Decentralizing the Centralized Energy System Using CCAM Model: Key to Greener Energy Mix and Sustainability in Nigeria

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Abstract

Nigeria energy system is strongly centralised and unsustainable, associated with waste of huge amount of primary energy input, full of insecurity and climatic change threat and crises. To averts these energy crises, the entire energy requires an urgent energy revolution and this could be achieved by decentralising the country strongly centralised energy using an appropriate model whose energy mix is more of renewable energy. This paper presents how the Community Choice Aggregation Model (CCAM) can decentralise the entire energy system of Nigeria and ensure sustainability. The sustainability criteria of Gibson and Jaccard were used to evaluate the sustainability capacity of CCAM in line with existing Nigeria energy policies. The criteria include potential risks to the environment and humanity, the scale, adaptive capacity and resilience of an energy system, avoided path dependency, intra and intergenerational equity, participatory and inclusive governance, efficiency, and cost-effectiveness. The results from the evaluations have proven CCAM with partnership/joint ownership structure a veritable energy decentralization tool for ensuring greener energy mix and sustainability in Nigeria and the globe. The essentials of this paper can be employed for future energy planning and policy implementation.

Key Words: *Energy sustainability, Greener energy, Decentralising, Community, Sustainability Criteria, Renewable energy, CCAM.*

Introduction

Decentralizing the centralized energy system means geographically spreading multitudes of energy generating stations and producing energy from sources at or near site where it is consumed. Decentralized energy includes high efficiency cogeneration (CHP), on-site renewable energy and industrial energy recycling and on-site power. An energy system is sustainable if its supply rate largely outweighs the rate of consumption with manageable collateral effect, having the ability to serve the present generation energy needs without compromising the energy needs of future generation (Shove *et al*, 2015; Adams et al,2016;Hafner et al,2018;IEA,2020). An energy mix is said to be greener if it can be transmitted and/or consumed without any significant negative impact to the environment. Greener and sustainable energy mix may include more of the renewable sources such as solar, biomass, wind, geothermal, low-impact small hydroelectric sources and energy from incineration of nuclear waste by integral fast reactors (Farrel, 2011;Africa Report,2015;Adewuyi and Awodume,2017; BP,2020).

Nigeria as a nation is endowed with abundant energy resources that could lead her to self-sufficiency and sustainability if properly harnessed. Ironically, the country is full of threats of energy insecurity and vulnerability, threats of climate change and unsustainable future, to an extent, her electricity power supply was termed to be epileptic whose sustainability requires a state of emergency (World Bank, 2015; ADB,2017;Boisgobault and Alkabbani,2020). More over putting pressure on households generating their own electricity ,especially in the rural areas using power generators coined as " I pass my neighbour" that have killed many citizens through emitted fumes and fire out breaks. In finding solutions to these energy crisis the National Energy Commission through it organ (National Energy Policy) has developed excellent policies but unable to implement them due to endemic corruption, lack of political will and multicultural nepotism by the government and vandalism and sabotage coupled with incessant attacks from Niger Delta militants and oil thefts(Achakpo *et al*,2015;Aliyu et al,2018).

Amidst the energy crises bedevilling her economy, a shift towards a more sustainable energy system using an appropriate model cannot be overemphasized. In addition, decentralising energy requires a strategic evolution in the existing physical, regulatory and institutional architecture of the energy sector of a country. Thus, the choice of the Community Choice Aggregation Model (CCAM) in tandem with various efforts of resolving the energy crises and empowering community stakeholders through substantial returns on investment that will ensure safer environment and go towards economic, social and political developments. The Community Choice Aggregation Model (CCAM) has been proven suitable for energy sustainability in Canada, Germany, Denmark, China, France and Netherland, and South Africa (Gipe, 2011;Aguirre and Ibikunle,2014;Achakpo et al,2015;Abubakar et al,2016;Gyamfi et al;2018). The model decentralized their strongly centralized energy system and supported communities to plan, generate, transmit and manage their energy mix. This paper evaluates the suitability of the Community Choice Aggregation Model (CCAM) as a tool for effective greener energy decentralization in achieving energy sustainability in Nigeria. In this case, Gibson and Jacquard's sustainability assessment criteria were employed.

Methodology

The present states of Nigeria energy supply and demand were assessed with that of the global energy in order to validate the reasons for adopting the Community Choice Aggregation Model CCAM of energy sustainably. A workable ownership structure of Community Choice Aggregation Model (CCAM) was chosen, defined and described with suitable energy mix. To know whether CCAM is sustainable with the chosen energy mix, the sustainability criteria of Gibson (2005) and Jaccard (2006) were employed to create a framework for an accurate policy evaluation, analysis and assessment in line with existing energy policies in Nigeria. These criteria include intra and generational equity; risks to environment and humanity; scale, adaptation and resilience of the system; lower path dependency, participatory, inclusive and democratic governance, efficiency and cost effectiveness.Table1 summarizes the Jaccard and Gibson's sustainability criteria for assessing and evaluating CCAM.

