Irish International Journal of Engineering and Scientific Studies
I. Int. J. Eng. Sci. S.
Volume: 5; Issue: 04,
July-August, 2022
ISSN: 2853-4387
Impact Factor: 3.184
Advance Scholars Publication
Published by International Institute of Advance Scholars Development
https://aspjournals.org/Journals/index.php/iijess

THE SOCIO-ECONOMIC IMPACT ASSESSMENT OF SOLAR PHOTOVOLTAIC(PV) SYSTEMS WITHIN NSUKKA LOCAL GOVERNMENT AREA OF ENUGU STATE

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Keywords: Energy, Solar photovoltaic, Socio-economic impact, Survey, Solar panel, Nsukka.

ABSTRACT: *Household energy consumption survey data collected between September and October 2019 was utilised to assess the socio-economic impact of Solar Photovoltaic systems within Nsukka local government area of Enugu State, Nigeria.The study presents the findings of the assessment of the role that access to Solar PV plays among energy users as well as the benefits, challenges and recommendations for maximising the benefits of Solar PV as a tool for poverty reduction amongst energy users in Nsukka local government area and Nigeria in general.The research has revealed that solar energy plays a great role in promoting the socio-economic life of dwellers in Nsukka local government area. The findings also showed that various uses of Solar PV systems were found among homes, churches, schools, farms, industries, and road lights and were mostly used for lighting, charging electronic devices, and powering of appliances. The major challenges to the use of Solar PV systems as found from the study were: systems installed typically used cheap and poorly integrated components (Non durable batteries and solar panels, etc.), high cost of installation and maintenance, inadequate skilled personnel to install and maintain Solar PV systems and lack of favorable government policy on the use of Solar PV systems, among others. The study concludes that prompt and adequate policy interventions are needed in order to maximise the potentials of Solar PV applications in the zone.*

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1.INTRODUCTION

Energy is needed for basic human needs: for cooking, heating, lighting, boiling water and for other household-based activities. Energy is also required to sustain and expand economic processes like agriculture, electricity production, industries, services and transport. Energy consumption in Nigeria is dominated by Fossil energy with the attendant environmental and economic implications [1-3]. Electricity, regarded as a clean energy contributes only about 2% of Energy consumption in Nigeria. Average electricity consumption per inhabitant in Nigeria is estimated at 150 kWh per capita which is one of the lowest in the world [4].

Available statistics on the Nigeria energy scenario has shown significant gap between demand and supply of electricity which has led to frequent power breakdown. In 2011, it is estimated that customers connected to the grid suffered an average of 28 blackouts per day[4] Regular black-outs necessitated the frequent use of stabilizers in order to protect electronic equipments as well as constant use of generators which add to the costs faced by end-users. This scenario does not only affect the living standards of the populace but it is also one of the biggest setbacks to sustainable environment and socio- economic development.

To meet up with the energy needs by considering the escalating population growth and socio-economic activities, the Nigerian government has focused attention on renewable energy resources by incorporating renewable energy resources into the country's energy mix[5-6]. With the vast renewable energy resource and a National Energy Policy, as well as a National Renewable Energy Master plan. Nigeria is well positioned to up-scale the use of renewable energy [7].

In Nigeria, one of the renewable energy resources in abundance is Solar energy. The nation is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 2.5 hours at the coastal areas and 9.0 hours at the far northern boundary [8]. Solar energy development can bring major benefits for economic and social development especially in rural areas through the different range of applications. Most regions in Nigeria have viable solar radiation required for most solar projects and have supported decentralized solar energy projects. Apart from few private commercial Solar PV installations; privately owned home solar systems and some government funded solar PV systems can be seen scattered all over some cities of Nigeria.. More so, the governments of different regions, in collaboration with some International donor agencies have scaled up Solar PV installation in the metropolitan areas as well as rural communities without access to national[9-10] .

