Reduction Of Carbon Footprint in Electricity Generation in Nigerian

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Abstract- The main purpose of this paper is to provide a comprehensive reduction in carbon footprint in electricity generated from existing thermal power plant in Nigeria as the aspect of cellulosic ethanol biofuel production. Cellulosic ethanol biofuel has the potential to cut off 88% of greenhouse gas in electricity generation compared to fossil fuel depend on the source of heat and power used in cost of production.

Indexed Terms- biofuel, renewable electricity, cellulosic ethanol, energy demand, generation.

I. INTRODUCTION

Nigeria is a vast country with a total of 356,667sq miles (923,768sq km), of which 351,649sq miles (910,771sq miles or 98.6% of total area) is land. The nation is made up of six -Geo -political zones subdivided into 36 states and the federal capital territory (FCT) [1].

Electricity in Nigeria is generated through thermal and hydro power sources. The main source of electricity generation comes from fossil fuels especially gas which accounts for 86% of the capacity in Nigeria with the remainder generated from hydro-power sources [2]. But the existing thermal stations and hydro power plants are challenged with the problem of insufficient gas supply and low water levels, respectively. Hence, Nigeria is now determined to increase electricity generation capacity and diversify the energy mix in the short term by expanding the existing hydro power plants while installing steam turbines in the thermal plants, thus converting the open gas fired power plants to a combined cycle. The Nigeria also plans to install a nuclear power plant in the long term, coal fired thermal plants, and renewable power source (solar, wind, water, biomass, tidal, biofuels) in the medium term (3).

A. ENERGY DEMAND AND SUPPLY

Electricity plays a very important role in the socio-economic and technological development of very nation. The electricity demand in Nigeria is about 9895MW, not including export demand from other country. The Nigeria is faced with acute electricity problems, which is hindering its development notwithstanding the availability of natural resources in the Nigeria.

B. HOW MUCH MONEY SPEND IN ELECTRICITY GENERATION IN NIGERIA

The inadequate power supply situation in Nigeria has been identified as a major challenge facing much business in the country. Nigeria spends about $ 14 billion (ft 5 trillion) annually on generators, maintenance and fueling in other to keep our business afloat-. We need to look at an alternative source of power, such as cost of purchase, maintenance, and fuel of generating sets in the country for the purpose of electricity both for manufacturing and general consumption.

C. GENERATION

The Total Installed Capacity of the currently generating plants is 7,876 MW (Table 1.0), but the Installed available Capacity is less than 4000MW as at December 2009. Seven of the fourteen generation stations are over 20 years old and the average daily power generation is below 2,700MW, which is far below the peak load forecast of 8,900MW for the currently existing infrastructure. As a result, the nation experiences massive load shedding. Through the planned generation capacity projects for a brighter future (Table 1.1); the current status of power generation in Nigeria presents the following challenges:

i. Inadequate generation availability;
ii. Inadequate and delayed maintenance of facilities;
iii. Insufficient funding of power stations;
iv. Obsolete equipment, tools, safety facilities and operational vehicles

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v. Inadequate and obsolete communication equipment
vi. Lack of exploration to tap all sources of energy form the available resources; and
vii. Low staff morale.

Table 1a: Existing Power Generation Capacities in Nigeria

s/n	Plant	Plant types	Location state	Age (years)	Installed units	Installed capacity (MW)	Unit available
1	Egbin	Thermal	Lagos	22	6	1320	4
2	Egbin AES	Thermal	Lagos	6	9	270	9
3	Sapele	Thermal	Delta	25-29	10	1020	1
4	Okapi	Thermal	Cross river	2	3	400	2
5	Afam	Thermal	Rivers	25	20	702	3 '
6	Delta	Thermal	Delta	17	18	840	12
7	Omoku	Thermal	Rivers	2	6	150	4
8	Ajaokuta	Thermal	Kogi	Na	2	110	2
9	Geregu	Thermal	Kogi	1	3	414	3
10	Omotosho	Thermal	Ondo	New	8	335	2
11	Oloninsogo	Thermal	Ogun	New	8	335	2
	Subtotal	Thermal			93	5976	44
12	Kainji	Hydro	Niger	38-40	8	760	6
13	Jebba	Thermal	Niger	24	6	540	6
14	Shiroro	Thermal	Niger	22	4	600	2
	Subtotal	Hydro			18	1900	14
	Grand total				111	7876	58
	Summary	%thermal			84	76	76
		%hydro			16	24	24

