Investigating Renewable Energy Potentials in solving Energy crisis in Niger Delta Riverine Communities, Nigeria.

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Abstract - The continual change in the global climatic condition leading to rise in ocean level, flooding among others has generated debates on the needs to go green; increasing investment in renewable energy. Increasing investment in renewable energy is assumed will create more job, ensure healthy environment, and ensure energy security. Thus, this research aims at investigating renewable energy potentials in Nigeria towards meeting rural riverine energy needs in Niger Delta. The study, employed cost analysis approach to evaluate cost, sustainability, and environmental friendliness of generating electricity for the rural riverine communities using Biomass technology. The research revealed that hydroelectricity dominates renewable energy and serve as the major sources of renewable energy in Nigeria and the least cost in terms of per unit cost of electricity (kWh). The study further revealed also, that it is more cost effective and economical to generate electricity for the rural riverine communities using biomass-municipal waste than using diesel generating set. The research therefore recommends among others that the government should embark on strategic private partnership with both local and foreign investors in renewable energy. To achieve this, government needs to introduce the feed-in-tariff as a way of encouraging the investors.

Keyword: *Renewable energy, Biomass, Niger Delta, Riverine communities, Nigeria*

I. INTRODUCTION

Nigeria as a country is highly endowed with abundant energy resources; renewable and non-renewable that is yet to be tapped. The country's renewable energy is distributed in such a way that every part of the country has a form of renewable energy sufficient to meet its energy needs. Despite the abundant renewable energy in the country, majority of the population still live without electricity. Statistics have shown that only 40% of Nigerians has access to electricity and only 10% of the rural dwellers have access to electricity (Okeke, 2016).

Of all the sources of energy, renewable energy has been identified in literature as the most potent source of energy in terms of sustainability, availability and environmental friendliness (Sambo, 2005; Okeke, 2016). This is because of its capability to transmit; convert and save other sources of energy as well as its potentials to generate sufficient energy in a friendly environment. Renewable energy does not only represent an alternative to fossil fuel, but also the only option which can guarantee sustainable development of the economy, ensure survival of mankind and ultimately ensure the preservation of climatic change. Adebayo (2014) noted that it is quite possible for the world to shift towards renewable 100%, since renewable energy is globally distributed such that every country has one or two different sources of renewable energy sources that can be harnessed. Thus, renewable energy is often referred as the most human friendly source of energy (Arvind & Kaushik, 2017).

The continual change in the global climatic condition leading to rise in ocean level, flooding among others has generated debates on the needs to go green and increasing investment in renewable energy. The shift in attention by energy economist from nonrenewable energy sources to renewable is due to the projection of the depletion of fossil fuels (such as petroleum products, coal and natural gas) in the nearest future and the new quest to move to greener energy sources. Renewable energy such as solar energy, wind energy, hydropower energy, geothermal energy and biomass energy are replenishing, inexhaustible and infinite. The argument is that Renewable energy can be used as much as they are needed and there is no need to worry about them running out. In addition, renewable energy is environmentally friendly and emits little or no harmful gas to the environment compared to fossil fuels (Noko, 2016).

One of such advocates is the "Paris Agreement" that took effect in November 2016 at New York, where about 196 parties entered into agreement to jointly reduce investment in activities that increase the emission of greenhouse gases, promote investment in renewable energy through appropriate funding and maintaining climate temperature rise below 2 degrees Celsius. The ideology behind the agreement is that rise in climate temperature will further result to climatic change and will not only increase the ocean/sea level but also the warmness of the atmospheric that increase the amount of heavy rainfall (United Nation Framework Convention on Climatic Change (NFCCC, 2017). A good example is the recent Irma & Harvey Flood that hit US where many life and properties were lost to the storm.