A critical challenge that continues to constrain the advancement of socio-economic status of Nigerians is the prevalence of poverty. In spite of abundant solar energy, Nigeria lack stable power supply. This is due to low technological advancement, pervasiveness of poverty, pitiable corporate governance culture, and poor management of existence facilities. It is widely acknowledged that access to electricity through reliable and efficient solar energy grid is an essential ingredient for the growth and

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development of the nation's economy. It is also regarded as a vital requirement for modern economic and social development. These assertions stem from the fact that electricity opens the door to a host of technologies that promote quality education, enhanced public health, and economic development. These technologies include emissions-free light, refrigeration and communication devices. Without access to reliable electricity, communities are unable to participate in the benefits of modern advances and are left isolated and literally in the dark.In view of the above scenario, this study seeks to investigate the socio-economic impact of Solar PV systems within Nsukka local government area of Enugu State, Nigeria.

2. MATERIALS AND METHODS

The study employed a combination of data collection techniques and collected both quantitative and qualitative data. This included: a review of literature relevant to the study, administration of a structured questionnaire, and interviews with relevant institutions that installed solar PV system in general, and systematic observations.The project data is based on a survey conducted for twenty days, in late September and October 2019, with the help of 4(four) researchers drawn from Energy Research Centre, Nsukka and department of Agricultural Economics, University of Nigeria, Nsukka. With the aid of graduate enumerators in the study area, interviews and structured questionnaireswere administered to Solar PV system owners and users in the communities within Nsukka Local Government Areaof Enugu State

Two hundred questionnaires were administered to respondents in the urban and semi-urban areas of Nsukka Local Government Area. During the process of cleaning the data, five questionnaires were eliminated while three were found to be missing. The remaining questionnaires involving 192 respondents were valid. The five that were eliminated had one or more key variables missing.

The data collected relate to household socio- economic characteristics and expenditures as well as the challenges of using conventional energy before Solar PV installations in their respective domain. The data also relate to information on energy use and expenditures as well as the socio-economic impacts derived from Solar PV installations in the zone. Descriptive statisticsof frequency counts, simple percentage, mean and difference of means as well as correlation analysis and other statistical inferences were utilised to analyse the data obtained from the study.

3.RESULTS AND DISCUSSION

3.1 Identification of Solar PV systems

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TABLE 1: IDENTIFIED SOLAR PV SYSTEMS IN THE FIELD SURVEY

LOCATION OF SOLAR PV	YEAR OF INSTALLATION/USAGE	PLACE OF INSTALLATION	SPONSOR
FEDERAL GOVT GIRLS COLLEGE (FGGC),LEJJA	2017	(1).ICT UNIT AND SOME ADMIN BLOCKS (2).SOLAR STREET LIGHTS AT SCHOOL PREMISES	FEDERAL GOVT
QUEEN OF THE ROSARY SECONDARY SCHOOL(QRSS), NSUKKA	2019	SOLAR PV FOR PUMPING WATER FROM BOREHOLE AT SCHOOL PREMISES	SENATORIAL CONSTITUENCY PROJECT
QUEEN OF THE ROSARY SECONDARY SCHOOL(QRSS), NSUKKA	2018	SOLAR PV SYSTEMS AT REV. FATHER'S HOUSE	SELF
16(SIXTEEN) RESIDENTIAL BUILDINGS WITH SOLAR PV SYSTEMS	2-5 YEARS	RESIDENTIAL PREMISES	SELF
21(TWENTY ONE) PRIVATE HOMES AND FLATS WITH **MTN HOME SOLAR SYSTEMS**	1-5 YEARS	RESIDENTIAL PREMISES	SELF
ST CYPRIAN'S SPECIAL SCIENCE SCHOOL, NSUKKA.	ABOVE 5 YEARS	SCHOOL HALL AND LIBRARY	EXTERNAL BODIES
ENERGY RESEARCH CENTRE, UNN	3 YEARS, ABOVE 10 YEARS	(1).BIOMASS BUILDING (2). OLD ADMIN BLOCK . (3) SOLAR THERMAL BUILDING (4). SOLAR PV BUILDING (5)NEW ADMIN BLOCK	CENTRE MANAGEMENT
DEPARTMENT OF ECONOMICS, UNN	2017	LECTURER'S OFFICES AND CLASSROOMS	CENTRAL BANK OF NIGERIA
FACULTY OF VOCATIONAL EDUCATION, UNN	2013	FACULTY LIBRARY AND SOLAR STREET LIGHT AT THE PREMISES	FEDERAL GOVERNMENT
SAINT THERESA'S COLLEGE, NSUKKA	2019	PRINCIPAL'S OFFICE	SCHOOL MANAGEMENT

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Table 2. below, presents the tabulation of socio-economic characteristics of the respondents.

