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A SURVEYOFBIOMASS AS AN ALTERNATIVE RENEWABLE ENERGY

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ABSTRACT
This paper presents biomass as another source of reliable renewable energy. Biomass simply means gathering large quantity of vegetation to serve as a source of energy and power.The paper investigates anaerobic method of producing biogas from agricultural and food waste, especially food crops.Biogas is produced by means of controlled anaerobic digester treatment of organic materials by bacteria.The control mechanism of this method is discussed taking cognisance of its advantages and drawbacks when compared with other renewable energy system.However, the harvest and discharge techniques of the biogas using separator, gas holder and bag gasholder were investigated. The biogas is similar to natural gas, hence, serves as a good source of energy.In addition, co-generation system (electricity and heat), is achievable with biomass (biogas) on the basis of reciprocating engine. The sustainability of biomass always generate hot debate but practices like short rotation harvesting and re-planting are already designed to make it sustainable.This report discussed the negative impact of burning biomass on the ecosystems and the atmosphere.The carbon footprint of biomass is discovered to be a great task to calculate compare to calculating the carbon footprint of other renewable energy sources e.g solar, wind, turbine etc. However, replenishment of biomass and re-absorption of carbon dioxide, co_2 by the replenished biomass is an area of concern in this study.

Keywords: *biomass, biogas, anaerobic, co-generation, carbon footprint, ecosystems*

INTRODUCTION

Un-interrupted power supply has been a great concern in this part of the world and precisely our nation, Nigeria. Business renewable energy is a very reliable and efficient amongst other renewable energy sources. It is a renewable source of fuel to produce fuel [1].Biomass is fuel from organic materials, a renewable, sustainable clear energy used to generate electricity. Some of the materials that make up biomass fuels are:

i Green crops
ii Agriculture / food waste
iii Forest debris / waste
iv Community or local solid waste (Refuse)
v Agriculture residue

Biomass is a proven available fuel-input for power generation. In the course of using biomass for power generation, it is pertinent to take cognizance of the following components of the process: Biomass feedstocks, Biomass conversion and power generation technologies. Biomass is one of the most plentiful and well-utilized sources of renewable energy in the world. The most common biomass used for energy is wood from trees. It is used to raise steam, which in turn, is used

to generate electricity. Biogas is a mixture of Methane (CH_4) and Carbon Dioxide (CO_2) as well as some minor constituents including Sulphur Dioxide (SO_2), Hydrogen Sulphide (H_2S), Ammonia (NH_3), Hydrogen and Nitrogen. Biogas is readily used as a fuel in Power or combined heat and Power (Co-generation) units and has the potential to be used as a substitute for natural gas after appropriate cleaning and upgrading. Large scale Plants using Municipal Solid waste (MSW) requires between 8,000 and 9,000 tonnes MSW/MW/Year. The Table 1 below indicates the operational parameters of a representative anaerobic digester using 3 different energy crops.

Table 1: Operational parameters of a representative anaerobic digester using Energy Crops

Energy Crops	Per Year
Input of Maize Silage(Tonnes)	5940
Input of Rice Silage(Tonnes)	2181
Input of Clover Silage(Tonnes)	1374
Total Feed stocks(Tonnes)	9495
Biogas Production(Million m3)	1.88
Electricity Produced(MWH)	4153
Thermal Energy produced(MWH)	4220
Own Electricity Consumption(MWH)	161
Own Thermal Energy Consumption(MWH)	701
Electricity available for sale(MWH)	3992
Thermal Energy available for sale(MWH)	1697

Source: Murphy et al, 2010

A lot of contention and passionate views on the renewability and sustainability of biomass energy source had been established, particularly where large power stations are in the process of switching a significant of their fuel to biomass. Biomass is considered a renewable energy source based on the concept that the plant materials used can be replaced through re-growth and the carbon dioxide that is emitted from burning the harvested biomass can be absorbed by the new plant growth. The carbon dioxide, CO_2, released in the combustion process of biomass is often more than would be released if we were burning the equivalent in coal, oil or gas. The important difference is that fossil fuel like coal contain carbon that was kept or sequestered thousands or millions of years earlier and when this source and quite unlike managed forests and plant crops which can be managed sustainably to provide a continuous fuel source and a system for re-absorbing carbon dioxide that is released through burning.

