy technologies have been studied to different level of

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success and efficiency because some conversion techniques are known for their technical challenges such as low energy net yield, water pollution, conversion efficiency and capital investment (Rittmann, 2008 and Rao et al., 2010). However, the most three famous waste-to-energy (WTE) technology in the world today is (a) gasification, (b) anaerobic digestion and (c) combustion. The phenomenon of WTE is a complex process that must be accomplished in stages as (Budzianoskwi, 2012). More also, inorganic fraction of municipal solid waste can be burnt directly as refuse derived fuel (RDF) in an incineration energy production plant for heat or electricity generation.

### 2.3.1 Gasification of MSW

Gasification of waste to produce energy involves thermo-chemical conversion reactions. The process is used to induce production of varieties of gases such as carbon dioxide, steam, methane and other by-products like ash and tar under the conditions of high temperature and low concentration of pure oxygen or air. Methane is the basic product gas from gasification process and after being allowed to pass through some cleaning processes, then it can be applied directly to run an Internal combustion engine (IC) for electricity generation. Gasification has been used in many part of the world for effective WTE management with positive environmental and economic impacts. It is a very fast growing technology with promising nature in area of bio energy applications. It has the tendency to reduce the mass of the waste by 70-80% and volume 80-90% while preserving the land area for waste land filing (Budzianoskwi, 2012; Mohammed et al., 2012).

### 2.3.2 Anaerobic Digestion

Anaerobic digestion is purely a bio-chemical conversion process used to produce a fuel for energy in a well-controlled enclosure called digester. As a well-known dynamic process, it is currently in used in developed and developing countries for treatment of both wet and dry biomass resources. It involves the application of microbial actions on bio-waste in absence of oxygen for biogas production. The complete process of anaerobic digestion is complex involving series of heterogeneous chemical reactions such as hydrolysis, acidogenesis, acetogenesis and methanogenesis. These are integrated process that becomes feasible with microbial influence to degrade organic waste, which results to the production of biogas and other energy-rich organic compounds (Lastella et al., 2002; Lata et al, 2002).

### 2.3.3 Incineration

Incineration of MSW has the ability to drastically reduce the volume of MSW as much as 80-90%. Waste incineration technology has three basic components: incineration, energy recovery and air pollution control system (Lee et al., 2007). The combustion process of waste in incineration plant release gaseous pollutants from oxides of sulphur, carbon, nitrogen and possibly little ash particles. This is the major reason why it is necessary to incorporate pollution control system in a complete

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set-up of the plant to avoid environmental pollution. An incineration plant operates within a temperature range of 800-1000$^{o}$C.

## 2.4 Estimated Energy and Electric Power Generation Potential

The assessment was carried out through thermo-chemical conversion route. Singh et al. (2011) stated that waste generated in developing countries have almost the same chemical composition since the variation between regions is being determined by climatic, cultural, industrial, infrastructural and legal factors. The energy and power potential was estimated as follows:

$$E_p = HV \times W \times 0.0011628 \quad (1)$$

$$P_{gp} = \frac{E_P}{24} \quad (2)$$

Where $E_p$ = Energy potential (kWh), $P_{gp}$ = Power generation potential, HV = Calorific value of the waste (kcalkg$^{-1}$), W = weight of the waste (tons or kg) and Calorific value (higher heating value) = 905 kcal/kg.

## 3.0 RESEARCH METHODOLOGY

In order to obtain the required data and accurate information, the adopted methods includes: fieldwork, observation and periodic assessment. The study area was divided into three groups, that is, the university campus, university farm areas and the state metropolis. The metropolis was further sub-divided into five different locations namely: Gomshey dumping spot, general hospital, Dandal police barrack, state secretariat and open air theatre. Table 2 depicts the equipment and machine used.