Data on age distribution of respondents indicates that majority of them are in their active years as 84% of them falls within 15 and 44 years of age. Of this proportion, 35.9% are between 15-34 years and 47.9% between 35 and 44 years of age indicating that most owners and beneficiaries of Solar PV systems are in their active years.

3.2 SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

Table 2: Socio-economic Characteristics of Respondents

Parameters	Frequency	Percentages
Age distribution (years)		
15-24	53	27.6
25-34	16	8.3
35-44	92	47.9
45-54	26	13.5
55-64	5	2.6
65 and above	0	0
Total	192	100
Occupation		
Farming	7	3.6
Trading	33	17.2
Civil/Public servant	99	51.6
Student/Unemployed	53	27.6
Total	192	100
Annual Income (₦)		
Below 100,000	53	27.6
100,000-499,000	28	14.6
500,000-999,000	64	33.3
1Million-1.49Million	14	7.3
1.5Million and above	33	17.2
Total	192	100
Educational level		
Primary	3	1.6
Post-primary	58	30.2
Tertiary	129	67.2
Others	2	1.0

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Total	192	100
Access to Credit Facilities		
Yes	184	95.8
No	8	4.2
Total	192	100

Source: Field Survey, 2019

Other issues covered are occupation which reveals that most of the respondents (51.6.%) are civil/public servants.20.8% engage in trading and farming while 27.6% are students/unemployed.

In terms of income, 27.6% of the respondents had incomes below N100,000 and virtually all of them are students who have little or no source of income (see Table 3) while 14.6% had between N100,000- N449,000, and 33.3% had N500,000 – N999,000. Only 7.3% had N1Million-1.49Million while 17.2% had N1.5Million and above as annual income.

On the issue of educational level, the study reveals that most of the respondents(67.2%) are in tertiary institution or attended tertiary institution while 30.2% acquired post-primary education indicating a high level of literacy among the respondents. 1.6% acquired primary education while 1% acquired other forms of education.

In terms of access to credit facilities, the results indicate that a greater percentage of the respondents (95.8) had no access to credit facilities which may empower them to acquire Solar PV systems. Only 4.2% had access to credit facilities which probably may have led to self sponsorship of the Solar PV system acquired by them (see Table 4)

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3.3Energy Use Statistics of Respondents

Table 5: Energy Use Statistics of Respondents

Table 3: Cross tabulation of occupation and income

Occupation		Income					Total
		below N100k	N100-N499k	N500-999k	N1M-N1.49M	N1.5M & above	
	farmer	0	1	6	0	0	7
	trader	0	12	15	4	2	33
	civil/pub.servant	0	15	43	10	31	99
	student/unemployed	53	0	0	0	0	53
Total		53	28	64	14	33	192

Table 4: Cross tabulation of access to credit facilities and sponsorship of solar PV system

Access to credit facilities		Sponsor			Total
		government	foreign donors	Self	
	No	131	3	50	184
	yes	0	0	8	8
Total		131	3	58	192

Parameters	Frequency	%(Percentage)
How many years have you been using the solar PV systems?		
< 3years	157	81.8
3-5yrs	10	5.2
5yrs & above	25	13.0
Total	192	100.0

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Who sponsored the Solar PV system that you are using?		
government	131	68.2
foreign donors	3	1.6
self	58	30.2
Total	192	100.0
What are your major sources of power supply?		
grid	27	14.1
fossil fuel	153	79.7
ren,energy	12	6.3
Total	192	100.0
What was the situation of power supply from the national grid before the installation of the solar PV?		
fair	4	2.1
bad	68	35.4
very bad	120	62.5
Total	192	100.0
How regular do you have EEDC supplied power (light) daily?		
0-3hrs	104	54.2
4-6hrs	79	41.1
7-9hrs	9	4.7
Total	192	100.0
Do you have a generator?		
no	2	1.0
yes	190	99.0
Total	192	100.0
What is your average monthly		

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expenditure on energy use?		
4000.00	53	27.6
5000.00	3	1.6
6000.00	33	17.2
8000.00	47	24.5
9000.00	56	29.2
Total	192	100.0
Would you support solar systems as an alternative energy supply if it is efficient and affordable?		
yes	192	100.0
no	0	0
Total	192	100

Source: Field Survey, 2019

Table 5 presents energy use statistics of the respondents. The results indicate that majority of the solar PV installations (81.8%) existed recently, within the last 3 years indicating a recent increased awareness of solar energy resources. It also revealed that 13% of the installations existed more than 5 years ago. The results also showed that majority of the respondents (79.7) utilize fossil fuel as their major source of power supply due to the unreliable and epileptic nature of supply from the national grid. Only few of the respondents (6.3%) adopted renewable energy as their major source of power supply.

