

# INTEGRATION OF SOLAR ELECTRICITY INTO NATIONAL GRID: CASE STUDY OF NIGERIA. THE NEED FOR ENERGY REFORM

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**Abstract** - The study sought to integrate solar electricity into national grid in Nigeria. Electricity supply is a catalyst for economic growth and development. This article x-rayed the need for power generation to be diversified in the 21<sup>st</sup> century so as to address the needs, availability and accessibility of electricity. The study is a survey research design. The population of study comprises all the 36 states in Nigeria. There are 6 states in south-east, 6 states in south-south, 18 states comprise of north-north and 6 states of south-west. There are 186 LGAs, 121 LGAs, and 112 LGAs for north-west, north central and North-east, 137 LGAs for South-west, 124 LGAs for South-South and 95 LGAs for South East. The entire 36 states were used for the case study. The questionnaire of 5-point scale had two section; section A and section B. Section A was designed to obtain background information on respondent, interviews and projects on solar electricity and section B was design to elicit information on 5 research question which guided the study. The survey research looked into megawatts, consumption, grid implementation, availability, accessibility and other functional project that have been built using solar electricity transmission. The data was analyzed using descriptive and econometric approaches. The section A of the questionnaire was acquired on personal data of respondent from various state, percentage and implementation analysis. The findings showed Nigeria have a population of 150 million people. 70% of its population are living in rural area and have no access to electricity supply. It recommends that society needs electricity supply, to contribute positively to economic growth and development. The study concluded that government of Nigeria needs to take action toward solving energy problem by integrating solar electricity for benefit of all.

**Key Words:** Integration, electricity, solar, energy.

## 1. INTRODUCTION

Electricity is the bulwark for economic growth, social development and employment. It is important catalyst in all spheres of human endeavor and industrial production; manufacture. The socio-economic activities of modern societies revolve around the hub of energy availability. Electricity must cover and reach remote places such as rural area and as well as urban area. It also encompasses ways toward implementation, accessibility, availability for benefits of all. Solar electricity is the direct conversion of sunlight into electricity for power/energy generation. Integration is an on-going process of fixing, implementing

and linking ideas or system for expectation. For integration to be valuable to individual, organization, it must be correct, reliable and objective.

Integration is a diagnostic approach or procedure that measures behavior, efficiency, standard reliability, strength, performance or other dynamic qualities. Additionally, it must meet scientific, technical criteria, design and provide meaningful insight. Integration is an assessment, investigation that give organization, countries more than just data and information, it opens door to strategic changes and helps measure progress. Integration can help lead to increase self-awareness and inspire people toward implementation and usage. A reform is defined as that device, plan, designed to change, modify or improve an existing situation in energy and society.

Energy reform can take many form, it may be routine review of existing power problem or may be in response to a need. Hence, it is on this premise that the researcher's wants to integrate solar electricity into National grid in Nigeria so as ensure full implementation. Solar electricity is defined as the direct conversion of sunlight into electricity for power degeneration (Oparaku, 2012) (Okafor, and Uzuegbu 2010) (EPIA 2014) (Eyibe 2016). This definition implies that solar electricity can be utilized through the following objective: -

1. To explored integration of solar electricity to national grid in Nigeria.
2. To reduce country dependence on other source of energy such as fossil fuel.
3. To deploy this energy source to rural areas as well as urban area.
4. To create ways to subsidize and develop solar farm, solar lighting and household use, solar energy transmission and solar energy technologies.

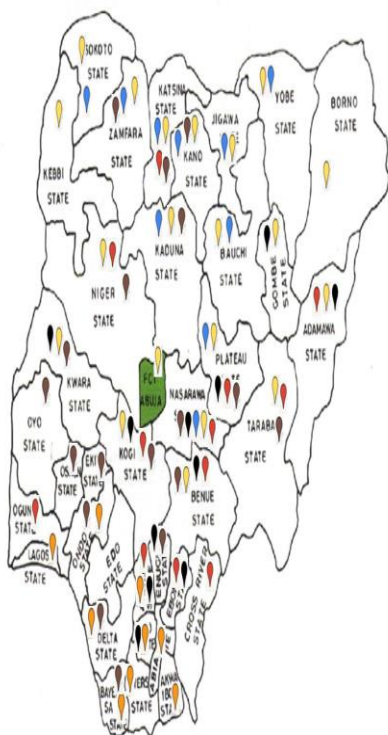
In the 21<sup>st</sup> century there is need for plan, innovations designed to change, modify and improve the current state of energy supply. Nigeria has experience problem in the area of epileptic electricity generation, transmission and distribution. The country has the potential to harness energy from the sun. Solar electricity have many diverse application for industrial work, oil/gas sector, agricultural sector, house and rural rectification (EPIA 2015). Nigeria is situated within the tropic of cancer and Capricorn between 4<sup>o</sup> and 14<sup>o</sup> above