**Table 2** Equipment and Machine used

| *S/No* | *Equipment and Machine used (BOSEPA)* | *Numbers of machines and equipment* | *Numeric values of the equipment* |
|---|---|---|---|
| 1. | Bulldozer | One | 01 |
| 2. | Tipper | Twenty | 20 |
| 3. | Tractor | One | 01 |
| 4. | Pay loader | One | 01 |
| 5. | Compactor | Over Fifty | 50+ |
| 6. | Bins | Over Two thousand | 2000+ |
| 7. | Shovels | Over one thousand | 1000+ |
| 8. | Brooms | Over three thousand | 3000+ |
| 9. | Excavator | One | 01 |
| 10. | Vector control unit | One | 01 |

## 3.2 Various Methods of Converting Waste to Energy

3.2.1 Equipments and Machines Studied with the BOSEPA, Borno State Environmental Protection Agency, Maiduguri, Borno State, Nigeria.

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**Figure 2** BOSEPA Bins store

**Figure 3** BOSEPA Truck yard with Tippers

**Figure 4** BOSEPA Pay loader


**Figure 5** BOESPA Vector Control

### 3.2.2 Data analysis

The logic based model taken into consideration several parameters of waste production, such as population density, maximum building density, commercial traffic, area and shops, road network and its relative information (e.g. road width, dead-end street, etc.) linked with the location of waste bins. The model also follows a unified and correlated categorization approach for all commercial and industrial activities in the area of study using a weighing system for all of the considered factors. The model used is reflected in Equations 1 – 2. Some selected field surveys are highlighted in Figure 2 - 5.

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**Figure 6** Wastes from General Hospital
(Date 26th May 2024 Time 8:40:50am)

**Figure 7** Combine waste at Gomshey dumping spot
(Date 23th May 2024 Time 8:48:22am)

**Figure 8** Combine waste at Gomshey dumping spot
(Date 26th May 2024 Time 8:23am)

**Figure 9** Combine waste at State Secretariat
(Date 26th May 2024 Time 10:15am)

## 4.0 EXPERIMENTAL RESULTS

The energy and the power generation potential were obtained from a model equation of plasma gasification process given in Equations (1) and (2). The weight of the solid waste (SW) obtained by estimate after some serial of quantitative analysis. Tables 3 – 7 represent the estimated power generation potentials from the solid wastes generated from various spotted locations in Maiduguri.

**Table 3** Total solid waste, energy and power generation potential of SW at the general hospital in 2024

| *Location* | *Type of waste* | *Estimated weight ($kg/m^3$)* | | *Energy potential (kg/h)* | | *Power generation potential (kW)* | |
|---|---|---|---|---|---|---|---|
| | | April/May | Jun/Jul | April/May | Jun/Jul | April/May | Jun/Jul |
| Maiduguri General Hospital | Plastics | 400.00 | 400.00 | 420.93 | 420.93 | 17.51 | 17.54 |
| | Rubbers | **300.00** | **483.00** | **315.70** | **508.28** | **13.15** | **21.18** |
| | Newspapers | 150.00 | 257.00 | 157.85 | 270.45 | 06.58 | 11.27 |
| | Food wastes | 350.00 | 256.00 | 368.32 | 269.40 | 15.35 | 11.23 |
| | Agricultural waste | 60.40 | 100.60 | 63.56 | 105.86 | 02.65 | 04.41 |
| | Others etc. | 100.00 | 275.00 | 105.32 | 289.39 | 04.38 | 12.06 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Total** | **1360.40** | **1777.60** | **1431.60** | **1864.30** | **59.64** | **77.69** |

**Table 4** Total solid waste, energy and power generation potential of SW at Gomshey in 2024

| *Location* | *Type of waste* | *Estimated weight (kg/m³)* | | *Energy potential (kg/h)* | | *Power generation potential (kW)* | |
|---|---|---|---|---|---|---|---|
| | | April/May | Jun/Jul | April/May | Jun/Jul | April/May | Jun/Jul |
| Gomshey dumping spot | Plastics | 600.00 | **610.00** | 631.40 | **633.50** | 26.31 | **26.51** |
| | Rubbers | 500.00 | 480.00 | 526.18 | 530.70 | 21.92 | 22.80 |
| | Newspapers | 300.00 | 320.00 | 315.70 | 320.50 | 13.51 | 15.45 |
| | Food wastes | 300.00 | 315.00 | 315.70 | 300.40 | 13.51 | 14.50 |
| | Agricultural waste | 171.00 | 180.00 | 179.95 | 180.45 | 07.50 | 08.50 |
| | Other etc. | 170.70 | 156.50 | 179.63 | 181.00 | 07.49 | 08.25 |
| **Total** | | **2041.70** | **2061.50** | **2148.55** | **2146.55** | **2148.55** | **81.51** |