Results from the table also revealed that the power supply situation of most of the respondents (62.5%) was very bad before benefiting from the installed solar PV systems. 35.4% said it was bad while only 2.1% said it was fair. Most of the respondents (68.2%), indicated that the government sponsored the solar system they are benefitting from; while 30.2% indicated the systems were self sponsored, and only 1.6% of the respondent affirmed it was sponsored by foreign donors.

Further revelation from the table showed that a greater percentage of the respondents(54.2%) utilize power for less than four hours while only 4.7% enjoy power supply for 7-9 hours from the national grid on a daily basis. In order to supplement the poor power situation in the zone, the table revealed that virtually all the respondents(99%) had generator power plants as alternative power supply. The energy use expenditure of the respondents as shown in the table also disclosed that they spend between N4000-N9000 monthly on energy use with more than 50% spending between N8000-N9000. No doubt all the respondents were willing to support and adopt solar energy systems as an alternative to unreliable power

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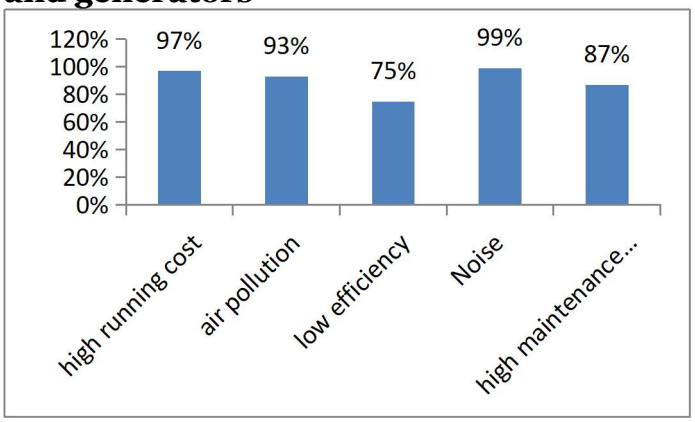
from the national grid, if solar systems are efficient and affordable.

3.4 Challenges of using fossil fuels and generators

Figure 1: Challenges of using fossil fuels and generators

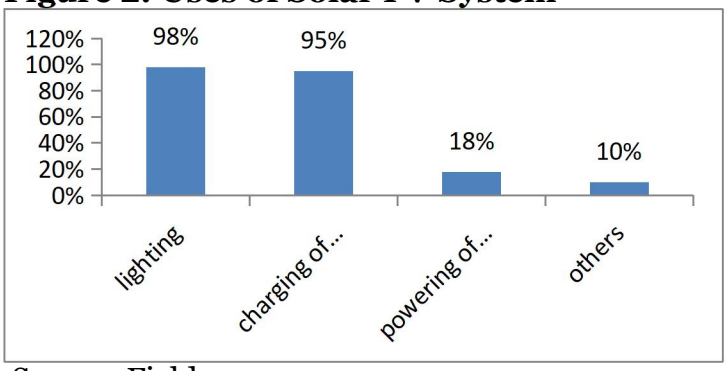


Source: field survey 2019

Figure 1 depicts the challenges of using fossil fuels and generators as elicited from the respondents. Results indicate that a greater percentage of respondents experienced all the challenges listed in the options of response with the highest number of response (99%), indicating noise pollution as the worst challenge. This is followed by high running cost (97%), air pollution (93%), high maintenance cost (87%) and (75%) for low efficiency. This implies that the challenges of using fossil fuels and generators cut across socio-economic and environmental factors. Apart from the high depletion of financial resources involved in running and maintaining generators, environmental safety is also threatened because of the noise and air pollution associated with the usage.