Increasing investment in renewable energy is assumed will create more job, healthy environment, energy sustainability and energy security. The government of Nigeria in attempt to develop the renewable energy sector of the country, has drafted renewable energy policy framework that will guide the government in harnessing the nation's renewable energy. The need for renewable energy policy is to guide the government in developing appropriate policy to address energy needs of the country. This is further necessitated by the fact that conventional grid electricity cannot be extended to most communities especially the rural areas which River/Bayelsa States riverine communities happen to be part (NREEEP, 2015).

The major energy issues in Nigeria can conveniently be categorized as inefficient energy supply system and utilization; environmental concerns; energy financing; inadequate technological capabilities and weak institutional frameworks (Sambo, 2005). An estimated 60-70% of the Nigerian population do not have access to electricity. At present, only 10% of rural households and 30-40% of the country's total population have access to electricity (Suleimon, 2011; Abubakar et al, 2015). Going further, Okeke (2016) found that 51.2% of rural households in North-Central, 70.4%- North East, 57.7%- North-West, 33.6%-South-East, 31.3%-South-South and 18.8% in South-West geopolitical zones do not have access to electricity.

In the riverine communities in Niger- Delta, particularly River/Bayelsa State which serves as the focal area of this study, grid electricity is yet to be extended to the riverine rural communities largely due to large presence of rivers that hinders successful transmission of grid electricity. In response to this challenge, the Multinational Corporations (MNCs) has resulted to powering the communities with Diesel-powered generators. Though, this approach has been able to provide power for their host communities. But the question is, can't there be a better option giving the cost implication (resources and health issue) of providing such service to the communities both to the firms and the host communities? The world at large and Nigeria in particular has shifted attention to clean energy that is safe to human health and more environmental friendly, as such renewable energy sources such as biomass, solar and wind energy should be considered in generating electricity for the riverine communities.

Several renewable energy technologies have been developed that can power a small community like the riverine communities in River/Bayelsa state. Findings revealed that, Rivers State alone burn more than 400,000 metric tons of waste per year (not including those littered in the rivers), and generate over 1200 metric tonne of waste daily which can produces 8,800 kW or 8.8 MW (Adebayo, 2014; Ohunakin, Adaramola, & Fagbenle, 2014). According to Umesh (2013) Rochen Green Plant (Biomass plant using municipal waste) installed in India by Pune Municipal Corporation (PMC) generates 10MW of electricity using 700 metric tonnes of waste. The 10MW of electricity has capacity to supply electricity to about 6500 households which is more than enough to supply electricity to three riverine communities using Rochen Green Plant with 3MW capacity for each of the communities.

One disturbing concern is that the amount of waste being burnt in River state is increasing at a rate of approximately 8% per year, as we produce more and more waste materials (Adebayo, 2014; Ohunakin, Adaramola, & Fagbenle, 2014). It is therefore pertinent now, to think of how this waste burnt indiscriminately in the state can be converted to provide clean energy to the riverine communities. Although, the cost per unit of power of renewable energy ($0.26– 0.50/kWh) remains markedly higher than that of grid electricity ($0.10–0.25/kWh), which is the main reason government of most countries introduces the feed-in-tariff (FIT) to encourage investment in renewable energy (Couture & Gagnon, 2010; Nganga, 2012).

According to Mohammed et al (2017) close to 65 countries as at 2012 have adopted one form of FIT or another. These include countries in Europe, USA, and China. A few African countries like South Africa, Kenya, Algeria, Tanzania, Rwanda, Egypt and Uganda have also queued in. Much of the advocacy and adoption of renewable energy option oversea are based on the quest to achieve clean energy that will reduce carbon emission in the atmosphere, which with more technology innovation will become more competitive with conventional electricity supply. While in the past, the 'success' of energy carriers was mostly driven by financial considerations, leading to fossil fuels such as coal and oil being the preferred choices, the introduction of renewable energies has resulted in more of a sustainability driven approach, necessitating more sophisticated measurements of a wider range of criteria.

Financing the rural energy needs of the riverine communities has been described by Ogueri (2015) as a major tool to improve the living standard of the rural dwellers by ensuring constant electricity (not schedule electricity) while transmitting low Cabondioxide in the atmosphere. Oladeji (2014) noted that, it is not acceptable that about 52% rural dwellers have no access to power despite the enormous abundance of energy in the country (see Abubakar et al, 2017).