Table 1b: Existing Power Generation Capacities in Nigeria

s/n	Power station	Type	State	Capacity (mw)	Status
1	Egbin	Thermal	Lagos	1320.00	Existing
2	Afam	Thermal	Rivers	969.60	Existing
3	Sapele	Thermal	Delta	1020.00	Existing
4	Ijora	Thermal	Lagos	40.00	Existing
5	Kainji	Hydro	Niger	760.00	Existing
6	Jebba	Hydro	Niger	578.40	Existing
7	Shirorro	Hydro	Niger	600.00	Existing
8	Delta	Thermal	Delta	912.00	Existing
9	Orji	Coal	Rivers	20.00	Existing
10	Geregu	Thermal	Kogi	414.00	Ongoing
11	Omotosho	Thermal	Ondo	335.00 -	Ongoing
12	Papal anto	Thermal	Ogun	335.00	Ongoing
13	Alaoji	Thermal	Abia	504.00	Ongoing
14	Omoku	Thermal	Rivers	230.00	New IPP
15	Rain/ube	Thermal	Bayelsa	225.00	New IPP
16	Sapele	Thermal	Delta	451.00	New IPP
17	Eyam	Thermal	Edo	451.00	New IPP
18	Egbema	Thermal	Imo	338.00	New IPP
19	Caliber	Thermal	Cross river	561.00	New IPP
20	Mambilla	Hydro	Taraba	2600.00	New
21	Zungeru	Hydro	Niger	950.00	New
22	AES	Thermal	Lagos	300.00	Commissioned IPP
23	AGIP Okpai	Thermal	Delta	480.00	Commissioned IPP
24	Omoku	Thermal	Rivers	150.00	Approved IPP
25	Obajana	Thermal	Kogi	350.00	Approved IPP
26	Ibom power	Thermal	Akwa Ibom	188.00	Approved IPP
27	Ethiope energy ltd			280.00	Approved license IPP
28	Farm electric supply	Jm		150.00	Approved license IPP
29	ICS power			624.00	Approved license IPP
30	Supperlic ltd			1000.00	Approved license IPP
31	Mabon Ltd			39.00	Approved license IPP
32	Geometric ltd			140.00	Approved license IPP
33	Aba power ltd			0.00	Approved license IPP
34	Western tech energy			1000.00	License granted IPP
35	Lotus & Bresson			60.00	License granted IPP
36	Anita energy ltd			136.00	License granted IPP
37	First			95.00	License granted IPP
38	First independent			150.00	License granted IPP

D. HISTORICAL OVERVIEW OF REDUCING CARBON FOOTPRINT IN ELECTRICITY GENERATION IN NIGERIA

The recent development in carbon dioxide (C02) emissions generated from existing thermal power plants in the country. Methodology approach thermal power plants in Nigeria and their installed capacities were Identified, and estimation of CO2 emission from each of the plants was carried out using the emission factor method [5]. The proposed method requires the potentials converting flared as from the Nigeria oil and gas industry to compressed natural gas (CNG) which could be an alternative fuel for the 220-lag bus rapid transit (BRT-Lite) while reducing C02 emissions. In addition of this study is to provide an overview of gas flaring in the oil and gas industry and energy utilization in some selected sector in the country [6] Various environmental challenges pose a lot of threats to sustainable development, among which are global warming, air pollution, and loss of biodiversity The another method concludes that to move toward a low carbon economy in Nigeria, there is the need to institutionalize appropriate behavioral and social changes in the society as well developing technological capabilities in the area of clean of the area of clean technologies [7]. This method investigates the factors.

That influences the change in CO2 emissions from electricity generation in 'Nigeria. The logarithmic mean division index (LMDT) method of decomposition that was used. the main result show that (1) CO_2 emission from electricity generation decreased by O.5mt (2) electricity efficiency decreased CO_2 emission by 2.33ft (3)e electricity intensity decreased CO_2emission by 2.85mt (4) economic activity increased CO_2 emission by 28.27ft. The result shown that CO_2emission increased in Nigeria. Electricity efficiency and intensity contributed to the reduction of CO2 emission while economic activity has contributed to the increase in CO_2 emission in Nigeria. Since economic activities cannot be reduced with affecting the economics performance of Nigeria, energy efficiency improvement would be an important option to reduce CO_2 emission [8].