Table 1: Sustainability Criteria for Energy Systems (Gibson, 2005; Jaccard, 2006)
(I)Inter and intragenerational equity: The level of consideration for present options that preserve and/or improve opportunities for all humanity and for future generation. Evaluation considerations: ❖ The ability to build equitable livelihood for all; and ❖ The ability to reduce gaps between the rich and the poor in the present and in the future (II)Risks to environment and humanity**:** The extent to which an energy system affects biophysical and socio-biophysical systems and human health

Evaluation considerations:

- ❖ The ability to reduce direct and indirect human threats;
- ❖ The ability to reduce direct and indirect environmental threats;
- ❖ The ability to reduce and avoid extractive damages and waste; and
- ❖ The ability to consider all extreme event risks, despite their chances of occurrence

(III)<u>Scale, adaptability and resilience of a system</u>: The scale at which an energy system is able to adapt to supply and demand, and its likelihood of maximizing resilience and minimizing system stress

Evaluation considerations:

- ❖ The extent to which a system can adapt to a current energy system and respond to changing supply and demand requirements;
- ❖ The extent to which availability of a source is considered; and
- ❖ The extent to which resilience and flexibility are considered

(IV)<u>Lower path dependency</u>: The degree to which an energy system can help overcome the current inertial lock-in forces or constraints of path dependence on large centralized energy systems, and create a future innovation and constant technological improvement

Evaluation considerations:

- ❖ The degree to which change in technology innovation and evolution is considered; and
- ❖ The degree to which long-term thinking and transition to new zero-carbon economies are considered

(V)<u>Participatory, inclusive and democratic governance</u>: The ability of an energy system to enhance democratic values and enable a more participatory and inclusive decision-making process

Evaluation considerations:

- ❖ The extent to which governance structures include individuals in decision making exercises;
- ❖ The ability to create societal awareness of sustainability options; and
- ❖ The ability to mobilize and engage societies to apply sustainability awareness in all communities

(VI)<u>Efficiency & Cost--effectiveness</u>: Analysis of the feasibility of an energy system from an economic, social and environmental cost perspective

Evaluation considerations:

- ❖ The extent to which more is achieved with less material, economic and energy input.
- ❖ The extent to which all positive and negative externalities, pre-existing subsidies, and price distortions are considered in cost calculations; and.
- ❖ Once the above-mentioned considerations are monetized, the ability to meet energy demands

Results

Nigeria in Global Energy Supply and Demand

Nigeria is endowed with sufficient energy resources to meet her present and future energy development and sustainability. According to the statistics from the International Energy Agency (IEA), total Nigerian primary energy supply was 118,325 Kilotonnes of Oil Equivalent (ktoe) excluding electricity trade. From the conventional energy sources, natural gas accounts for 5%, Petroleum products for 41%, fuel wood for 51% and hydroelectricity for 3% (Figure 1). However,hydropower is the only renewable energy source currently exploited at the center that accounts for 0.4% of the country total renewable energy capacity and 19% of exploited energy connected to her grid(EIA,2015;IEA,2019).

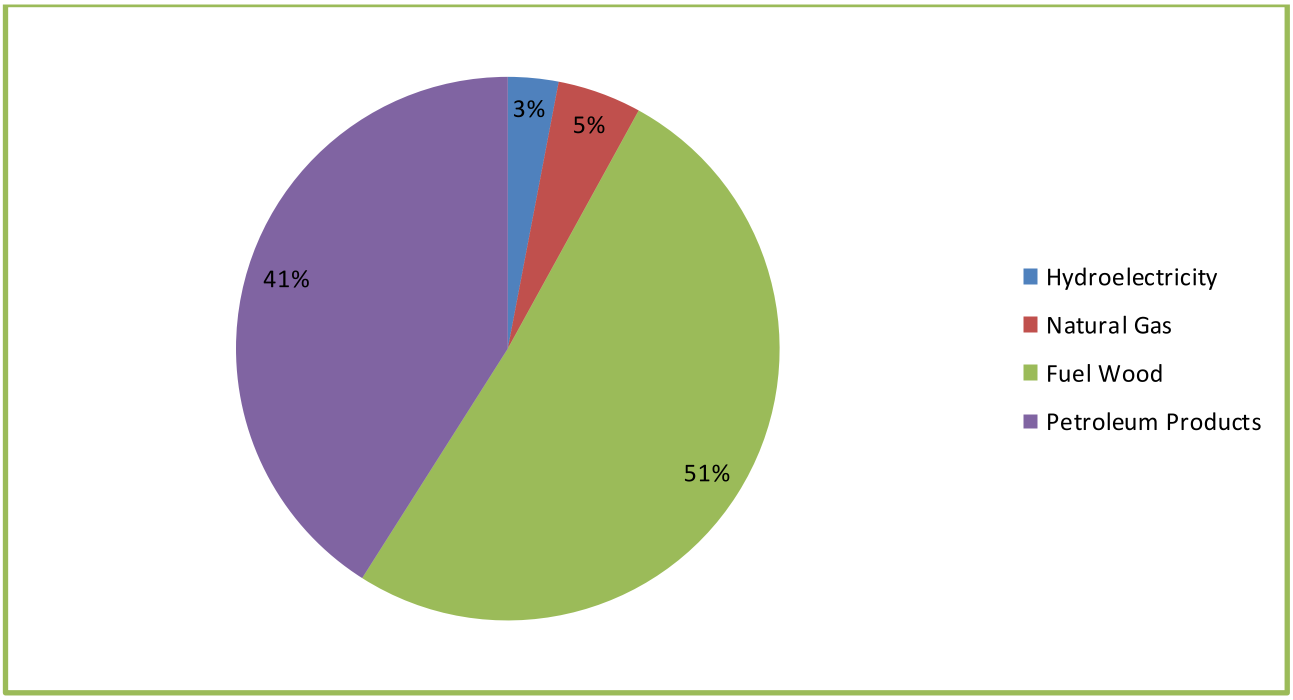


Figure 1: Total Energy Supply in Nigeria(After IEA,2019)