the equator. It is estimated that Nigeria receives  $5.08 \times 10^{12}$  kWh of sun energy per day and average of  $20 \text{mj/m}^2$  per day of sun isolation depending on the time of the year and location. (Akinbami 2001, Ade and Adetan 2008, Sambo, 2010). Despite the abundance of sun line and its potential for power generation, there is an ineffective power transmission throughout the country. The problem of gas flaring, oil spillage, carbon dioxide emission is a risk of damage to the environment (UNFCCC 2015) (EPIA 2015) (EPIA 2015). There is need to protect the environment from causative factors of global warming. The government of federation has social responsibility in investing in solar electricity for national use.

**METHODOLOGY**

The case study is a survey research aimed at integration of solar electricity into national grid in Nigeria. It is a survey research because Kerlinger (2004) states descriptive survey research as those studies which aim at collecting data, on and describing in a systematic manner, the features, characteristic, or facts about a given population. The data obtained from the survey were analyzed using descriptive and economic approach.

**AREA OF THE STUDY**



Nigeria energy resources distribution map

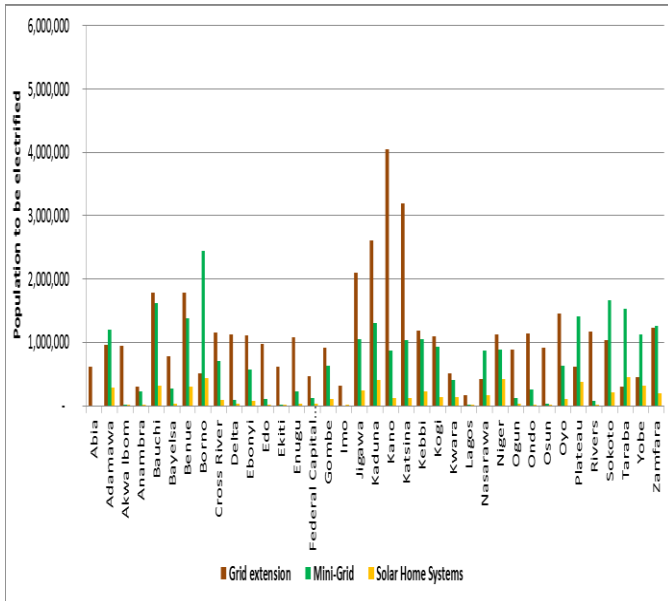
The areas of the study are the 36 states of Nigeria. The South-East, South-South, South-West, North-West, North-central and North-East geo-political zones of Nigeria. The South east is made up of five states namely Abia, Anambra, Ebonyi, Enugu and Imo. The South-South zone is made of 6 state namely Akwa Ibom, Bayelsa, Cross River, Delta, Edo and River, the South West zone inclue Oyo, Kogi, Lagos, Ogun, Ondo and Osun, the North-North comprise of Bauchi, Benue, Boronu, Gombe, Jigawa, Kaduna, Kano, Kastina, Kebbi, Kwara, Nassarawa, Niger, Plateau, Sokoto, Taraba, Yobe and Zamfara.

**THE POPULATION OF THE STUDY**

The population of the study will be made up of the 36 states of Nigeria.

**Table 1: Distribution of 36 states and its local government**

No.	State	LGA		States	LGA
1.	Abia	17	19	Adamawa	17
2.	Anambra	21	20	Bauchi	20
3.	Enugu	17	21	Benue	23
4.	Imo	27	22	Boronu	27
5.	Ebonyi	13	23	Gombe	11
6.	Akwa Ibom	32	24	Igawa	27
7.	Bayelsa	8	25	Kaduna	23
8.	Cross River	18	28	Kano	44
9.	Delta	25	27	Katsina	23
10.	Edo	18	28	kebbi	21
11.	Rivers	24	29	Kwara	16
12.	Ekiti	16	30	Nassarawa	13
13.	Lagos	20	31	Niger	25
14.	Ogun	21	32	Plateau	17
15.	Ondo	18	33	Sokoto	23
16.	Osun	30	34	Taraba	16
17.	Oyo	33	35	Yobe	17
18.	Kogi	20	36	Zamfara	16
					774 LGA



Electrification Options per State

**SAMPLE AND SAMPLING TECHNIQUES**

The entire 36 state was used for the study.