**Table 5** Total solid waste, energy and power generation potential of solid waste at state secretariat in 2024

| *Location* | *Types of waste* | *Estimated weight (kg/m³)* | *Energy potential (kW/h)* | *Power generation (kW)* |
|---|---|---|---|---|
| State secretariat | Plastics | 390.00 | 410.41 | 17.10 |
| | Rubbers | 350.00 | 368.32 | 15.35 |
| | Newspapers | **1675.00** | **1762.66** | **73.44** |
| | Food waste | 200.00 | 210.47 | 08.77 |
| | Agricultural waste | 100.00 | 105.23 | 04.39 |
| | Other | 600.00 | 631.40 | 26.31 |
| | **Total** | **3315.00** | **3488.49** | **145.36** |

**Table 6** Total solid waste, energy and power generation potential of SW at state secretariat in 2024

| *Location* | *Type of waste* | *Estimated weight (kg/m³)* | | *Energy potential (kg/h)* | | *Power generation potential (kW)* | |
|---|---|---|---|---|---|---|---|
| | | April | May | April | May | April | May |
| Gomshey dumping spot | Plastics | 350.00 | 360.00 | 368.32 | 370.20 | 15.35 | 15.58 |
| | Rubbers | 430.00 | 448.00 | 452.50 | 455.00 | 18.85 | 19.50 |
| | Newspapers | **1500.00** | **1550.00** | **1578.50** | **1582.00** | **65.77** | **67.87** |
| | Food wastes | 325.00 | 332.00 | 342.01 | 345.21 | 14.25 | 15.50 |
| | Agricultural waste | 50.00 | 51.50 | 52.62 | 54.25 | 02.19 | 02.57 |
| | Other | 405.05 | 415.50 | 426.25 | 461.30 | 17.76 | 18.24 |
| **Total** | | **3060.05** | **3157.00** | **3060.05** | **3267.96** | **134.17** | **139.26** |

**Table 7** Total solid waste, energy and power generation potential of SW Unimaid Commercial site 2024

| *Location* | *Type of waste* | *Estimated weight (kg/m³)* | | *Energy potential (kg/h)* | | *Power generation potential (kW)* | |
|---|---|---|---|---|---|---|---|
| | | April | May | April | May | April | May |
| Unimaid Commercial Centre | Plastics | 325.00 | 315.00 | 342.01 | 341.00 | 14.25 | 14.35 |
| | Rubbers | 129.00 | 130.00 | 135.75 | 137.50 | 05.66 | 05.67 |
| | Newspapers | 500.00 | 485.00 | 526.17 | 524.75 | 21.92 | 22.00 |
| | Food wastes | **1500.00** | **1450.00** | **1578.50** | **1581.00** | **65.77** | **63.87** |
| | Agricultural waste | 300.00 | 310.00 | 315.70 | 314.50 | 13.15 | 14.52 |
| | Other | 405.05 | 407.50 | 426.25 | 425.75 | 17.76 | 17.86 |
| **Total** | | **3230.09** | **3097.50** | **3379.13** | **3324.00** | **141.63** | **138.27** |