Globally,93% of energy is supplied through centralized generation out of which 67% of the primary energy inputs are wasted.This is a wastage, if efficiently deployed by effiecient decentralization measures could supply the existing world energy demand nearly thrice over and about $2.7 trillion can be saved globally to 2030(Green Peace International,2014;1EA,2018). The energy system of Nigeria is strongly centralised and the Federal Government solely manages the generation. The centralized system relies on many cables and expensive infrastructures such as pylons and sub stations to transmit and distribute power generation and heat. Apart from this huge amount of energy wasted through in efficient generation, more is still lost in cables during transmission and distribution, and more even wasted through inefficient end use due to disruption that are technically localised, weather related, vandalism and sabotage. Only about 22% of the total energy is actually utilized. On energy consumption by resources, biofuel and waste account for the highest (85.3%) of which residential consumption accounts for 89.6%, followed by fossil fuels (12.7%) including natural gas and oil products, electricity (1.9%) and currently coal is unexploited (Figure 2)(Mandell *et al*,2014,Moyo et al,2017;IEA et al,2020).

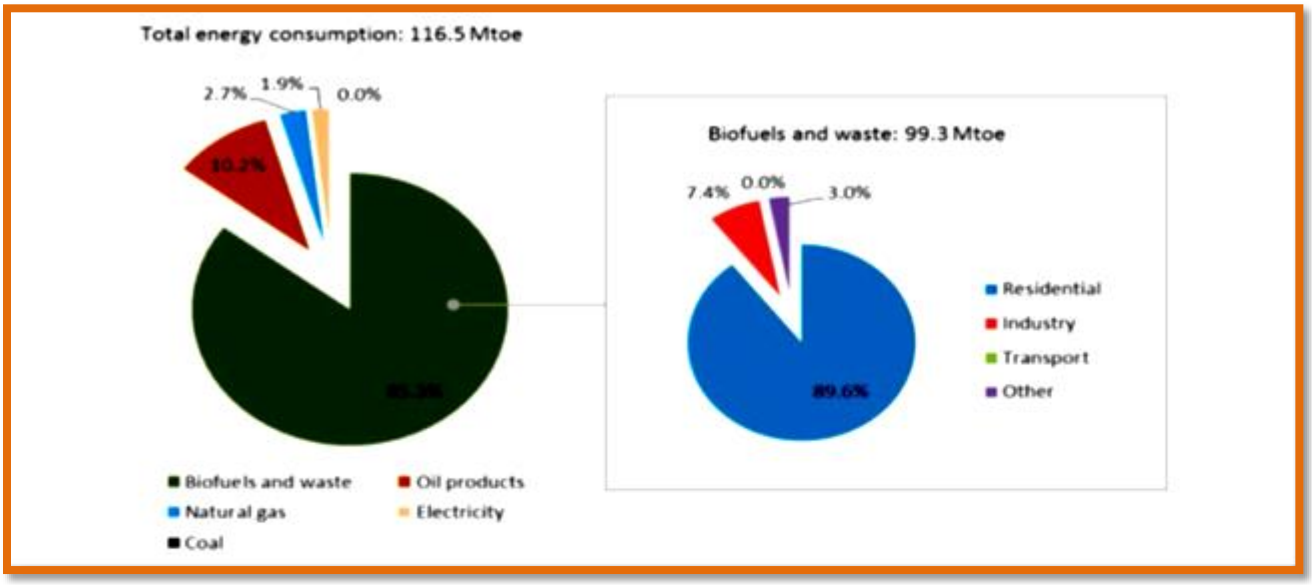


Figure 2: Total Energy Consumption by Energy in Nigeria Resources (EIA, 2019)

Nigeria's current energy mix is more of non-renewable sources energy with a total final consumption of 116,457 ktoe, of which the residential sector accounted for 78% (90709 ktoe)(Figure 3). Nigeria consumes the highest on residential consumption when compared with the peer countries and consume the least at industrial sector because of not being a major manufacturing country (IEA, 2015,IEA,2019).

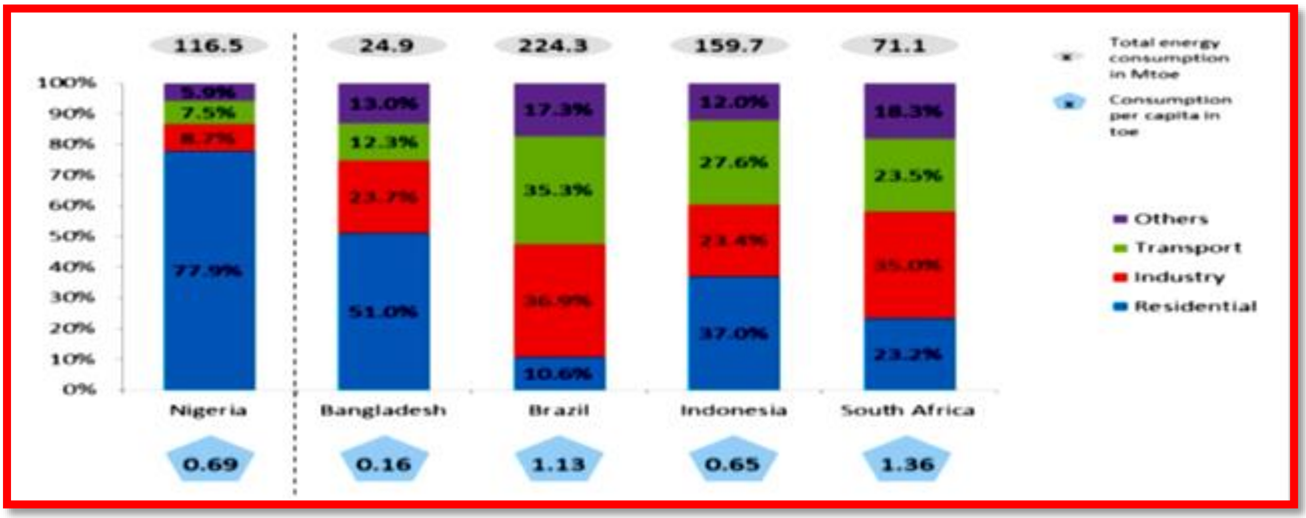


Figure 3: Total Energy Consumption By Economic Sectors And Consumption Per Capita For Nigeria and Peer Countries (After EIA, 2019)