Thus, this study aims at investigating renewable energy potential in Nigeria particularly in meeting rural energy needs of the riverine communities in Rivers/Bayelsa States.

II. LITERATURE REVIEW

Renewable Energy

Like every other concept renewable energy has no universal definition. However, all the definition on renewable energy as will be examined has three basic features in its definitions, including sufficient availability of energy (inexhaustive), sustainability of energy, and environmental friendliness of energy. Arvind and Geetanjali (2017, p. 14) argued that renewable energies are those energies that are inexhaustive in nature and are environmental friendly. They noted that, renewable energy is that energy that "offer our planet a chance to reduce carbon emissions, clean the air, and serve as essential input for an overall strategy of sustainable development in agriculture, animal husbandry, industry, transportation, domestic uses, environmental quality, education etc". Renewable energy can also be seen as those form of energy which replenishes as it is being used and also has significant reduction in Green House Effect (GHE) which is accumulated through the release of CO_2 in the air. Renewable energy is an alternative to fossil fuel but are the only options which can guaranteed sustainable development of the economy, ensure survival of mankind and ultimately ensure the preservation of climatic change. Renewable energy can be replenished unlike non-renewable energy (coal, natural gas and fossil fuel) the ratio of the time it takes between non-renewable energy formation and human usage is in the ratio one to one million, and this is the energy that is being used on a daily basis. This simply means that the world uses in one year, what takes millions of years for nature to process (Zhou et al, 2012).

Sources of Renewable Energy:

Biomass Renewable Energy: Jawahar & Michael (2017) argued that not every aspect of biomass is renewable since some of the sources of biomass (fuel wood) are not replenishable in nature and can exhaust as it is been used by the consumers. Biomass energy can be regarded as those sources of energy derived from municipal waste, animal waste, plant waste and are used as raw materials to generate energy for industrial and personal energy needs (Sambo, 2005).

Biomass can be grouped into two aspects, end-use biomass which includes feed biomass, fibre biomass, fuel biomass, chemical biomass and organic fertilizer biomass. Biomass energy can also be classified in terms of the sources of production to include, residue and waste biomass, fuel wood biomass, forage grasses and shrubs including aquatic biomass. Emberga et al (2014) argued that fuel wood biomass, outside being used as energy can also be used for other purposes to include sawn wood, plywood, paper work and even electric poles in most cases. They opined that Nigeria uses about 80 million cubic meters 4791.7 kg) of fuel wood every year for cooking and other domestic purposes.

Boehmel et al (2008) argued that biomass still represent the major source of energy and has been in use before the development of the conventional fossil fuel. In a similar study by Carpita and McCann (2008) on "plant sources of bioenergy" argued that, sugarcane related species like "Saccharum, Miscanthus and Erianthus" are great source of biomass energy in India. They identified other sources of plant residue to include corn stover, corn cobs, wheat straw, soybean straw and rice hulls.

According to Jawahar & Michael (2017), great deal of biogas can be generated from plants and municipal waste and argued that, Brazil has one of the biggest renewable energy programmes in the world that involves the production of ethanol fuel from sugar cane, which currently provides 18% of the country's automotive fuel. They also postulated that USA for instance, generates about 18% of its energy needs from biomass. Biomass energy is particularly referred to as local energy sources because it is more labour intensive than capital intensive resulting in huge employment generation in the rural areas. Based on these arguments, biomass is regarded as the most promising and viable alternative to conventional energy sources. It has a fixed carbon that can be converted to liquid, solid and gaseous (Amutio et al., 2012).