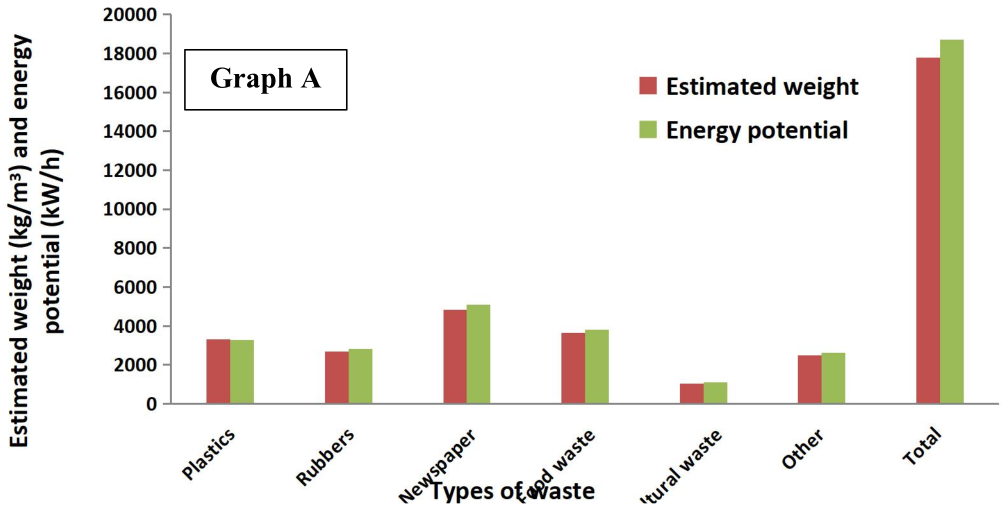


**Figure 10** Energy and power generation at Gomshey dumping spot

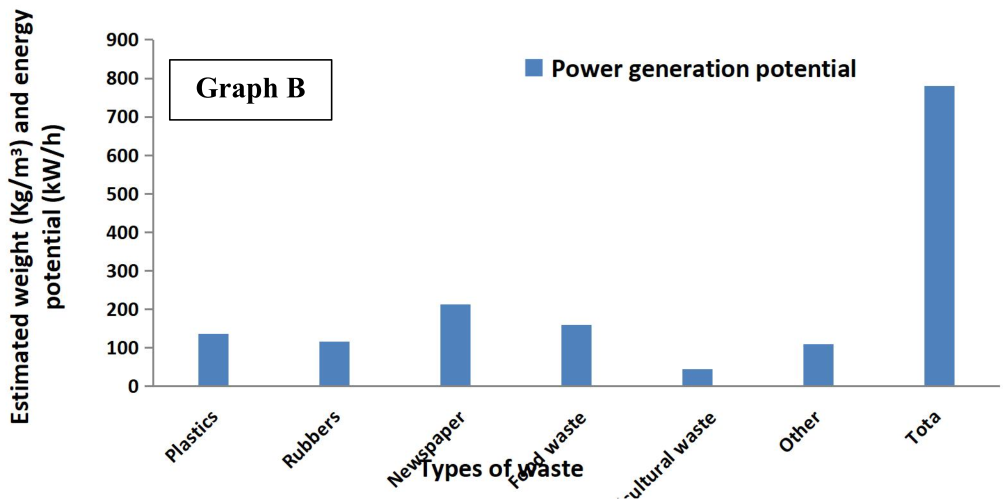


**Figure 11** Energy and power generation at Gomshey dumping spot

**Table 8** Total solid waste, energy and power generation potential of SW at university commercial dumping spot

| *Location* | *Types of waste* | *Estimated waste in (kg/m³)* | *Energy potential (kW/h)* | *Power potential (kW)* |
|---|---|---|---|---|
| University commercial dumping spot | Plastics | 120.00 | 126.28 | 05.26 |
| | Rubbers | 60.00 | 63.14 | 02.63 |
| | Newspapers | 200.00 | 210.47 | 08.77 |
| | **Food waste** | **400.00** | **420.93** | **17.54** |
| | Agricultural waste | 150.00 | 157.85 | 06.58 |
| | Others | 273.20 | 287.50 | 11.10 |
| | **Total** | **1203.20** | **1266.17** | **51.88** |