**INSTRUMENTATION FOR DATA COLLECTION**

The questionnaire IT: Integration of solar electricity questionnaire (code name 1 SEQ will be used for collecting the data). The questionnaire will have two sections, section A is designed to obtain background information on manager of selected firm and respondents while section B is designed to elicit information on the research. It is a 5 point scale questionnaire rated as follows: -

**RESULTS**

**RESEARCH QUESTION (1)**

Table 2: Application of solar electricity in Nigeria

S/N	ITEMS	SA	A	D	SD	N	X	REMARK
1.	Solar technologies seek operator to where they are deployed	290	275	124	90	774	8.24	Accepted
2.	Most solar technologies & appliance have specific operating range	295	270	120	89	774	8.24	Accepted
3.	Solar application are self-explanatory not dependent on other for direction	295	265	118	96	774	8.24	Accepted
4.	Most electricity consumer are often skeptical about solar system preferring to try out before accepting it	300	270	120	84	774	8.24	Accepted
5.	Most solar electricity user apply their knowledge in practical fashion	277	295	116	86	774	8.16	Accepted
6.	Many solar user are more in urban	288	290	126	70	774	8.3	Accepted

- Strongly Agreed (SA) - 4 point
- Agreed (A) - 3 point
- Disagree (D) - 2 point
- Strongly disagreed (SD)- 1 point

**VALIDATION OF THE INSTRUMENT**

The instrument was subjected to face validation. For face validity, the items of the instrument were judged on accessibility, clarity, availability, suitability and relevance of solar technologies.

**ADMINISTRATION OF THE INSTRUMENT**

The copies of the questionnaire will be administered directly by the researcher. The entire 36 state will be visited.

**METHOD OF DATA ANALYSIS**

Data collective will be organized around the research questions. The data generated will be subjected to descriptive, inferential and econometric approach.

Section A of the questionnaire which will generate information on the personal data of the respondent will be analyzed using frequencies and percentages. The other section of the questionnaire will be analyzed using mean for decision rule, the real limits of number of response mode were used. Thus  $4+3+2+1 = 10/4 = 2.5$ . any response therefore that is 2.5 and above will be regarded as accepted while response below 2.5 will be regarded as rejected

	than rural area							
7.	Most solar energy users are predominantly rich	284	294	116	78	774	8.2	Accepted
8.	Most solar application are hard to maintain	80	117	290	283	774	6.3	Rejected
9.	Most rural dweller do not have access to electricity and are poor	296	275	114	90	774	8.2	Accepted
10.	Most solar users are more in rural area than urban area	176	120	286	292	774	8.2	Rejected

Table II above reveals the extent of solar application and electricity in Nigeria. From table two (2) above, clearly shows the applications of solar electricity, user and importance towards national grid. Solar applications possess certain operating conditions. It is essential to determine how

and it can be deployed. The users and consumers fall within urban rich and rural area. It is revealed that most people live in rural and do not have access to electricity than urban area. There is need to augment energy supply through solar electricity.

**RESEARCH QUESTION II**

**Table 3: To what extent would you rate solar electricity transmission as successful in meeting needs of consumers?**

S/N	ITEMS	SA	A	D	SD	N	X	REMARK
11.	Many Nigerian who hitherto were unable to have access to energy can now have sufficient accessibility energy through solar system	294	288	120	74	774	8.29	Accepted
12.	Majority of the beneficiaries now live a happier life than before	300	280	100	94	774	8.25	Accepted
13.	Is it expensive to maintain	292	280	108	94	774	8.2	Accepted
14.	Majority of solar users have sufficient energy availability as a result of solar system	284	296	110	84	774	8.24	Accepted
15.	There is reduction in harmful emission of gases	288	292	100	94	774	8.20	Accepted
16.	Reduction in demand of fossil fuel as result of solar electricity	301	281	104	88	774	8.46	Accepted
17.	Is there much failure/fault in use of solar	294	290	102	88	774	8.46	Rejected

The item listed in table III above record positive response from respondent. As the world transition globally, we need to protect the environment from causative factor of global warming. Solar electricity integration will help reduce noise pollution, high cost of importation of generator, oil import as incase of generator usage. For item 12 and 13 it shows that

solar electricity is environmental friendly, reliable, clean source of energy. Solar energy from sun provide consistent, steady power source for a long time. Additionally, from item 13 the only maintenance on a solar module is to clean the glass on regular basis.