Arguably, biomass can be regarded as "carbon neutral over its life cycle" since it releases only sufficient CO2 equivalent captured during its growth. This is unlike, the fossil fuel which releases a sufficient CO2 equivalent to its growth, and has been locked for millions of years. By contrast, fossil fuels release CO2 that has been locked up for millions of years. According to a study by Jawahar & Michael (2017), which examined plant biomass as a renewable energy source in India, they depicted that, biomass is one of such renewable, that can generate over 33 percent developing countries energy needs. The study argued that, biomass generate about 75% of rural energy needs in India.

Solar Renewable Energy: It is argued that the amount of energy generated by the sun in one hour cannot be exhausted in one year globally. Solar energy is a clean energy derived from the heat of the sun ray on earth being harnessed employing various evolving set of technologies including photovoltaic, solar thermal energy, solar architecture, solar heating plant, concentrator, solar pond and many other technologies. Solar energy arguably constitutes the source of every other form of energies including biomass through the process of photosynthesis. Chilapku (2013) argued that solar energy is an important source of renewable energy since its technology can either be categorized as passive or active depending on the nature and process they are used to generate and distribute power. According to the study by Vaselbehagh (2017), on potential of solar energy in India; they depicted that solar energy can

generate as much energy as man needs on daily basis, arguing that solar energy is the world most abundant energy resource. They further stated that solar energy passed the three feature of renewable energy; it is sustainable, inexhaustible and environmental friendly. This was collaborated by US Energy Department when they stated that the amount of energy the earth receives is equivalent to energy needs of humans.

Ji et al (2017) puts it that, solar energy can "directly supply much of the world's required energy". Solar energy can be used for lighting of the street and building, heating and cooling of the building, heating or cooling of swimming pools and power electrical appliances. Others usage may include been used to wash and dry cloth, powering small communities, to power ICT centres among many other usages. In a recent study by Trans & Smith (2017) on renewable energy technologies. They argued that solar energy can be used to solve the global problem of low electricity supply; they argued that with more than one-third of the world population living without electricity, solar energy promises a better chance to improve the masses standard of living.

In spite of the huge potential benefits from renewable energy from the sun, the pace of development of solar energy system has been generally slow globally. The slow pace of solar energy development can be attributed to the expensive nature of solar energy technologies and the special environment requirement for its success. Studies have revealed that solar energy can be used to power small communities especially in the rural areas where conventional grid electricity cannot be extended to.

Wind Renewable Energy: Wind energy like every other form of renewable energy are generated from the sun light or solar energy. Winds does not just occur on its own, it a product of uneven heating of the atmosphere by the sun, as well as the irregularities or rotation of the earth surface over time. Bai et al (2017) opined that the "wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover". This wind flow can be harvested and converted to electricity through the use of modern turbines. The turbines converts kinetic energy in the wind. The wind energy is generally and equitably distributed across countries of the world. Outside using wind to generate electricity for building and small communities, it can be used to grinding grain and pumping water, generate electricity for industries, households among others.

According to Bai et al (2017) the amount of "economically extractable power that is available from wind is more than the current human power usage from all sources". They put the estimation at around 72 TW of energy generated from wind. They argued further that one turbine of wind has the capability to generate electricity that can 300 homes in its life span. Investment in wind energy can be much more harnessed if the cost of the technology is subsidized by the government to encourage private sector investment. They argue that although, data on renewable energy from wind turbine cost is not adequately available but investment in turbine should be seen from the perspective of achieving a cleaner energy that is more environmental friendly.

Geothermal Energy: Geothermal energies technologies derive heat originating from the earth's molten interior and the decay of radioactive materials in the crust. The potential size of geothermal energy is much larger than estimated and can be exploited of over 100 million quads of available worldwide. Like every other renewable energy source, geothermal are currently been exploited in so many countries to generate sufficient electricity at cost competitive with conventional electricity generation sources for heating space, industrial processing, and aquaculture.