To sustain biomass, the following should be done:

1 Source locally; this will enhance local businesses.

2 Research more on the extraction process.

3 Make the most of waste.
4 The best biomass systems make use of waste that would have been sent to land fill where their decomposition releases protect greenhouse gases like methane.
Support sustainable land management- show support for crops that encourage the healthy management of biodiversity and forests. Avoid crops that damage the local ecosystem.

CARBON- FOOTPRINT OF BIOMASS

Biomass is not totally carbon neutral fuel source because there are CO2 equivalent emissions during the extraction and processing of biomass fuel. However, measuring the carbon footprint of biomass is so challenging due to complex nature of Earth's living systems. To calculate the precise carbon savings of a biomass energy system can be tasky, but despite being difficult to quantify, biomass can provide both a cost effective and low carbon alternative when sourced sustainably. One great concern in the biomass industry is the harvesting of the forests to provide continuous wood fuel. Practises like short rotation, harvesting and replanting are designed to be sustainable. Also, the amount of time it takes for the forest to be become replenished and CO_2 to be absorbed, as well as the potential negative impacts on biodiversity removing carbon from the delicately balanced ecosystem of a forest.

SOURCES OF BIOMASS

Biomass can be sourced from food, cash crops, and animals. The biomass fuel obtained from these sources is mainly ethanol. Ethanol is a liquid fuel that can be extracted from starch like cassava and sugar through cane through fermentation (Ogwo 2012). Other types of biomass fuel include biogas (Methane), Carbon dioxide from putrefying plant and animal matter in landfills (Sambo 2005). With the heavy tonnage of local waste product as shown in Table 2 for few wards in Somolu local government in Lagos State; then biomass is sustainable in this part of the world. According to analysis on Energy used in developing Countries by International Energy Agency (IEA), 2.4 billion people use Biomass according to (Audu & Aluyor 2012). Biodiesel (Akyl Ester) is already used in Brazil in a time there is depletion of non-renewable energy sources. In Nigeria, the total energy supply is 105 Million Tonnes of Energy with Crude oil contributing 14%, Natural gas 7%, Biomass 78% and Hydro 1% (Osaghae, Obioh and Fagbenle 2009). Agriculture has provided larger share of Biomass with animals, agricultural waste and wood residue estimated to be 1.2 PJ in 1990 (Obioh and Fagbenle 2004). One of the agricultural products that can be used as Biomass in Nigeria is Sugar cane. Its main plants component contain approximately one third of its stored energy

METHODOLOGY

Methodology used involves extensive review of Literatures from the internet and other sources including print. This paper investigated the biomass conversion process which can be achieved using any of these process and electricity generation using Biomass

Thermo-chemical process- This process can further be sub-divided into:

(i) **Combustion**- It involves burning of biomass (oxidation) in a high pressure boiler to generate steam which is used to drive the steam turbine. The net power cycle efficiency that can be achieved is about 23% to 25%. Additionally, the biomass combustion can be co-fired with a coal in a coal fired plant.

(ii) **Gasification**- This is achieved by the partial combustion of the release of a gaseous product. The resulting gas is a mixture of carbon monoxide, water, co_2, char, tar and hydrogen, fuel cells or gas turbines.