**RESEARCH QUESTION III**

**Table 4: To what extent are accessibility and availability of solar electricity and solar technologies?**

S/N	ITEMS	SA	A	D	SD	N	X	REMARK
18.	Solar technologies can be deployed anywhere as long as it is accessible to sun	298	284	106	86	774	8.40	Accepted
19.	Solar technologies are expensive	300	290	95	89	774	8.26	Accepted
20.	There are no readily available solar technologies for us in Nigeria	298	290	100	86	774	8.26	Accepted

21.	Lack of adequate and well trained technical expertise	290	296	99	89	774	8.26	Accepted
22.	Most of solar technologies centre are not conducive for research	294	292	98	90	774	8.26	Accepted

From table V above, item listed shows that solar technologies can be deployed anywhere as long as there is sufficient sun radiation clearly the constraint remains that it is expensive, lack of trained expertise, inadequate research centre. This

means that while integration of solar electricity positively affects the live of consumer, accessibility and availability remains a basic problem.

**RESEARCH QUESTION 4**

**Table 5: What are the challenges and implication posed by integration of solar electricity to national grid?**

S/N	ITEMS	SA	A	D	SD	N	X	REMARK
23.	Government lack of will to invest in solar energy integration	298	291	116	69	774	8.26	Accepted
24.	Solar technologies importation subsidization	300	292	108	82	774	8.26	Accepted
25.	Political instability, corruption of various board and management	288	298	118	70	774	8.26	Accepted
26.	Vandalism issues	290	281	11	92	774	8.26	Accepted
27.	Critical issues of inefficiencies					7		
28.	Is there any need for awareness on solar energy technologies and integration	300	270	106	98	774	8.26	Accepted
29.	Solar energy integration research and development	298	290	96	90	774	8.26	Accepted
30.	Consumer should be taught and exposed to new technologies of the information age	290	301	96	88	774	8.26	Accepted

Table 5 reveals the challenges and implication posed by integration of solar electricity to national grid. From the above table, it is clear that the energy reform is important in the 21<sup>st</sup> century and beyond. There is need for road map

aimed at investing in solar electricity, awareness creation and a way to stamp out corruption and laxity among energy regulation management and board.

**RESEARCH QUESTION 5:**

**Table 6: How many solar electricity project have been implemented and integrated in your state**

S/N	ITEMS	SA	A	D	SD	N	X	REMARK
31.	Is there any functional solar lighting system in your state	295	275	110	94	774	8.26	Accepted
32.	Any operational solar farm in your state	277	298	101	98	774	8.26	Accepted
33.	Solar house electrification	290	280	118	86	774	8.26	Accepted
34.	Can solar electricity be integrated to national grid	301	292	96	84	774	8.26	

**DISCUSSION/LITERATURE REVIEWS**

The result of the study showed that solar electricity should be integrated to national grid. One important economic growth catalyst is electricity. Insufficiency in energy demand causes constraints to development in domestic, agricultural,

education, health, and foreign investment. It should be observed that electricity is a social responsibility. Therefore, provision of affordable accessible and sustainable electricity supply is critical to development. The solution to Nigeria power crises lies in solely integrating solar electricity into the streams of non-renewable source of power and national grid. A rural electrification drive based on solar electricity



should be advocated for supplying homes, school, clinic, small and medium scale farm, industries and business.

Ajibola (2014) opined that solar electricity is reliable, consistent and provide steady power source for longtime. Nigeria lies within the tropic of cancer and capricorn between  $4^{\circ}$  and  $14^{\circ}$  above the equator. It is estimated that Nigeria receives approximately  $5.084 \times 10^{12}$  kwh of sun energy per day and average of  $20 \text{mj/m}^2$  per day of solar isolation depending on time of the year and location. (Akinbami 2001) (Ade and Adetan 2008). This is equivalent to about 258.62 million barrel of oil produced annually and about  $4.2 \times 10^{-5}$  Gwh of electricity production annually. It is important to integrate solar electricity into national grid to augment energy supply from fossil fuel energy resource. The item showed exquisitely that Nigeria as a country should integrate solar electricity into its national grid.

The second research question, consumers' application of solar electricity in Nigeria Shows that government policy in the power sector often times in favors of conventional energy technology at the expense of solar electrification. This has made solar electricity have less importation and costly. Government should subsidize solar technologies to give it advantage over conventional energy. The necessary policy measure should be put in place to make solar electricity the bulwark of power generation in Nigeria. From the item 6,7,9,10 shows that most rural dweller do not have accessible electricity supply, there is need to sue solar electricity to augment power supply.

Again, research question III, to what extent would you rate solar energy transmission as a successful in meeting the needs of consumer showed and received and diversification. Solar electricity is environmental friendly and long term sustainable energy strategy. It protect power supply from market fluctuation and volatility from item 15,16,17 shows that solar electricity integration will help reduce power transmission losses, noise pollution, harmful gas emission disturbance compared to generating set. The sole cost of running generator to produce power should be discouraged. Solar electricity integration has the potential to improve standard of living.