The current energy generation most especially in the electrical sector relies heavily on burning fossil fuels such as natural gas and crude oil with associated CO_2 emissions and huge primary input energy wastage. In fact, three times more energy is put in the centralised model than is demanded by consumers. In the face of climate change, energy security and sustainability concerns, such wastage is indefensible (Mohammed *et al*, 2014;Trotter et al,2017;Xu et al,2019). To put an end to this environmentally destructive wastage, energy reform is urgently need, overhauling the current regulatory and policies to decentralise the strongly centralised energy system for sustainability. Decentralized energy mix could either be more of renewable or non-renewable but the former is clean and optimal, environmentally friendly, more efficient, conserved, reliable and more secured. For Nigeria, the best approach for greener energy mix and sustainability is to adopt model whose energy mix is more of sun and wind as their sources are available in all parts of the country, their use require simple technology and low cost financing without minimal environmental hazards(Achakpo *et al*,2015).

Nigeria has its geographical location as an advantage,that, the equitorial region which is full of large amount of solar energy.Solar radiation is fairly well distributed in Nigeria with an average solar radiation of about 19.8 MJm^{-2} and an average sunshine hours of 6 hours a day,ranging between about 3.5 hours at the coastal areas and 9.0 hours at the far northern region(Abubakar *et el*,2016;REN 21,2017;IEA 2020)

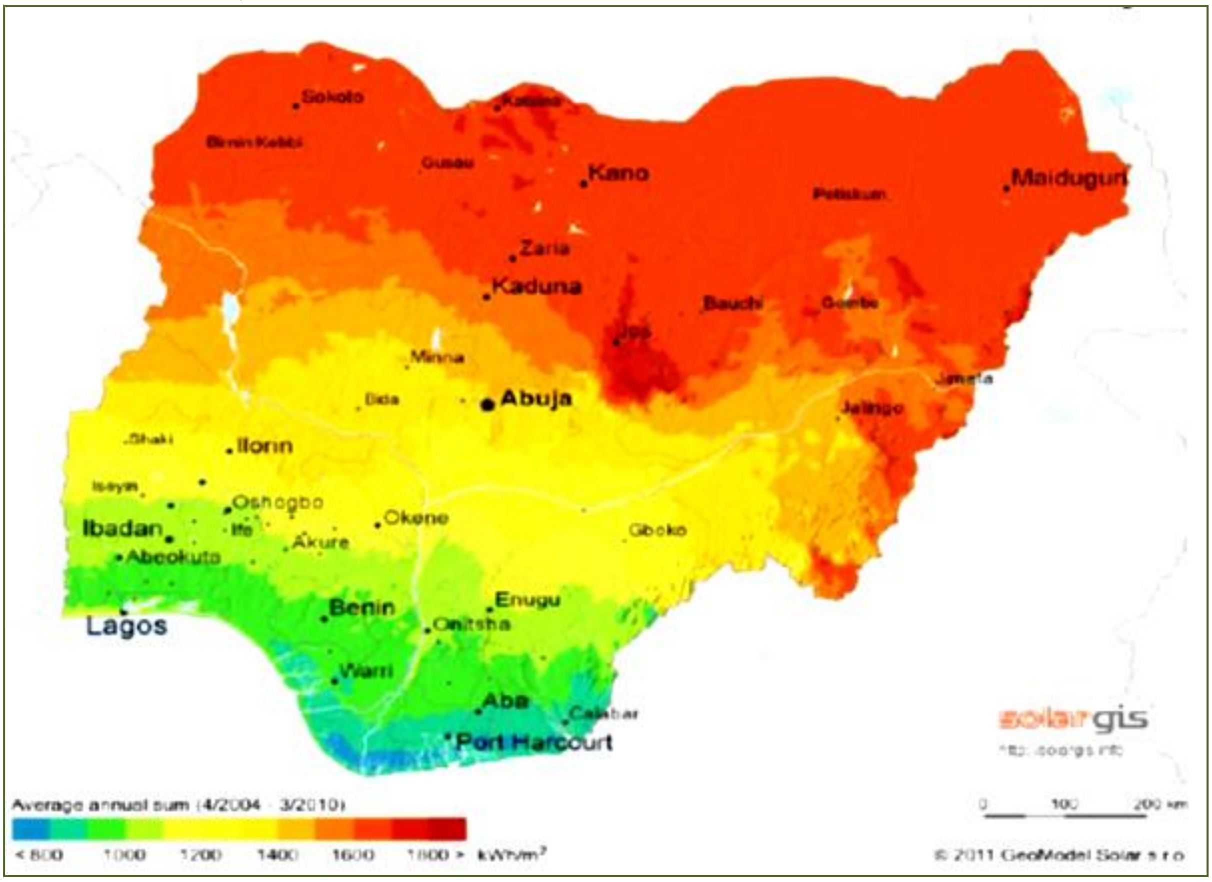


Figure 4: Nigeria’s Average Solar Radiation Map (www.ases.org/tag/**geomodel-solar,2020**)