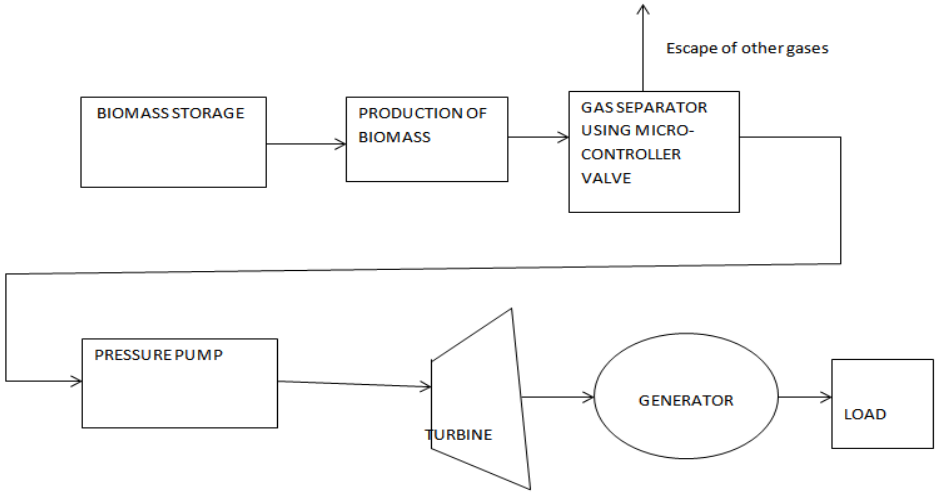
(iii) **Pyrolysis**- It is a subset of gasification system. In this process, the partial combustion is maintained at a lower temperature (450°c to 600°c), resulting in the creation of a liquid bio-oil, as well as gaseous and solid products. The oil can then be used as a fuel to generate electricity.

Bio-chemical process: This is also called Anaerobic Digestion. It is a process which takes place in almost any biological material that is decomposing and is enhanced by heat, moisture and airless conditions. The resulting gas is mainly methane and carbon dioxide which is called bio-gas. The bio-gas is cleaned-up and used to drive turbines, micro-turbines and also can be upgraded to bio-methane for distribution.

ANAEROBIC DIGESTION

Anaerobic digestion is a biological process that converts Biomass feed stocks with relatively high moisture content into a Biogas. It is a naturally occurring process which can be captured to provide effective means to treat Organic materials residues and waste from many Industrial and Agricultural process. Anaerobic digestion is most commonly operated as a continuous process, hence needs a steady Supply of feed stocks. The feed stocks require some pre-treatment to maximize methane production. Co-digestion of multiple feed stocks is most commonly practised to achieve the best balance of Biogas yield and process stability. Two main products of anaerobic digestion process are Biogas and residue digestate, which after treatment, can be used as a bio-fertilizer.

ELECTRICITY GENERATION USING BIOMASS



Figı: Block Diagram representing Electricity Generation using Biomass

Biomass Storage: This refers to the compartment where the biomass is kept.

Production of Biomass: This refers to Biogas production using any of the methods of Biomass production.

Gas Separator: This refers to the stage where the various gases produced are separated. Methane is allowed to pass to the next stage using a microcontroller which operate or open the valve based on the density of the methane gas. Other gases based on their density cannot open the valve, so they are trapped and sent to a safe compartment where they can be disposed safely.

Pressure Pump: Here, the pressure of the gas is raised to a level where it can successfully drive a turbine.

Turbine: This is the prime mover of the rotor of the generator which drives the generator producing electricity.

CALCULATIONS OF THE ROTATIONAL ENERGY OF THE TURBINE

Rotational energy of the Turbine = Pressure of gas X C.A of Turbine blade X Velocity of gas

Where C.A = cross-sectional area

Suppose pressure of gas = 1 bar = 1.01×10^5

Cross-sectional area of turbine using rotor radius of 0.60m $=\pi r^2 = 3.142 \times (0.60)^2 = 1.131m^2$

Assuming turbine efficiency of 60%

Table 1: Table showing rotational energy of Turbine and Energy converted to Power.