Additionally, research question 4 what are the extent of accessibility and availability of solar electricity and solar technologies in Nigeria showed a positive and negative responses. From the visit to other states of the federation, most respondent complained that solar technologies are expensive with abundance of sunshine and its potentiality, Nigeria Government should find way to subsidize the price of solar technologies. This would help effective utilization. From item 21,22 showed that we need to domesticate the production of component part of solar technologies and encourage research and development of solar photovoltaic.

Research question 5 what are the challenges and implication posed by integration of solar electricity to national grid

shows solar electricity integrated should be pursue with effective implementation. We must advocate for power transmission and distribution to be taken out of the exclusive list to the concurrent list. This would help and challenge many states of the federation to generate and be provider of power in their own domain. The law that prohibits states from developing its own electricity generation should be reviewed and reassessed. Nigeria's' challenges in energy sector hinges on bad leadership, corruption of various board and management, vandalism and lack of political will to invest on solar electricity and technologies research.

Likewise research question IV, how many solar projects have been implemented, in use and deployed on your states shows that many of the federal are currently investing in solar technologies. The Taraba and niger state solar project of 5 mw, 50mw Solar farm in Kaduna state and 10mw wind in Kaduna state are project built using solar energy. The body responsible for energy regulation and distribution is Nigerian Electricity Regulatory Commission (NERC). The National grid of solar electricity comprises of 330kv and 162kv currently wheeling capacity of 5,300mw under constrained loading condition. The Singapore solar electricity generation yield 975mw of electricity. From item 34 shows that we can integrate solar electricity into national grid. Our problem in Nigeria is not money problem but idea problem. Enugu state can work hard through coal become a full provider of local power plant. Lagos and Anambra state that generate plenty of waste can turn these wastes into power for national good. Niger state and Kwara state can also generate sufficient power through Shiroro dam (Nwosu 2011, Eyibe 2014). The development of workable strategies to integrate solar electricity to national grid should be pivotal in any decision-making in Nigeria.

#### RECOMMENDATION:

1. We must realize that provision of electricity is a social responsibility.
2. There is need to sanitize, investigate of all allegation of corruption in energy sector.
3. The law that prohibits a state from developing its own electricity generation should be reviewed and re-assessed.
4. We must recognize electricity as catalyst for economic growth and development.
5. The solution to Nigeria's electricity problem is in the integration of solar electricity to national grid.
6. Awareness, financing and research should be explored in solar energy and technologies.
7. We need conducive energy research centers in Nigeria
8. The University of Technologies across the country should be empowered financially to acts as renewable energy research and development centre for the country.
9. There is need to domesticate the production of component of solar technologies to enhance cost reduction.

10. The government must collaborate with public private partnership and with leading countries in area of solar system.
11. Case study like this would help monitor energy standard and report the extent to which energy integration are effective.
12. Integration of solar electricity should motivate, government to have clear goal, sense of purpose, direction and provide basis for giving incentive and support.
13. Solar electricity will help industrial need, household use rural electricity and improve standard of living.
14. Government should help subsidize the cost of solar technologies.
15. There is need for technical expertise, technical training centers for solar electricity installation, repair and maintenance.

### CONCLUSION:

We must try to work out strategies to integrate solar electricity into national grid electricity is the hub of economic growth and development. This is because these two main forces will be shaping the world. Economic growth is the measure of ways in which money, industry, trade are determined in a society, countries or world. Development is growth of business, technologies, trade, industry or world. The result of these two forces will be a new ways of thinking about how to manage the world's economies and a corresponding need to create new institution to do so. These institutions will be needed at four levels; local, state national and international.

Clearly, absence of reliable energy supply will live a populace socially backward and unemployed. The quality of energy needed today is particularly essential to create employment, industrial needs, household use and rural electrification. Power supply through solar electricity will provide availability and accessibility of energy generation. Many states have complained that solar technologies are expensive. The government of federation should help expensive this solar technology.

Finally, raising awareness or knowledge formation in energy entails research and development. The case study recommends that the solution to Nigeria energy problem lies in solely integration of solar electricity into national grid aimed at power generation. It is a cliché that action speak louder than words but the truth is that that it does not matter how compassionate you are, if you talk continuously about integration of solar electricity but do not put your belief into practice; and compassion without action are sentimental humbug. Society requires constant, sufficient electricity supply, employed people, not inadequate poor electricity supply and unemployed people to contribute immensely to humanities.

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