If solar modules were used to cover 1% of the Nigeria land mass,it would be possible to generate a clean energy of 1850x 10^3 GWh of solar electricity per year,which is over 100 times the current grid electricity consumption level in the country(Abubarkar *et a*l,2016;Olouchi et al,2021).The solar radiation in the northern part of the country is more compared to that of its sourthern part(Figure 4). Curently, wind energy is not used in Nigeria but in profering solution to the lingering energy crisies in the country,researches were conducted to determine its potential in her various geopolitical zones.The results from the research are presented in a map(Figure 5). The annual wind speed at 10m above the ground varied from 2.3 - 3.4m/s for along the coastal areas and 3.0-3.9m/s for high lands areas and semi-arid regions.Sokoto state is capable of a power potential of 97MW/yr(IEA,2015,IEA 2019).

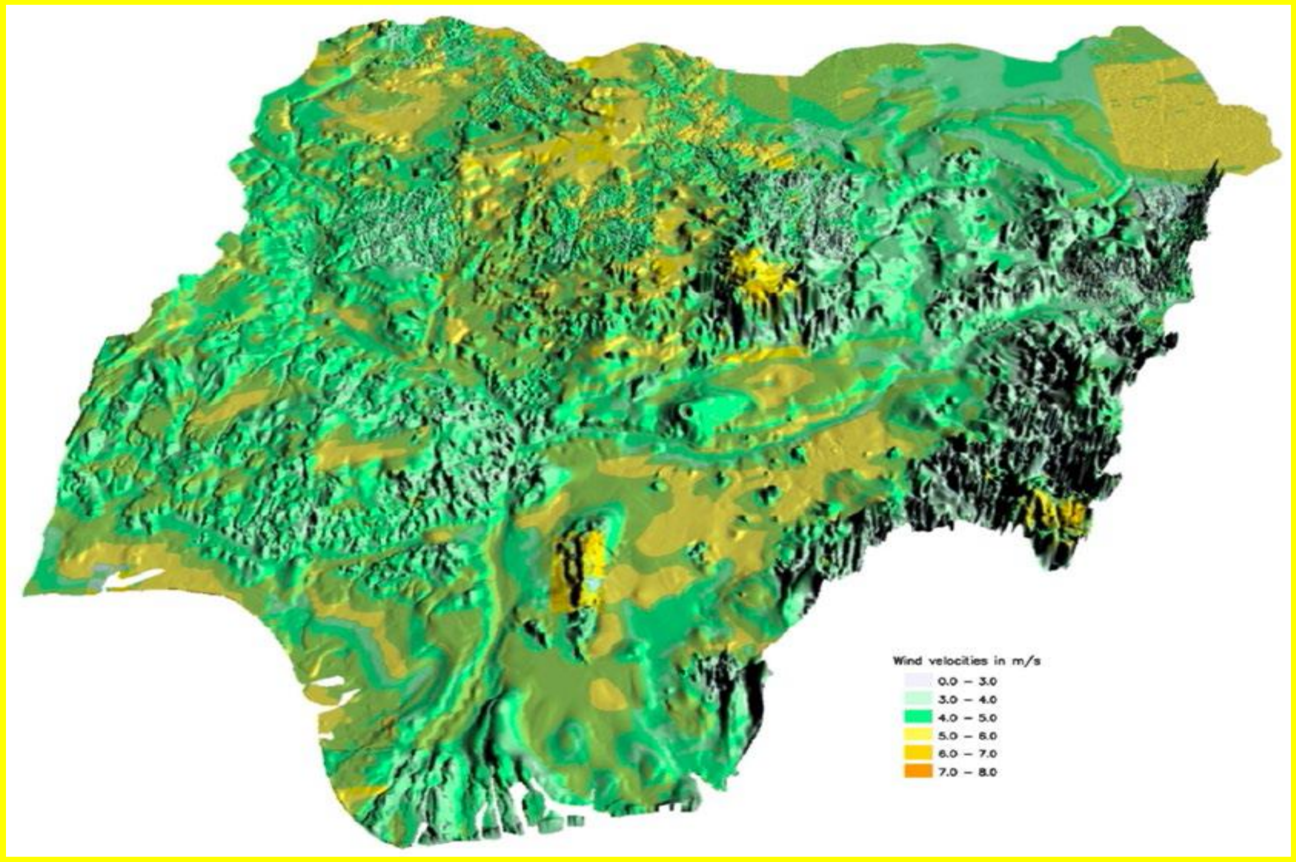


Figure 5: 3D Wind Map of Nigeria, 80m Above the Ground (EIA,2019)

Wind speeds are strongest in the hilly regions of Northern Nigeria, ranges 4.0-5.12 m/s and weak in the south, ranges from 1.4-3.0m/s excepts for the coastal regiopns and offshores from Lagos through Ondo,Delta,Bayelsa,Rivers to Akwa Ibom states.These coastal region have great potential for harvesting strong wind energy through out the year with peak wind speed in April and August at the same locations(EIA,2015;BP,2020).