II. METHODOLOGY

A. RENEWABLE ELECTRICITY GENERATION TECHNOLOGIES

A renewable electricity generation technology harnesses a naturally existing energy flux, such as wind, sun, heat, biomass, tidal and biofuel and converts that flux to electricity. Natural phenomena have varying time constants, cycles, and energy densities. To tap these source of energy, renewable electricity.

Generation technologies must be located where the natural energy flux occurs, unlike conventional fossil fuel and nuclear electricity generating facilities, which can be located at some distance from their fuel sources. Renewable technologies also follow a paradigm somewhat different from conventional energy sources in that renewable energy can be thought of as manufactured energy, with the largest on proportion of costs, external energy, and material inputs occurring during the manufacturing process although conventional sources such as nuclear and coal powered electricity generation have a high proportion of capital to fuel costs, all renewable technologies, except for biomass generated electricity (bio power), have no fuel cost. The trade-off is the ongoing and future cost of fossil fuel against the present fixed capital cost of renewable energy technologies. Renewable electricity achieves economies of scale primarily at the equipment manufacturing stage rather than through construction of large facilities at the generating site. Large hydroelectric generating units are an exception and have on site economics of scale, but not to the same extent as coal waste and nuclear-powered electricity plants.

B. BIOFUEL

Biofuel are a source of energy derived from biomass, such as corn grams and other plant life. There is currently a large push in research and development of this energy source as they are renewable as opposed to the currently used fossil fuels [25].

C. CELLULOSIC VS FOSSIL FUEL

Currently, the majority of energy in the Nigeria is produced by the fossil fuels, oil and natural gas. Unfortunately, by, there have been problems with fact that these resources are not renewable. There has been a recent push to develop a renewable energy source with which to fuel energy needs, such as for vehicles and other personal use. Ethanol produced from corn is one such step. However, other form of plants is able to produce much more energy from ethanol they produce.

D. PRODUCTION OF CELLULOSIC ETHANOL BIOFUEL

Ethanol production from cellulosic material such as agricultural residues (e.g, wheat straw and corn stove) and energy crops (e.g switch grass and miscanthus) is considered a highly promising option for further ethanol production, helping the energy diversification and de-carbonization of the transport sector. Compared to conventional (or first generation) ethanol production from food and feed crops (mainly sugar and starch-based crops), cellulosic (or second generation,2G) ethanol is considered to provide better performance in terms of green-house gas (GHG) reduction and low risk of direct and indirect land use change impacts. Those advantages have led to the promotion of cellulosic ethanol in the legislation around the globe.

Advanced biofuels contain 3.5% for 2030 within the 14% target for renewable energy in transport. The as the biofuel are defined by the directive as biofuel's that are produced from the feedstock listed M Part A OF annex IX that includes among others, agriculture and forestry residues as well as energy crops. Those biofuels will continue to count double towards the target. In addition, biofuels must meet a 65% greenhouse gas reduction threshold (installation starting operation from 1 January 2021), to try to ensure substantial GHG saving compared to fossil – based fuels.

Cellulosic biofuel is an advanced is required to have a greater than or equal to60%GHG saving compared to a 2005 petroleum baseline [10]. The renewable fuel standard (RFS) program required 36 billion gallons of biofuels to be used by 2022, of which at least 16 billion gallons were supposed to come from cellulosic biofuels [11]. Like renewable energy standard, it favors fuels with lower carbon intensities and biofuel producers will receive credit based on the lifecycle emission savings of their fuel compared to fossil fuel. The thermochemical process uses heat to convert biomass into liquid fuel. This method is particularly suited for feed stuck high in lignin, such as wood. Partial combustion at low temperatures in the absence of oxygen produces pyrolysis oil that is then refined to liquid fuel [12,13)

Table 2: Raw Materials and Quantity

COST	CELLULOSE PRODUCTION APPROACH		
	Off-site	Off-site	Off-site
Raw material and consumables			
Biomass, day	0.25	0.25	0.33
Sulphuric acid	0.02	0.02	0.02
Ammonia	0.03	0.03	0.05
Cornsteep liquor	-	-	-
DAP	0.01	0.01	0.01
Sorbitol	0.01	0.01	0.01
Cellulose	0.65	0:46	0.15
Cellulose transport	0.01	-	-
Caustic	0.03	0.03	0.05
Lime	0.01	0.01	0.01
Water	0.01	0.01	0.02
Subtotal			