Renewable Energy Potentials in Nigeria

Renewable energy has considerable potential in Nigeria, and could bridge the major energy gaps in rural areas, particularly Riverine communities in Niger-Delta, where extending grid electricity to those communities are often hindered by the abundant rivers in those areas. Nigeria as a country has been potentially endowed by various class of energies including conventional energies (Fossil fuel, liquefied natural gas, coal) and renewable energy resources (biomass, wind, solar, hydro, tidal, geothermal among others) in such an enormous quantity that can never be exhausted. In fact, Noko (2016) opined that only solar and biomass energy if fully harnessed can generate all the energy needs of the country thereby totally reducing the challenges of CO_2 emission in the atmosphere.

Adebayo (2014) credibly put concentrated solar thermal power potential in Nigeria at over 427,000MW, Biomass at about 230, 000MW. Meaning that solar or biomass energy alone can supply all the energy needs of the country. Large-scale renewable power generation could prove transformational, while small consumer and household-level systems could offer energy independence for the majority with presently limited or zero access to reliable electricity.

The potential of renewable energy in Nigeria arguably has not been fully discovered or known to policy makers. More especially the potential benefits of renewable energy in meeting the rural energy needs, household heating and electricity supply needs, industrial plant powering and heating among others. Babkir & kumar (2017) examined renewable energy potential in Nigeria. Their findings revealed that Nigeria can be solely powered by renewable energy. For instance, biomass energy sources can generate over 23, 000MW of electricity in the country. According the estimation of Ngumah et al (2013) the biogas generated from the 170,541.66 MWh is equivalent to ₦1.01 trillion. This accordingly implies that about "17% (4.34 billion m^3) of the 25.53 billion m^3 total estimated biogas

potential is required to totally displace kerosene and coal as domestic fuel, while 80% (20.42 billion m^3) of this total estimated biogas potential will reduce wood fuel consumption by about 66%".

The location of Nigeria close to the equator places the country at an advantage to generate enough solar energy that can drive the economy through various solar energy technologies. ECN (2015) noted that Nigeria lies within high sunshine belt and every part of the country receives fair share of direct sun light rays. This means that the country can fairly generate all its electricity needs from solar energy and can sufficiently power all industrial needs in the north with solar energy technologies. The southern part of the country and 7.0KWm2/ day at the northern boundary". They noted that the coastal region of the southern part of the country like Rivers, Calabar, Aba and Warri receives about 4909.212 kWh of energy from the sun, equivalent to about 1.082 million tons of oil, "and also put at about 13 thousand times of daily natural gas production based on energy unit".

Wind energy potential in Nigeria is not yet accurately forecasted this stem from the fact that wind energy seasonal and location variation since the strength of the wind which determines the volume of the energy generated depends sun effects. According to the report of ECN (2015) and Babkir & kumar (2017) the annual average wind speed is presently at 10m heights and varies between 2m/s to 8m/s. Wind energy is the least developed renewable energy sources in Nigeria despite the huge potential derivable from it. One reason for slow development of wind energy in the country is largely due to the fact that wind energy station requires initial high cost set up. Wind energy is the most cost effective when generating electricity in bulk compared to other renewable energy sources but is not suitable for individual household electricity generation like every other renewable energy source.

Hydroelectricity remains the only renewable energy that has been harnessed a little in electricity supply in the country until it was abandoned for liquefied natural gas as source of electricity. Nigeria is endowed with enormous rivers like River Niger and River Benue with other tributaries (with potential of generating over 200 MW of electricity) and many water falls which is the main source of hydroelectricity all over the world. The nature of distribution of rivers in the country implies that small scale hydro plant can be established in many states of the country each generating over 50MW of electricity. The current hydroelectricity dams in the country with varying capacity are not even utilized to their optimum capacity. For instance, Kamji dam in Niger state (capacity of 836MW), Jebba dam in Niger state (capacity of 540MW), Mambila Plateau (estimate of 2.330MW) among others can generate sufficient electricity with additional expansion and usage to its full capacity.