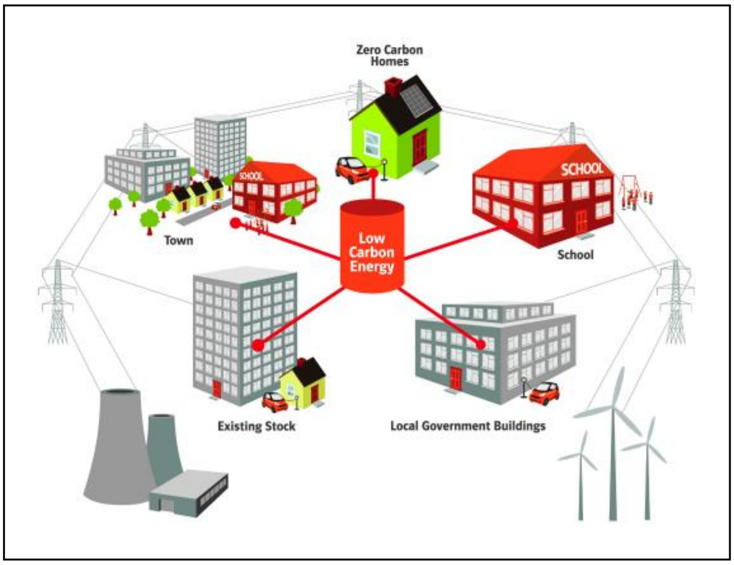
The Workable Ownership Structure of CCAM

The Community Choice Aggregation Model (CCAM) is an energy decentralising model which involves a community having majority of the voting right in taking decisions on the type of renewable energy technological that could suit her energy services and size in terms of the stake holders needs and wants, thereby maximizing the socio economic benefits of the affected society.

The community in CCAM model could be a group of individuals, farmers, landowners, local rural-electric co-operatives, municipal utilities and local governments, or public/private partnerships that can initiate, generate, control and own an energy system in their locality. There are three major workable ownership structures for CCAM and these include 100% community cooperative where individuals who share in the same interest in the community pool their capital through the purchase of shares. The Partnership/ Joint ventures that occurs when the communities do not have access to sufficient capital and therefore partner mostly with private renewable energy developers, utilities etc to enable a project financing. The Landowners structures ownership structure occurs when landowners who own adjacent land band together and pool their resources for the project funding (Community Energy Partnership Program, 2011;ADB,2017,IEA,2018)

Out of these workable CCAM structures, the most suitable for Nigeria is the Partnership/Joint Venture structure because of the level of poverty in the country, which is about 61%, coupled with the current economic recession(OECD/EIA,2010).Most communities are very poor having no access to sufficient capital. Therefore, they can collaborate with private renewable energy developers, utilities or cooperative as joint venture to enable the CCAM financing while profits, ownership, control and decision-making will be relatively equal. The CCAM energy mix is more of solar and wind with biomass and small-scale hydropower and tidal energy and the proximity of the generating plants to energy consumers allows any waste heat from combustion processed to be piped to buildings nearby through cogeneration to ensure the use of all primary input energy(Green Peace International,2014;Africa Report,2015;Adewuyi and Awoduni,2017,Gyamfi et al,2018). The CCAM is very flexible, it can serve a single building or a whole community, even being built out across entire cities and it can fit into urban and rural low carbon emission energy plans energy (Figure 6).

(a)



(b)

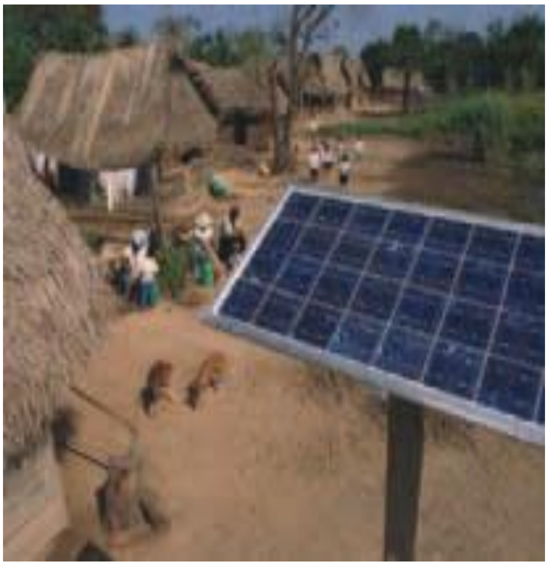


Figure 6: (a) The Urban Cities CCAM Network. (b) The Rural Stand Alone CCAM (Green Peace International, 2014)

The CCAM presents a unique opportunity can help developing country like Nigeria progress towards the provision of clean, affordable, reliable energy, towards economic growth and poverty alleviation. Seventy percent of total population in Nigeria lives in the rural areas and since the energy production level of any community in CCAM model dictates her pace of development,energy sustainability can be acheived by the adoption of renewable energy technologies especially for rural communities and in stand-alone applications will improved energy supply and enhance the overall economic development. It can enable communities to identify and make use of optimum solutions and reducing over dependence on any one source, along with the vulnerability that that entails (Farrel, 2011; IEA, 2019).

The Suitability of CCAM for Energy Sustainability in Nigeria

The determination of the sustainability of an energy mix requires the assessment and evaluation of the proposed CCAM model using appropriate sustainability criteria. The following are the findings from the sustainability assessment and evaluation of the CCAM model using the sustainability criteria of Jaccard's (2005) and Gibson's (2006).

A. Risk to the Environmental and Humans:

- The ability to reduce direct and indirect human and environmental threats:

CCAM base is mainly from renewable energy sources. Generally, renewable energy sources perform well when compared with the conventional energy sources by minimizing risks to human and the environment because they are almost clean. The life cycle risks of the common global energy generation system by ranking are given in Table 2.