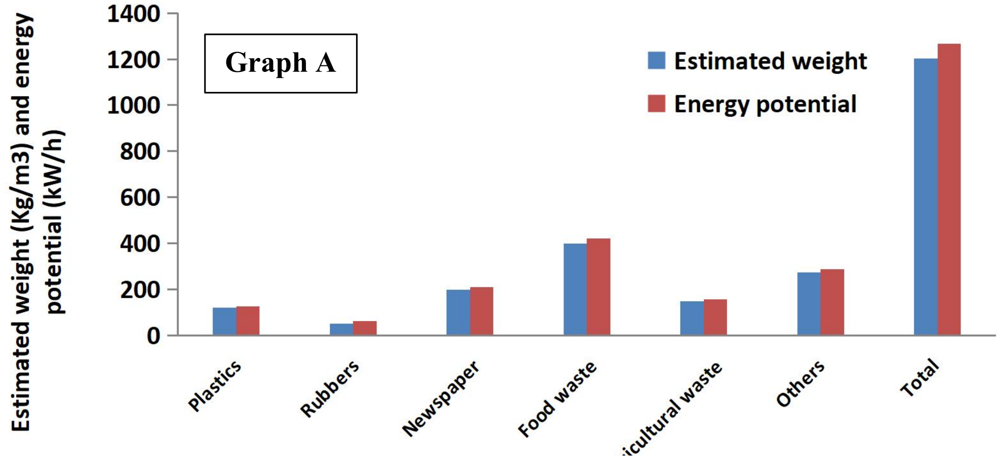


**Figure 12** Energy and power generation at university commercial dumping spot

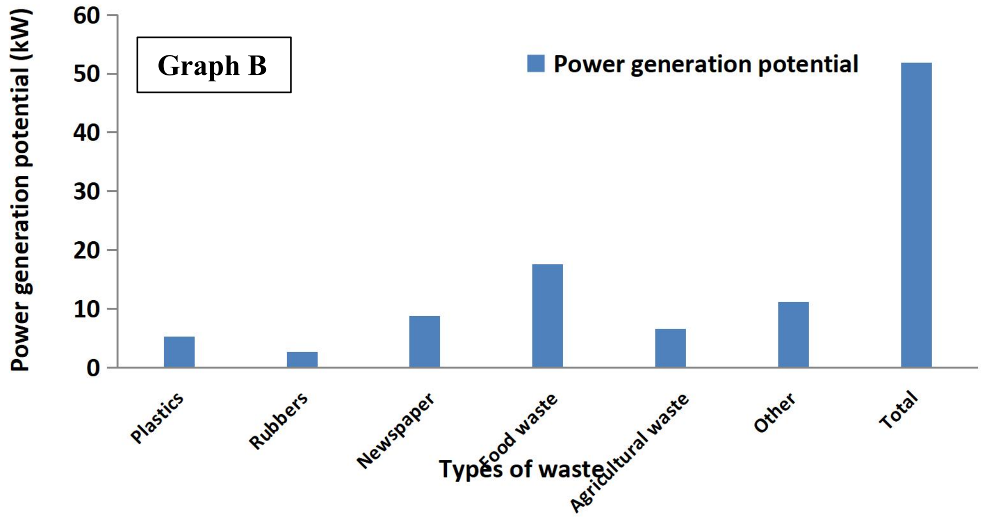


**Figure 13** Power generation potential at university commercial dumping spot

**Table 9** Combine total solid waste, energy and power generation potential of solid waste

| *All Locations* | *Types of waste* | *Estimated waste ($kg/m^3$)* | *Energy potential (kW/h)* | *Power generation potential (kW)* |
|---|---|---|---|---|
| 1. General hospital<br>2. Gomshey dumping spot<br>3. State secretariat<br>4. University commercial dumping spot | Plastics | 3110 | 3272.76 | 136.37 |
| | Rubbers | 2667.7 | 2807.31 | 116.97 |
| | Newspaper | 4832 | 5084.88 | 211.87 |
| | **Food waste** | **3631** | **3821.03** | **159.21** |
| | *Agricultural waste* | *1032* | *1086.01* | *45.25* |
| | Other | 2500.04 | 2630.88 | 109.62 |
| | **Total** | **17772.74** | **18702.87** | **779.29** |