III. RESEARCH METHODOLOGY

This research will adopt quantitative research method, since the data gathered by the researcher will be presented and discussed quantitatively. In the analysis of data collected in comparative study, it is a common practice for practioners to adopt cost- benefit analysis in data analysis but the limitation of this approach usually lies in its time consuming nature and technicality of estimating various means of measuring benefits of a project to the target audience (Clasen, 2004). Cost benefit analysis are mostly adopted by organisation to weigh the desirability of a particular project or decision. In the word of Clasen (2004) "CBA helps predict whether the benefits of a policy outweigh its costs, and by how much relative to other alternatives, so that one can rank alternate policies in terms of the cost–benefit ratio." To compare one project investment with other competing projects, to determine which is more feasible. It allows decision makers to appraise projects in a consistent and comparable manner. For the sake of feasibility, this research adopted cost based analysis in the analysis of data collected (cost-benefit analysis was not adopted because of the time frame allotted to this research). Where comparism is made between the different classes of renewable energy sources to determine which the most viable renewable energy sources for the rural riverine communities in River state.

The data for this study are basically sourced both primarily and secondarily. For instance, the primary data was sourced from the oil producing companies regarding what it caused them to generate and supply electricity to the communities for full 12 hours in a day. On the other hand, the secondary data's are sourced from various energy institution, NGO's, renewable energy technology sellers and government agencies.

IV. DATA PRESENTATION, ANALYSIS AND INTERPRETATION

Presentation and Analysis of Results

Table 1 World Renewable Energy Outlook: Installed capacity, Cost and Capacity generation

World Average Cost Estimate	**Biomass**	**Wind Power**	**Hydro Power**	**Solar Energy**
World Total Installed Capacity	89GW	350 GW	1061GW	179GW
Global Average Installed Cost Range (USD/kW: 2014)	400 - 6820	1190 - 3680	450 - 3500	1570 – 4340
Global Average Cost Per Unit (USD/kWh: 2014)	0.03 – 0.14	0.08 – 0.16	0.02 - 015	0.14 – 0.47
Capacity Generation Range	750kW- 64MW	35MW – 320MW	25MW – 500MW	1MW – 118MW

Source: Researcher own computation 2017 (Sources of information that aid this computation are listed at the appendix).

Thus, biomass, wind, hydroelectricity, geothermal including solar energy can hence forth provides electricity to both the industry and the household in a more competitive price. It also revealed that the estimated global installed capacity of biomass is 89GW, wind power (350GW), solar (179GW) and hydroelectricity stands at 1061GW representing the highest installed renewable electricity in the world.

The table also revealed that global average installed cost range of $KW (2014 estimate) ranges from $400-$6820 (biomass), $1190-$3680 (wind), $450-$3500 (Hydroelectricity) and about $1570-$4340 (solar energy). It therefore clear that solar energy cost most to be installed of all the renewable energy sources. The table further revealed that, in terms of per unit cost of renewable energy, solar energy cost more across different part of the world with average cost per unit of $0.14-$0.47 (₦48.9-₦167.3). While hydroelectricity cost the least in terms of cost per unit with a global average unit cost of $0.02-$0.15 (₦7.1-₦53.4). Although, biomass energy especially in China cost very low, as low as $0.08 on average.

Table 2. Nigeria Renewable Energy Outlook: Installed capacity, Cost and Capacity generation

Nigeria Renewable Electricity Estimation	**Biomass**	**Wind Power**	**Hydro Power**	**Solar Energy**
Nigeria Total Installed Capacity	15MW	Na	1.992GW	119MW
Average Installed Cost Range (₦/kW: 2015)	₦144,000 – ₦2,404,800	Na	₦234,000 - ₦1,728,000	₦565,200 – ₦2,368,800
Average Cost Per Unit (kWh: 2015)	₦16.56 – ₦75.6	Na	₦12.6 – ₦45.96	₦56.6 – ₦128.4
Capacity Generation Range	265kW- 780kW	Na	25MW – 500MW	50kW – 118MW

Source: Researcher own computation 2017 (Sources of information that aid this computation are listed at the appendix).