Table 2: Life cycle risk potential of energy generation systems (Laleman *et al*, 2011)

Risk Substance	Natural Gas	Coal	Nuclear	Wind	Solar
NO_2	Medium	High	Low	N/A	N/A
SO_2	Low	High	Medium	N/A	Low
CO_2	Medium	High	Medium	Low	Medium
Mercury	N/A	High	N/A	N/A	N/A
Uranium Waste	N/A	N/A	High	N/A	N/A

The greenhouse gas emissions (GHG) from renewable sources are significantly lower than those associated with fossil fuels are. The median values for all renewable energy sources range from 4-46g CO_2 eq/kWh while those for fossil fuel range from 469-1001g CO_2 eq/kWh (Edenhofer et al., 2011;BP,2020). The renewable energy strategies are essential for cutting 60-80% of the world's green house gases with the help of CCAM energy decentralization (Green Peace International, 2014;IEA;2020).

- The ability to reduce and avoid extractive damage and waste:

Occurrence of extractive damages and creation of hazardous waste is an empty set as such threats are unexpected from CCAM energy mix that is mainly of renewable energy sources.

- The ability to consider all extreme event risks, despite their probability or likeliness:

The risks associated with CCAM hybrid energy mix mainly of wind and sun, which may be malfunction of wind turbine, or green house gas emissions from photovoltaic cells are not as threatening as extreme events associated with strongly centralised energy system such as large-scale oil spills, mining accidents, gas explosions and nuclear meltdown that can consume millions of lives. However, expected threats can be mitigated through technological innovation on the productions of wind turbine and solar photovoltaic cells (Abubarkar *et al*, 2016;IEA,2018).

B. Scale, Adaptation and Resilience of a System:

- The extent to which CCAM model can adapt to a current energy system, and respond to supply and demand requirements:

CCAM can adapt to existing infrastructures, even directly connected to the national grid to relieve overloads in transmission lines and supporting the line voltage depending on their size and location. It can be brought online quickly to accommodate energy supply and demand. For instance, Germany, have proven that the rapid uptake of renewable is possible, and even more so through CCAM ownership structures by generating 14,000MW of renewable capacity between 2000-2004 and in 2010 alone installed 7,400MW of solar energy out of which 50% is community owned(Gipe,2011;Olouchi et al,2021).

- The extent to which availability of a source is considered:

Although wind and solar energy supply fluctuate due to their intermittent nature, which is a major concern. There are ways of mitigating it that would allow for availability that is more reliant. These include decentralization, storage technologies and smart grid planning. Decentralisation, which is one of the characteristics of CCAM geographically diversify energy generation and enhances renewable energy production by increasing the probability of energy availability in different locations at a given time. Storage technologies aid the energy system to respond and adapt to fluctuation in energy availability while smart grids incorporate more renewable energy for deployment.

- The extent to which resilience and flexibility are considered:

CCAM encourages energy decentralization in a resilient manner by the rapid uptake of wind and solar energy sources when supplies are located at the point or near the point of maximum energy demand. This model can strengthened local power distribution grid by mixing multiplicity of smaller generation sources, which decreases the chances of large amounts of electricity coming from a central plant from going offline at once.

C. Lower Path Dependency:

- The degree to which change in technology innovation and evolution is considered:

CCAM has more room for accommodating technological innovations for advancements and cost optimization. While conventional energy systems are reaching similar levels of optimization, renewable energy technologies are at the start of their development, allowing for massive levels of optimization in the future (Aitken,2010;BP,2020).The rapid development of wind power in Europe has demonstrated the effect on minimising generation cost over the last 25 years.

- The degree to which long-term thinking and transition to new, zero-carbon economies are considered:

Long-term thinking in terms of shifting towards a zero-carbon economy would include the emergence of new firms, industries, markets and technologies, and social demands (Green Peace International, 2014,iea 2019). CCAM combines the social demand to minimize environmental and human risk and to create economic, political and social equity, and strong technological innovation and cost reduction potential through the use and promotion of renewable energy technologies needed to trigger such a shift.

D. Inter and Intragenerational Equity:

The ability to build equitable livelihoods for all:

CCAM has the potential to bring together a more diverse set of individuals who could be
involved in renewable energy development and providing superior benefits to communities involved, including economic and energy securities and opportunities and greater societal equity, by diversifying the number of people and institutions that can participate and benefit from renewable energy development (Achakpo *et al*,2015;ADB,2017). By giving a community the opportunity to own/invest in a project through partnership/ joint venture ownership structure, avenues of opportunities are opened, and equitable distribution of benefits is achievable from one generation to another.

- The ability to reduce gaps between the rich and the poor in the present and in the future:

CCAM ensures energy sufficiency and sustainability for all, both rich and poor through decentralization and social responsibility.

E. Participatory, Inclusive and Democratic Governance:

The extent to which governance structures include individuals in decision-making exercises:

CCAM involves local control, where voting right rest inthe hands of the community involved in which they can express their concern, needs and wants on a project and have a say in every decision taken. Therefore, through a CCAM approach, all stakeholders, from individuals, to professionals, to experts, to government officials, are involved in a more democratic decision making cycle (Edenhofer *et al*, 2011;Aliyu et al,2018).

- The ability to mobilize and engage societies to apply sustainability awareness in all communities:

CCAM encourages active participation of community members at all stages of the project development and management thereby providing better understanding of where the energy comes from and how it can be more efficiently used.