Velocity of gas(m/s)	Rotational Energy of Turbine (Watt)	Energy converted to power (Watt)
3	342693	205615.8
4	456924	274154.4
5	571155	342693
6	685386	411231.6
7	799617	479770.2
8	913848	548308.8
9	1028079	616847.4
10	1142310	685386

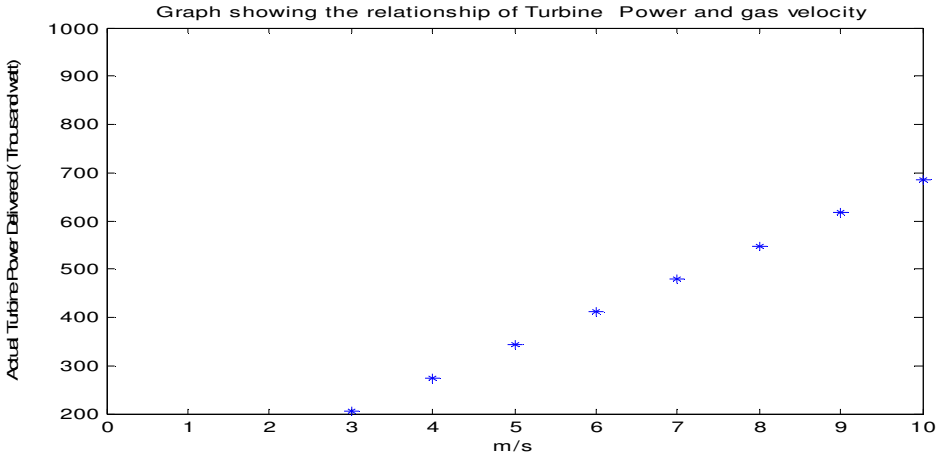


Fig 2: Graph showing the relationship of Turbine Power and Gas Velocity

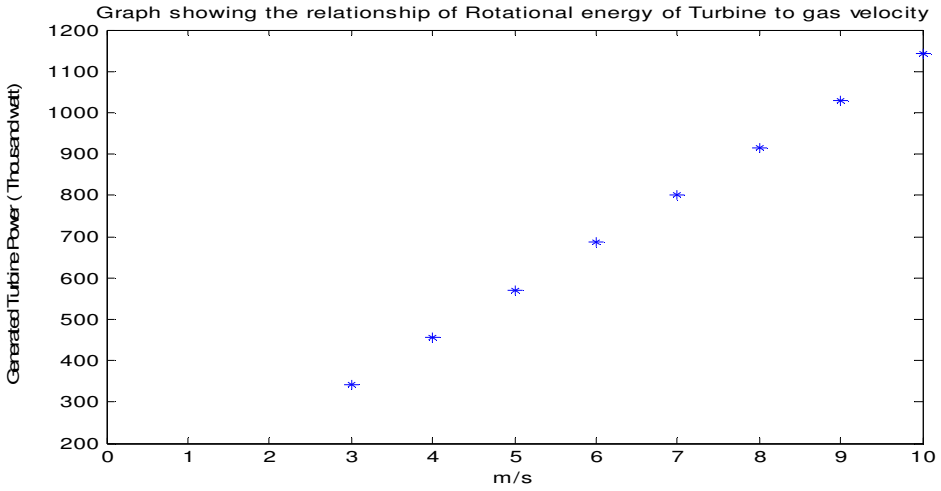


Fig 3: Graph showing the relationship of rotational energy of turbine and Gas Velocity

OBSERVATION: The more, the velocity of the Biomass gas, the more energy produced. Alternative means of increasing the energy produced is to increase the pressure of the Biomass gas using pressure pump. It is also seen that as the rotational energy of Turbine increases, the Turbine power also increases.

RESULTS AND DISCUSSIONS

The table 2 below shows waste collection of data gathered through Questionnaires in Somolu Local Government Area of Lagos State in Nigeria.

Table 2:

DAY / WARD	Monday (KG)	Tuesday (KG)	Wednesday (KG)	Thursday (KG)	Friday (KG)	TOTAL (KG)
A	28421	26143	18235	21765	27343	121907
B	27890	23135	20675	25442	20879	118021
C	31674	25128	24769	24876	22168	128615
D	24097	22564	22893	21354	19547	110455
E	30775	28034	24807	21340	21221	126177
F	29560	27861	25760	23677	18900	125758

Table 3: Approximate Tonnage of Biomass and Mega-Watt generated per Year.