3.5 Uses of Solar PV system

Figure 2: Uses of Solar PV System



Source: Field survey, 2019

Figure 2 presents data on the uses of solar PV system by the respondents. The highest number of response (98%) indicated that solar PV was used to provide lighting in the houses and classrooms and within their school environment. It was also used to provide lighting in some offices and facilities. 95% of respondents utilize solar PV for charging of electric appliances such as phone batteries, rechargeable radios and fans as well as rechargeable reading lamps and lanterns.

18% of the respondents indicated using it for powering of appliances such as television, radio, fan, refrigerator and washing machine while 10% used it for other activities such as pumping water from borehole as observed during the field survey at Queen of the Rosary Secondary School,(QRSS) Nsukka where solar PV is used to pump water from borehole to a reservoir tank for students usage.

3.6Socio-Economic Benefits of Solar PV Systems

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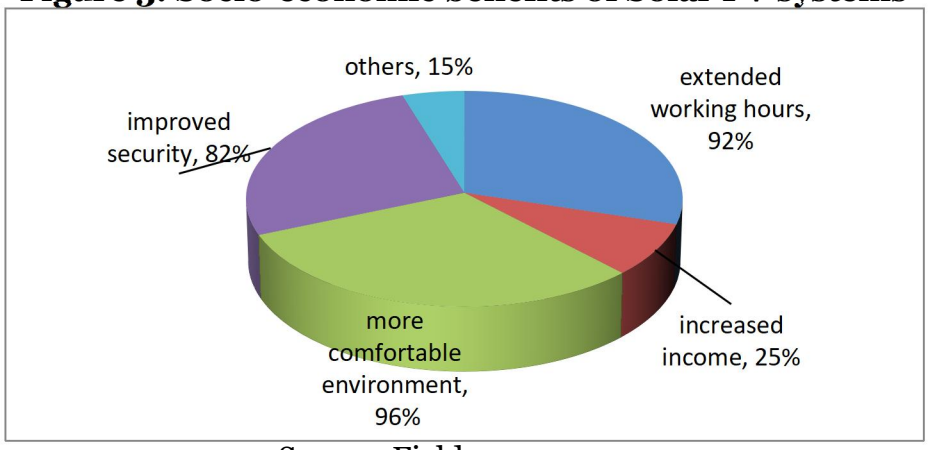
Figure 3: Socio-economic benefits of Solar PV systems



Source: Field survey, 2019

Figure 3 presents data for the socio-economic benefits of Solar PV systems as captured in the survey. The data indicates that highest percentage of respondents (96%) enjoy more comfortable environment in the form of reduced noise and air pollution which can be detrimental to one's health. Results also indicate that 92% experienced extended working hours in their houses, classrooms and offices. Solar energy has improved on education by providing lighting system for reading, where by student's studies at night without any interference of power fluctuations. Workers also improve their productivity because of uninterrupted power supply. More so, household chores are made easier since it can be undertaken at anytime without fear of power failure. 82% benefited from improved security in the form of uninterrupted security lights within the residential premises and school environment. 25% benefitted from increased income as a result of increased productivity on their workplace. 15% benefitted from other ways such as uninterrupted access to water resources as witnessed at QRSS, Nsukka. In addition, respondents testified that solar energy has improved on communication system by making charging of phones easier and cheaper:

3.7Constraints/Challenges of Using Solar PV Systems

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Table 6: Constraints/Challenges of using Solar PV systems

S/N	FACTORS	MEAN	ST.DEV	PERCENTAGE	DECISION
1	The systems installed typically used cheap and poorly integrated components (Non durable batteries and solar panels, etc.)	3.36	0.482	84	Accepted
2	High cost of installation and maintenance	3.22	0.414	80.5	Accepted
3	Vandalisation	1.72	0.503	43	Rejected
4	High performance depends on the season (i.e.dry and rainy season)	3.59	0.513	89.7	Accepted
5	Inadequate skilled personnel to install and maintain Solar PV systems	2.98	0.190	74.5	Accepted
6	Limited information on Solar PV Systems	3.01	0.102	75.3	Accepted
7	Lack of favorable government policy on the use of Solar PV systems	3.3	0.474	83.5	Accepted

Source: Computed from fieldwork, 2019

Table 6 presents the constraints/challenges of using Solar PV systems. The table presents means, standard deviation and percentages for each item indicating different mean values and percentages. The results of table 6 showed that the mean scores were between 1.72-3.59 and the percentages were between 43% and 89.7%. The table shows that out of the seven items in the table, six of the items, items number 1, 2, 4, 5, 6 and 7 have mean values above 2.5 and thus are accepted as challenges of using solar PV systems while item number 3 has mean value below 2.5 and is rejected as a challenge of using Solar PV systems.

