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Feasibility Study on the Use of Palm Pressed Fiber and Palm Kernel Shell to Generate Electricity for 1500 Domestic Household Community

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Research Article

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ABSTRACT

Nigeria is richly endowed with hydrocarbon and other natural resources, however, history has shown that the nation is yet to achieve sufficient electricity supply in relation to the national demand. This situation has been tipped to worsen by energy commentators, given the available power supply with increasing rate of the country's population and electricity demand triggered by economic development. The continuous depletion of fossil fuel resources coupled with attempts to salvage the ecosystem from global warming have propelled countries to resort to alternative energy sources to take care of their demand for energy. Consequently, it has become expedient to develop green energy resources, to take care of industrialization prospects of the country as well as the electricity challenges which has increased the cost of industries operation, while some households are without electricity supply.

INTRODUCTION

At present, fire wood and biomass constitute greater percentage of primary energy sources for majority of Nigerians due to electricity deficiency in the country. The resulting effect of excess use of wood and biomass for cooking and heating gave rise to deforestation, emission of greenhouse gases and global warming, and other environmental concerns associated with such action. Due to poor energy laws and insufficient supply of energy, the little quantity available is

mostly channeled to industrialized and developed cities, thereby creating energy inequality within Nigerian energy system. This action has undoubtable led to serious movement of most Nigerians from rural to urban towns.

Factors such as poor infrastructural development, lack of maintenance culture, use of obsolete infrastructure within power transmission and distribution lines, poor states of the few existing power stations and corruption has made it more difficult for Nigerian Government to meet the energy need of her citizens. It is therefore exigent to develop and integrate other energy sources such as renewable energy abundantly present in Nigeria into country's energy system together with existing hydrocarbon to ameliorate the energy deficiency of Nigerians and possibly attain full electrification in the country for both rural and urban dwellers. Developing and integrating the renewable energy will definitely reduce the already over pressure being observed on the national grid. Having comprehensive energy roadmap that is sustainable, environmentally friendly and economically viable in both long and short terms will undoubtable improve the deplorable energy appropriation system currently experienced by majority Nigerians especially those of rural dwellers. This action will discourage negative rural-urban migration, improve quality of lives of those living within the rural communities and provide employment for many rural dweller. The 17 Sustainable Development Goals (SDGs) which replaced the Millennium Development Goals (MDGs) was adopted on 25th September 2015, by world leaders to eradicate poverty, inequality and environmental pollution by 2030. SDGs No seven (7) tends to stand out due to it connecting role towards the actualization of other 16 SDGs. It cardinal objective is to facilitate access to universal clean and cost effective energy. Nigeria is known to be the most populous country in Africa and 7th in the world, with an estimated population of 173.6 million. As a member of United Nation (UN), it is quite obvious that the country will play a key role in actualization of green (clean) energy target of the SDGs. As a leading crude oil exporting country with an estimated production capacity of 2.5 million barrel per day, and an average oil and natural gas reserves at 28.2 billion barrel and 165 trillion Standard Cubic Feet (SCF) respectively, combined with US $521.8 billion gross domestic product. It is not in doubt that Nigeria is responsible for high hydrocarbon based energy production and consumption. Despite its higher hydrocarbon based energy production, the energy supply in Nigeria is still a nightmare and abysmally low. Recent report on Nigerian electricity supply by Giwa et al. stated that more than 40% of Nigerians lack access to electricity supply while 40% still depend on the of fossil fuel for electricity.

LITERATURE REVIEW

In August 2015, 4,810.7 MW of electricity was recorded as the highest ever electricity generated in the country. This value is eight (8) times less than electricity generated from solar energy alone in a Germany, a temperate country to when compare with a tropical country like Nigeria. Regardless of the above quantity of electricity generated (4810.7 MW) in 2015, Nigeria is still ranked as one of the lowest electricity generation nation in Africa.

Energy source outside fossil fuel and coal are termed alternative or renewable energy source. The use of alternative energy resources for power generation help to reduce emissions of pollutant gases such as CO_2 emission (an important constituent for global warming), NOx and SOx formation etc., associated with hydrocarbon energy sources [1]. The following energy sources can be considered as either renewable or alternative energy sources: Biomass, geo-thermal, wind, nuclear fusion, biogas, ocean tides and solar power.

About 8X102 MJ of biomass has been recorded in Nigeria while Giwa reported an estimated 144 million tons of biomass potential in Nigeria. According to report, the following biomass resources: Wood, animal waste, aquatic biomass, shrubs

and forage grasses are present in Nigeria. If this great quantity of biomass energy resources is well harnessed and integrated into Nigerian energy mix, energy supply within the country will undoubtable be improved.

One of the common ways to extract energy from biomass is through combustion. Over the years, better and cleaner technologies and mechanism have been built for extraction of energy from biomass resources [2]. Any of the under listed technologies and mechanisms could be used for energy extraction from biomass resources:

- Direct combustion: This involve heating biomass materials to produce steam, which can be used in running steam turbine for electricity generation.
- Co-firing: This involve mixing coal and any other combustible material as a fuel for power plant. The combustible material could be biomass, natural gas etc.
- Combined Heat and Power (CHP) or Regeneration: It involves combustion of solid biomass to generate steam for power generation and heat for process and space heating respectively.
- Biomass gasification: It involve running biomass in an oxygen-controlled environment at a higher pressure to liberate hydrogen and carbon monoxide known as syngas. Syngas is used in running gas turbine power plant for electricity generation.