Ward	Average(Kg) Daily	Total Per Year(Tonnes)	MW Generated
A	24381	8899.2	0.8899
B	23604	8615.5	0.8615
C	25723	9388.8	0.9388
D	22091	8063.2	0.8063
E	25235	9210.9	0.9210
F	25151	9180.3	0.9180

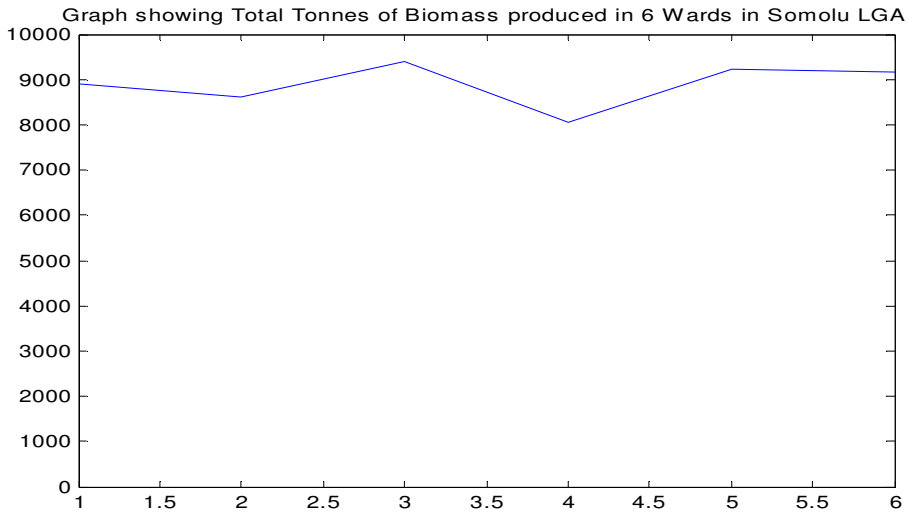
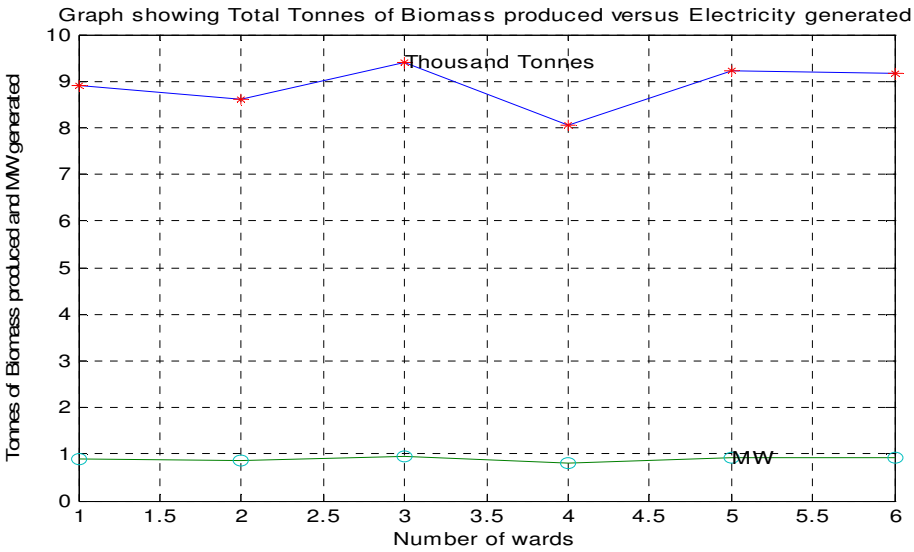


Fig.4: Graph showing total Tonnes of Biomass in Somolu LGA



Figs: Graph showing total Tonnes of Biomass produced and Electricity generated

DISCUSSIONS

It is shown that an approximate 1 MW of electricity can be generated per year in few wards in Somolu LGA of Lagos State and with more wards, the electricity generated also increases

CONCLUSION

The epileptic power supply in Nigeria can be improved upon by using waste generated to produce more electricity for homes and industries across the States. Based on the level of waste generated daily in Lagos using Somolu as a case

study, electricity generation from Biomass is sustainable because of the huge Tonnes of waste generated all over the Nation. Bio- Fertilizer can also be derived from the remnant of the waste.

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