The above table revealed that of all the renewable energy sources in Nigeria, hydroelectricity is the most highly tapped and utilized with an installed capacity of 1.992GW for both large and small hydropower station in the country, it use to be the major source of electricity supply in Nigeria before it was replaced with Liquefied Natural Gas(LGN). The solar energy comes second with a total installed capacity estimated at 119MW throughout the country. the biomass takes the third place with 15MW, and finally the wind energy has no data, although some online website argued that wind turbine is established in some places like Nigeria university, FUTO among other places.

There was no data to accurately estimate the renewable energy potential Niger Delta rural communities. Intuitively, we understand that riverine communities have very low degree of sunshine because of the large body of water in the area, ruling out solar energy as the best alternative source of renewable energy in the region. Secondly, wind is relatively low, since, high sunshine is often accompanied with high degree of wind and we know there was no data at all for wind energy in Nigeria ruling out wind energy. Hydroelectricity be it large or small often relies on grid electricity distribution. In the case of the riverine communities is not possible given the large body of water, ruling out hydroelectricity as electricity source for the riverine communities. Thus, the research is left with only biomass as the best option in this case.

It was argued earlier that biomass electricity can either be sourced from agricultural waste plant and animal) or from municipal waste. The researcher after critical examination of the sustainability of agricultural waste in the region (low farming and low animal breeding) decides that municipal solid waste will be a better option to investigate.

Table 3 present the cost of generating electricity for Okoibiri community in Yenogoa. The researcher choice Okoibiri in Yenogoa is due to delay in the oil company providing data in Riverine communities. In terms of transportation, the estimated cost of transportation from Rivers capital to any of the riverine community is the same across the communities.

Table 3: **Cost of Generating Electricity with Diesel Generator for Okolobiri Community in Bayelsa State**

SN	**NARATION**	**Monthly**	**Yearly**
	Nameplate capacity of Power Generator: 100KVA (75KW)		
	Price of Generator: (including VAT, etc.) = **NGN16,000,000**		
	Depreciation Period (Years) = 10 years		
1	Yearly depreciation		NGN1,600,000
2	Monthly Operational cost - Personnel:		
a	3 operators (N40,000 each)	NGN 120,000	NGN 1,440,000
b	3 Security persons (1 on Night, 1 on Day & 1 on Off) - N40,000 each.	NGN 120,000	NGN 1,440,000
c	Daily diesel consumption – 12 hours per day (200 litres)	6,000	72,000
d	Cost of Diesel , including transportation = N200 / litre	NGN1,200,000	NGN14,4000,000
3	Land lease, Monthly rate for 50ft X 50ft Generator House, Substation facilities, Operator/ station guard hut @ monthly	NGN 120,000	NGN 1,440,000
4	Power Generation license / permits – yearly		NGN 200,000
5	Routine (Monthly) Maintenance Cost	NGN 100,000	NGN 1,200,000
6	Major maintenance - Yearly overhauls.		NGN 500,000
	Total		NGN22,220,000

Source: Shell BP Administrative

We could see from the table above that it cost Shell BP ₦22,220,000 for the company to provide Okoibiri community of 11,680 population with average household of 2,336 with electricity yearly. The above analysis revealed that per unit cost of electricity from that diesel generating set is about ₦67.64kWh. Of course, the figure is similar compared with the statistical fact obtained from WDI (2015), which estimate diesel generator plant per unit cost in Nigeria at ₦71.7kWh, petroleum generator at ₦69.5kWh and grid

electricity at ₦23kWh. However, table 4 below estimated the cost of generating electricity for the same community using biomass electricity plant.