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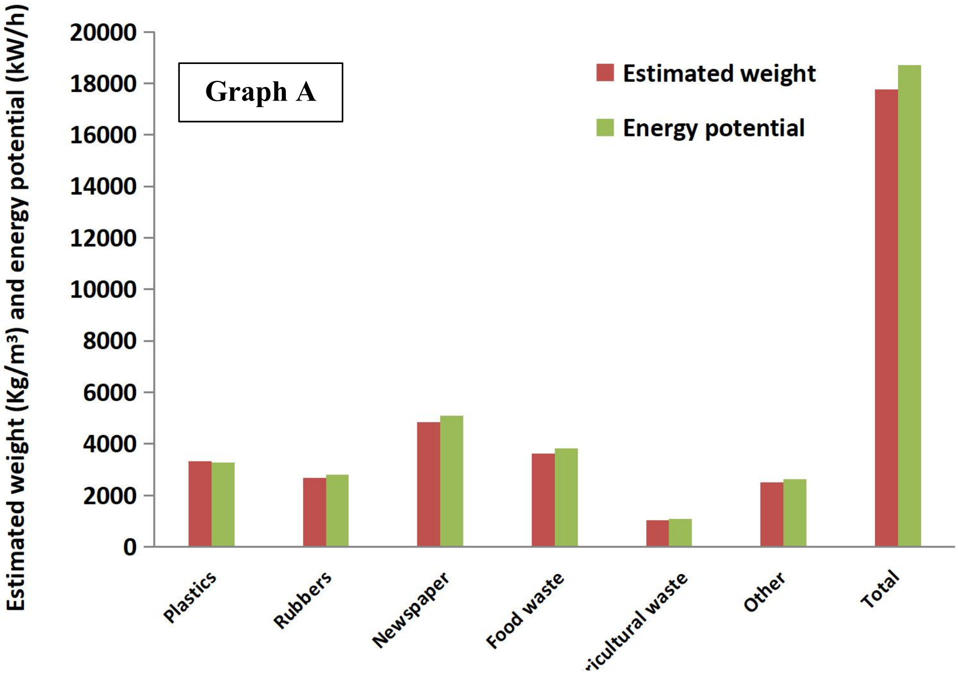


**Figure 14** Combined municipal energy and power generation from various locations

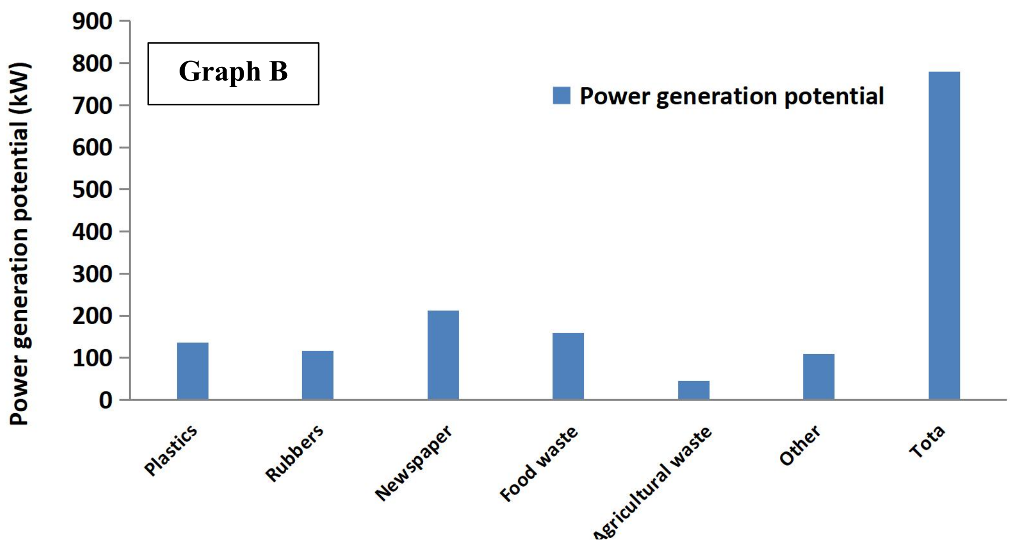


**Figure 15** Combine municipal energy generation potential at various locations

## 5.0 DISCUSSION OF RESULTS

The reports are classified into preliminary, primary and secondary classifications and are presented as stated below. Some selected results were present in the overall report.

### 5.1 Preliminary Analysis

Table 3 depict the energy potential and power potential of 508.28 kg/h and 21.18 kW respectively, while Table 4 has energy potential and power generation potential 633.50 kg/h and 26.51 kW

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respectively. This description is for Gomshey dumping spot. In the same vain, Figure 4.1 (Graph A) depict that newspapers has the highest estimated weight and also the highest energy while figure 4.2 (Graph (B) of the same figure shows that plastics has the highest power generation potential among the other waste generated. Similar evaluations are studied for other locations like the general hospital, state secretariat and commercial dumping site etc. Tables 5 – 6 show that newspapers were high in profiles, while Table 7 show that food wastes is higher.