Table 3: Raw Materials and Cost

COST	CELLULOSE PRODUCTION APPROACH		
	Off-site	Off-site	Off-site
Raw material and consumable			
Biomass, day	543,000	294,134	649,399
Sulphuric acid	362,422	393,514	405,899
Ammonia	1,237,049	1,330,499	1,461,321
Corn steep liquor	106,000	100,101	117,921
Dap	281,411	302,531	314,641
Sorbitol	107,101	113,716	120,060
Cellulose	255,447	-	-
Caustic	1,148,743	1,256,113	1 ,296,934
Lime	250,757	255,981	297,831
Water	5941	6097	88,28
Utilities			
Electricity	44780	44780	44780

Table 4: Raw Materials and Cost

Item	Unit	Cellulosic ethanol production	Bio-methane production
Biomass	T	1.00	1.00
Cellulose	Kg	7.75	-
Sulphuric acid	Kg	24.50	-
Lime	Kg	15.35	30.00
Phosphate acid	Kg	1.63	9.34
Corn steep liqur	Kg	12.75	17.30
Electricity	Kwh	165.5-	311.0
Steam	GJ	4.27	1.80
Output			
Ethanol	Kg	273.0	-
Methane	m^3	-	105.0
Co-product	Kg	127.0	306.0
Solid waste	Kg	55.0	15.0
Carbon dioxide	m	150.0	203.7

E. CHEMICAL EQUATION OF BURNING FOSSIL FUELS IN ELECTRICITY GENERATION AND BALANCING COMBUSTION REACTION

Fuel+ $0_2 \rightarrow C0_2 + H_20$
Hydrocarbon + Oxygen →carbon dioxide + water
$C_nH_{2n+2} + 0_2$ $C0_2 + H_20$

$$C_5H_{14} + \frac{19}{2} O_2 CO_2 + H_2O$$

$$C_6H_{14} + \frac{19}{2} O_2 6CO_2 + 7H_2O$$

F. CELLULOSIC ETHANOL COMBUSTION

$C_6H_{12}0_6 \rightarrow$ (Cellulosic Ethanol) + $C0_2$ +H_2
$C_6H_{12}0_6 \rightarrow 2CH_3\ CH_20H + 2C0_2$
Cellulosic Ethanol burns cleaner than un-lead gasoline producing lower GHG emission of particulate matter and toxics. Cellulosic ethanol has the potential to cutgreen-house gas emission by up to 88%.

Table 5: A partial listing of Computer developing Ethanol Cellulose Technologies

Company & headquarter location	Technology	Primary feedstock	Ethanol capacity	Comments
BCI, Dedham MA	Dilute acid	Bagasse	7560 million L/Yr (10 million gpy)	Plant to break ground in 2002
Bioengineering Resources, Fayetteville AR	Thermochemical gasification with fermentation			Pilot plant operating
Ethyl International Aurora, ON	Thermochemical gasification with	Wood		Pilot plant operating
	catalytic conversion			•
Fuel Cell energy Lake wood co	Thermochemical gasification with catalytic conversion	Oat halls, switch grass, wheat straw, and corn stover	370 million L/yr (1 million gpy)	Experimental plant operating
Logen, Ottawa, ON	Enzymatic			
Masada, Birmingham, AL	Concentrated Acid	MSW	3780 million L/yr (10 million gpy)	Plant to break ground early 2002
Paszner Technology, Inc, Surrey, BC	Cidfied a gueous acetone process	Wood		Commercial plants under construction
Pure vision Technology, Ft lupton CO	Enzymatic t	Wood		Constructing pilot plant

CONCLUSION

The purpose of this paper is to identify the method that can be used minimized green-house gas in electricity generation in Nigeria. The poor state of the electricity situation in Nigeria has been Impacting vary negatively on the life of the people, paralyzing Industrial and manufacturing machinery, and stultifying economic growth of the country. The case study of this paper is to use cellulosic biofuel is required to have a greater than or equal to 88% GHG saving compared to a petroleum baseline.

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