Table 4: **Estimated Cost for Biomass Electricity Supply in Okolobiri**

SN	Estimation	Monthly	Yearly
	Biomass Plant (Municipal Solid Waste Power Plant: Capacity 300 KVA (200KW)		
	Price = $30,000 (NGN9,150,000 @ $1=NGN305)		
	Shipping, Clearing & Installation = $20,000 (NGN6,100,000 @ $1=NGN305)		
	Total Cost = $50,000 (NGN15,250,000 @ $1=NGN305)		
	Depreciation Period (Years) = 10 years		
1	Yearly depreciation		NGN1,525,000
2	Monthly Operational cost - Personnel:		
A	3 waste packers and 3 machine operators @ ₦40,000 each	NGN240,000	NGN 2,880,000
b	3 Security persons (1 on Night, 1 on Day & 1 on Off) - N40,000 each.	NGN 120,000	NGN 1,440,000
c	Daily waste consumption for 12 hour electricity = 1 tonne	30	360
d	Cost of Municipal Solid Waste per tonne = N35,000 (i.e. loading = ₦10, 000, haulage = ₦25,000)	NGN 1,050,000	NGN 12,600,000
3	Land lease, Monthly rate for 50ft X 50ft Generator House, Substation facilities, Operator/ station guard hut @ monthly	NGN 120,000	NGN 1,440,000
4	Power Generation license / permits – yearly		NGN 200,000
5	Routine (Monthly) Maintenance Cost	NGN 100,000	NGN 1,200,000
6	Major maintenance - Yearly overhauls.		NGN 700,000
	Total		NGN21,785,000

Source: Researcher own computation 2017 (Sources of information that aid this computation are listed at the appendix).

The research revealed that it will cost the company about ₦21,785,000 to generate electricity for Okoibiri community with a population of 11,680 using Municipal Waste power plant. The above analysis revealed that per unit cost of electricity from biomass waste generating set is about ₦24.87kWh which is relatively lower compared with that of diesel generating machine at ₦67.64kWh.

As can be seen above, from the cost analysis between generating electricity from diesel generating machine and that of biomass waste generating machine, it was discovered that biomass municipal waste machine will not only be cost effective (explicit cost) but also increase employment in the community and reduced environmental degradation improving health of the community members. For instance, the analysis revealed that while diesel generating machine employ six workers including security officers. The biomass municipal waste generating set employ eight direct staff (five machine operators and three securities). Indirectly, the plant also employ other workers who load the truck that transport the municipal waste from the Port-Harcourt urban city to the riverine communities.

Secondly, the biomass generating plant generate electricity in a friendly environment through reduction in CO2 emission in the atmospheric compared to that of diesel generating machine that release much CO2 in the air. The high environmental degradation also result into health issue among the rural communities. The above fact makes biomass-municipal waste the most viable option for generating electricity in Riverine communities in Niger-Delta region.

V. CONCLUSION

The reviewed literature proved that renewable energies are sustainable, non-depleting/exhausting and are environmental friendly to the community (see Arvind and Kaushik, 2017; Adebayo, 2014 and Newson, 2012). It was equally learnt from the literature reviewed that the world is blessed with abundant sources of renewable energy such that one source of renewable energy is capable of supplying all the renewable energy needs of the world at large. That renewable energy as source of energy is fast growing and has the tendencies to displace conventional sources energy in the next 50 years (see IRENA, 2015; Abubakar, 2017; Zang et al, 2017). Literature reviewed showed that Nigeria is highly endowed with enourmous sources of renewable energy in the country that even the policy makers are not aware of its extent (Newson, 2012).

From the empirical analysis, it was revealed that hydroelectricity is leading source of renewable energy in the world with a total installed capacity of 1061GW followed by solar energy. It was equally revealed that hydroelectricity has the least average cost per unit in the world with an average cost per unit at \$0.02-\$0.15 (₦7.1-₦53.4). It is recommended that the government should embark on massive outreach and awareness program to ensure that household and industries are aware of the environmental implication of indiscriminate disposal of waste. Household and industries should be aware that such activities are capable of causing health issue through mosquito breeding as well as causing soil erosion and soil infertility (especially the polyethylene components). With proper waste disposal, Nigeria can generate about 1500MW of electricity in each state.

Data Sources

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https://www.alibaba.com/showroom/municipal-solid-waste.html

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https://en.wikipedia.org/wiki/Waste-to-energy_plant

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