**5.2 Primary Analysis**

The rate of accumulation of some of the municipal weight increase, decrease or remain constant depending on the change in economic activities and population density that occurs within the interval of days given at the course of survey. Table 8 shows that the waste was 400 kg/m$^3$, energy estimate was 420.93 kW/h, power was 17.54 kW and the overall power was 51.88 kW as evaluated for Gomshey dumping spot. The University commercial spot locations show that the food waste is higher than others (as seen in Figures 5 – 6). The same was also identified in Table 9 with an overall power generation potential of 779.29 kW.

Figure 5 (Graph A) shows that plastics decreased from 600 kg/m$^3$ estimated weight to 525 kg/m$^3$ and energy from 631.40kg/m$^3$ to 552.48 kg/m$^3$ and the power generation potential increase from 6.31 kW to 23.02 kW but still generate the highest energy and power potential. Figure 6 (Graph B) shows that newspaper increases from 1500 kg/m$^3$ estimated weight to 1675 kg/m$^3$, and energy from 1578.30 kW/h to 1762.68 kW/h with an increase in the power generation potential of newspaper from 65.77 kW to 73.44 kW.

**5.3 Secondary Analysis**

This is a combine estimated weight, energy and power generation potential. Figure 6 (Graph A) shows that from the combined estimated weight, and energy of all the waste generated at the different study area, food waste produces the highest estimated weight and energy, while Figure 8 (Graph B) shows that it also produced the highest power generation potential. In summary to have a high amount of energy and power generation potential, it is expected to have a high rate of accumulation of waste, which also depends on the population density of the area and the economic activities involved in that area. Therefore, it can be said that energy potential is directly proportional to estimated weight and power generation is directly proportional to energy potential. This study is similar to the work of Ogwueleka (2009) in conjunction with Lagos State Waste Management Agency (LAWMA) revealed that 0.63kg/capita/day is estimated for Lagos metropolis. This value is preferably used for this study based on the fact that many recent studies on municipal solid waste (MSW) evaluated figures between 0.6-0.8kg as capita/person/day. The work of Rao et al. (2010) on

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the calorific value of MSW in a developing country like India indicated that it varies from 800.70-1009.89kcal/kg and the average value is approximately 905 kcal/kg (Agboola, 2011). The thermo-chemical conversion is preferably used due to its ability to ensure the contribution of both biodegradable and non-biodegradable components of the waste to the energy output (Hamzeh et al., 2011).

## 6.0 CONCLUSIONS

Within the limit of field survey research, in one week it was found that 17772.74kg/m$^3$ is the estimated weight, 18702.87kW/h energy and 774.29kW of power generation potential. In an extended period of one month, it was found that 71090.96kg/m$^3$ weight of solid waste, 74811.48kW/h energy and 3097.16kW power generations potential was estimated. This amount of accumulation of wastes when related to energy and power generation is reasonable enough to address the indiscriminate dumping and burning of wastes which causes a lot of harm to the environment. The waste-to-energy (WTE) philosophy will provide environmental safe waste management, disposal and the production of clean electrical power to reduce the impact of municipal solid waste on the environment.

## 7.0 Recommendation

- To achieve quality environmental practise there is necessity for proper orientation of the general public and comprehensive feasibility studies on municipal solid waste (MSW).
- Generating energy through MSW should be conducted in full scale; this will help in the efforts to improve power generation in the country.
- Development of compressive waste-to-energy (WTE) management legislation is inevitable to attract private sector investment. Since power generation from municipal solid waste (MSW) has environmental benefits, and then incentive provision for the private investors' inclusiveness should be another welcome development from the government of the state.
- There is a need to enlighten the populace on the wealth inherent in their waste. Collection of waste commercialized container (bins) should be provided at strategic positions and at door step of every house this will encourage household to manage their waste for proper disposal. Solid waste management (SWM) policies and enforcement laws should be enacted; while various environmental organization and societies should do more until the dreamed on clean environment is achieved.

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- The government should take responsibility to initiate patented project on WTE, while also craving for vertical and horizontal partnership with organized private sectors for possible investment.

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