F. Efficiency & Cost-effectiveness:

- The extent to which more is achieved with less material, economic and energy input:

CCAM is more efficient than the centralized energy model because of its decentralized nature that encourages insignificant energy loss before consumption due to their proximity to the generation point. Furthermore, energy from renewable sources, such as wind and solar, is converted into useful electricity in one single step. This is not the case for energy produced from conventional forms, such as fossil fuels. In the case of fossil fuel, low efficiency levels of 22% is achieved, with most of the energy been lost through inefficient (Green Peace International,2014; IEA,2020) being lost as heat in electricity distribution systems. Usually, wind energy developers estimate 10-14% energy losses in energy production from wind turbines, causing for 86-90% efficiencies (Krohn, 2009; Green Peace International, 2014).

- The extent to which all positive and negative externalities, pre-existing subsidies, and price distortions are considered in cost calculations:

Renewable energy does not expose our economies to externalities such as fossil fuel price volatility, hazardous waste disposal, or greenhouse gas emissions, risk reductions that are not accounted in the standard methods of calculating energy prices (Mandell *et al*, 2014;Shahbaz et al ,2018;IEA,2020). As more renewable based energy systems are added, energy production costs decline. This is because of the replacement of conventional generation with renewable generation, which leads to the reduction in variable costs, such as fuel, GHG emissions and hazardous waste are discarded(Mohammed *et al*,2014;Xu et al,2019).

- Once the above mentioned considerations are monetized, the ability to meet energy demand: Monetizing external costs of all energy supply systems can improve the cost competitiveness of renewable energy in CCAM energy mix.

Discussions

For an energy system or model to be sustainable, its supply rate must significantly outweighs its consumption rate with insignificant environmental effect, having the capacity to serve the present and provision for future needs. From Figure 1, the present total energy supply is 118,325 ktoe excluding electricity trade, out of which fuel wood that was primitively used accounts for 51% followed by petroleum products 41% on which the country energy consumptions and trade solely depends. From Figures 2&3, it was observed that the current total energy consumption is 116,457ktoe, out of which the household account for 78%. There is the serious problem of energy unreliability over the years such that most industrial establishments and upper income households install very expensive generating sets amounting to over half of the total installed grid capacity. This constitutes huge economic losses to the Nigerian economy and environmental hazards threats.

The 1,868ktoe difference between total energy supply and consumption that is strongly centralised with large-scale fossil fuel dependence, means that the system has no plan for future generation. This insignificant energy difference coupled with the uncontrollable collateral effects from an energy mix more of non-renewable energy sources, the country energy system is unsustainable.Nigeria dependent on large scaled centralized fossil fuel energy genration means that it currently wastes nearly two-thisrds of the primary input energy. Replacing fossil fuels with renewable energy is the ultimate goal, but as they currently account for 80% of global energy demand, it is not yet possible to do so and sustain even a basic standard of living. Indeed, although the volume of renewable is increasing at an enormous rate, it is still being outstripped by rising energy demand.

Decentralisation using a model such as CCAM that ensures sustainability may be the way out of these energy security threats and sustainability. Based on the result from the sustainability test and evaluation carried out, CCAM has been. CCAM has been described as an important mechanism to provide communities with decentralized sources of renewable energy and as a decisive step towards a sustainable future. Based on the result from the sustainability test and evaluation carried out, CCAM is a proven tool for energy decentralisation proven a successful tool for energy decentralisation in line with Nigeria current energy policies.

Hale(2010) stated that community involvement is important as individuals are more likely to take action if they see that others with common interest are involved or if there is a community that they can become part in taking action. In global terms, decentralising a centralized energy system-using can could revolutionise the lives of the billions of people more especially in the rural communities who currently lack access to basic energy services. Decentralising Nigeria energy system CCAM will be highly flexible in scaling up to fit both urban and rural energy requirements in size and quality (Figure 6). Its energy mix sources mainly of sun and wind as shown in Figure 4 and Figure 5 are readily available having comparative advantages at the northern part of the country and allowing solutions to be tailored to local conditions and be installed faster than the centralized system. CCAM is a desirable model for energy sustainability because it helps minimize trade off through an open and transparent ways. Cost and environmental risks under CCAM do exist but are very minimal.For instance,in Table 2,out of the listed energy sources wind and sun that made up more of the energy mix in CCAM have the least emmision of only CO_2 gas ranked limited and medium for wind and sun respectively and the later with low SO_2.

Sustainable and greener energy mix can improve the standards of living in a country through increased food production, increased industrial outputs, increased employment opportunities, efficient transportation systems, adequate shelters, quality healthcare delivery and other human services. The CCAM energy decentralisation model allows the finacial costs and energy losses associated with the long distance national transmission system to be rduced and savings passed on to the consumers.Bringing energy production close to people's lives as one of the characteristics of CCAM helps in effort to promote energy efficiency and ensure energy suatainability.

Conclusions

Nigeria energy is strongly centralised,full of insecurity threats,environmentally unfriendly and manage with high level of corruption. Two –third of the primary energy input are wasted through system inefficiency.The employed strongly centralised energy model and technology are outdated In fact the energy system is unsustainable and in comatose.A paradigm shift is urgently needed to overhaul the entire system to put it in the path energy sustainability.Decentralising the strongly centralised energy system using Community Choice Aggregate Model(CCAM) is the panacea for greener energy mix and sustainability in Nigeria.

The CCAM with the partnership/Joint Venture ownership structure is the best fit for sustainable energy development in Nigeria.It energy is very flexible and has the capacity to deliver enhanced energy security through 'THIS IS MY OWN syndrome,drive technological innovation and scale up for real competition in global energy market.It can foster inherent economic advantage of renewable energy technologies,save consumers money in longer term,increase public involvement in tackling climate change and increase opportunities for local community leadership in the energy sector.It can bring down the high energy consumption levels especially in the households and reduce the influence of vested interest through its inherent transparent and democratic principles.

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