In other to avoid excessive deforestation due to lack of energy supply, many Nigerians have resorted to the use of charcoal stove and firewood for cooking and heating. Biogas from biogas digesters could also provide energy for both home and industrial use. This will no doubt help to alleviate the energy crisis currently experienced in Nigeria if properly developed. Currently, 80% of world energy consumption emanate from hydrocarbon and other conventional energy sources such as coal and hydro-power[3]. At present, hydrocarbon account for 67% Nigerian consumption.

Hydrocarbon, hydro and coal are the major energy sources in Nigeria presently. Due to insufficient energy supply in Nigeria, over 60% million Nigerians uses electric generating set to power their homes (Manufacturing association of Nigeria, 2010). According to MAN (2010), an estimated ₦1.5 trillion is being spent yearly to fuel the generating set. Because of the dismal energy situation in Nigeria, the power generating capacity is still below 4,000 MW against a proposed 10,000 MW (ECN, 2010). According to Energy Commission of Nigeria (2010), factors such as poor maintenance culture, corruption and absence of energy development program are major reason why the country power generating capacity was 1,500 MW at the end of year 2,000. Since the end of 2009, Nigerian electricity generating capacity experiences inconsistences, ranging from 3,000 MW to 4,000 MW due to shortage and inconsistence in gas supply and decrease in water level (Energy commission of Nigeria, 2010). Report released by Energy Commission of Nigeria (2010) shows that 3,700 MW of electricity generated before the end of December 2009 was limited to 2100 MW due to already mentioned constrains [4-6]. Hydropower plant and fossil power plants account for 31% and 64% energy generation in country respectively, while the remaining 5% come from other renewable sources of energy. An estimated 64 million out of 160 million Nigerians lack access to electricity (ECN, 2010).

This implies that about 40% of Nigerian population are unable to access electricity supply. Inability of the existing power station to operate at their peak due to obsolete transmission and distribution lines and poor energy policy has been identified as the reasons behind the low access to electricity supply by millions of Nigerians. Many energy commentators

have also expressed doubt in actualizing 35000 MW electricity generating capacity as proposed by the Government by the end of 2020 (Vision 2020).

Nigeria in early 1900's was a reckoning force among main palm oil producing nations. The country's foreign exchange depended on her role in global palm oil market till late 1960s. However, lack of technological development in palm oil production, Nigerian civil war and discovery of hydrocarbon in large amount are all responsible for the country's inability to maintain her commanding global stand on the list of palm oil nations.

Almost all the states of the nation are enriched with palm oil resources (or plantation), but the Niger Delta states are the most endowed. Nigeria boost of hundreds of Smallholder processing mills. These smallholder mills are responsible for 80% palm oil produced in the country [7]. Almost all the smallholder mills in Nigeria uses local techniques and manual means to process their palm oil and over 2.5 million hectares of palm oil plantation managed by smallholder ion Nigeria according to Nwachukwu and Lawis.

METHODOLOGY

Because of insufficient power supply, environmental pollution and challenges caused by disposal and open air combustion of under-utilized solid palm waste, many researchers have stated that electricity generation could be made available to millions of rural dwellers from the million tons of solid wastes generated during palm oil processing. This is very important since most rural communities are denied access to national grid.

The search for sufficient and sustainable energy, need for reduction in cost of production (which have been hacked by higher electricity tariff), evidence of larger quantity of biomass in the country and it higher energy content, and effect of hydrocarbon on the environment, many studies had be carried out on the use of palm fruit solid waste and other biomass resources to generate electricity.

Objective of study

The main objective of this work is to carry out a feasibility study on the use of Palm Pressed Fiber (PPF) and Palm kernel Shell (PKS) to generate electricity for a 1500 domestic house-hold community.

- To review related literature so as to determine the extent of work done on the use of PPF and PKS to generate electricity.
- To determine the availability of PPF and PKS for sustained power generation.
- To design a suitable power plant system using PPF and PKS mix as fuel for power generation.

RESULTS

Baseline data were obtained from primary (Field work) and secondary (literature) sources. Data obtained were used to calculate the average power consumption of 1500 domestic household, feeds sustainability, boiler and turbine selection, specific investment cost per kW.

Dulong formula was used to calculate Heating value of the PPF and PKS, while thermodynamic formulae were used to determine effective thermal output of the boiler and effective power output of the steam turbine. (Table1)

Table 1. Average household appliances and power rating of appliance in a typical 3-bedroom bungalow in a rural community.

Appliances,I,	Quantity (average)II,	Power rate (watts)III,	Power rate sum (Watts)IV = (II)* (III)	Power in (KW)V = IV/1000
Ceiling fan	4	24	96	0.096
Energy saving light bulb	12	18	216	0.216
Refrigerator108	1	200	200	0.2
Television	1	80	80	0.08
Electric iron	1	1200	1200	1.2
Mobile phone charger	4	5	20	0.02
DVD	2	15	30	0.003
			Sum=1842	Sum=1.842

DISCUSSION AND CONCLUSIONS

The summary of specific investment cost of the proposed power plant is presented. From results obtained, the following conclusion may be drawn

- PPF and PKS have higher energy content to serve as a boiler fuel for power generation.
- Using PPF and PKS as a boiler fuel, it is possible to generate 34504 KWhr while the power consumption of the 1500 community is 2763 KW.
- Economic analysis performed revealed that it is feasible using this system for power generation in Nigeria.
- Calculation has shown that the Palm Pressed Fiber (PPF) and Palm Kernel Shell (PKS) alone can generate up to 35 MW of electricity. This quantity of energy is enough to meet the energy demand of the more than 1500 domestic community household.
- Thermo-economic feasibility and environmental significance of bioenergy for Nigeria's sustainable development is site-specific and subject to factors such as incentives and financing, research and development, public enlightenment, government's policies and private investment.

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