This implies that respondents accepted the fact that installation of cheap and poorly integrated components;high cost of installation and maintenance; dependence of high performance of solar PV systems on seasonal variations;inadequate skilled personnel to install and maintain Solar PV systems; lack of favorable government policy on the use of Solar PV systems andlimited information on Solar PV Systems are common constraints/challenges of using Solar PV systemswhile vandalisation of Solar PV systems is rejected as a common challenge of using Solar PV systems.

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FIGURE 4: SOLAR PV APPLICATIONS IN NSUKKA L. G.A

Solar Panels

Solar PV for pumping water at Queen of the Rosary Secondary School, Nsukka

Mobile Telecommunications Network (MTN) Solar Home system at a residential building

Solar PV Panels at Federal Government Girls College, Lejja, Nsukka

Solar PV Panels for security light at Faculty of Vocational Education, UNN

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Solar PV Panels at Biomass building roof, Research Centre, UNN

Solar PV Panels at roof top, Energy Research Energy Centre Library, UNN

Solar PV panels at Faculty of Vocational Education, UNN

Solar PV battery house at St. Cyprian's Special Science School, Nsukka

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Solar PV panels at roof top, Principal's office St. Theresa's College, Nsukka.

Solar Chick brooder at Prof. Igboeli poultry Farm, Eziani, Nsukka

Solar PV panels at roof top at St. Cyprian's Special Science School Nsukka.

Solar PV panels at roof top, father's house, Queen of the Rosary Sec. School, Nsukka.

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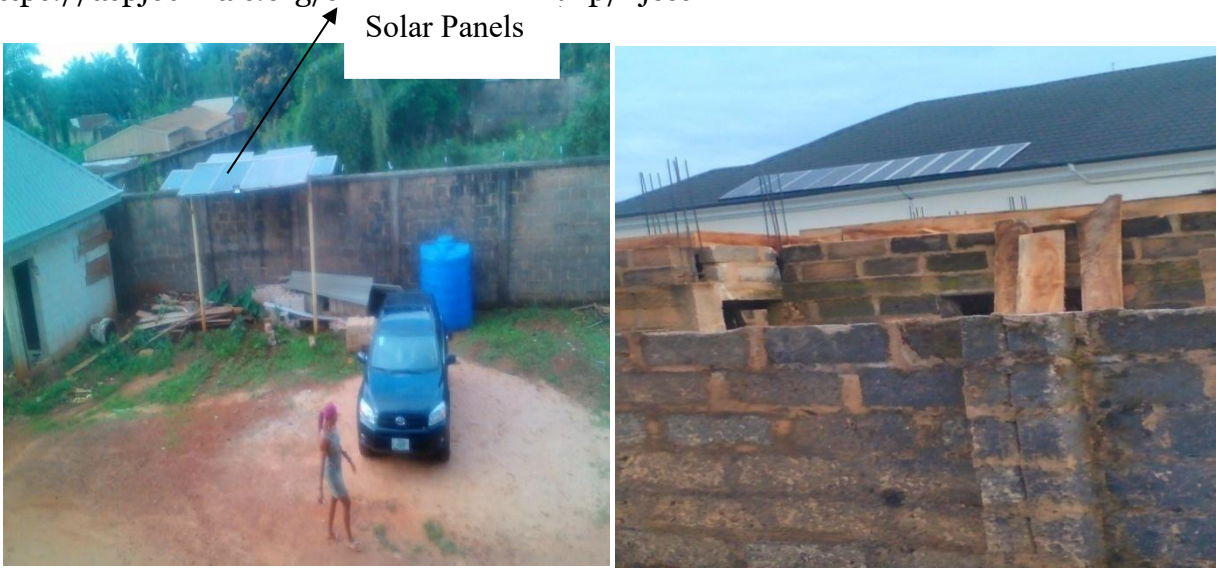

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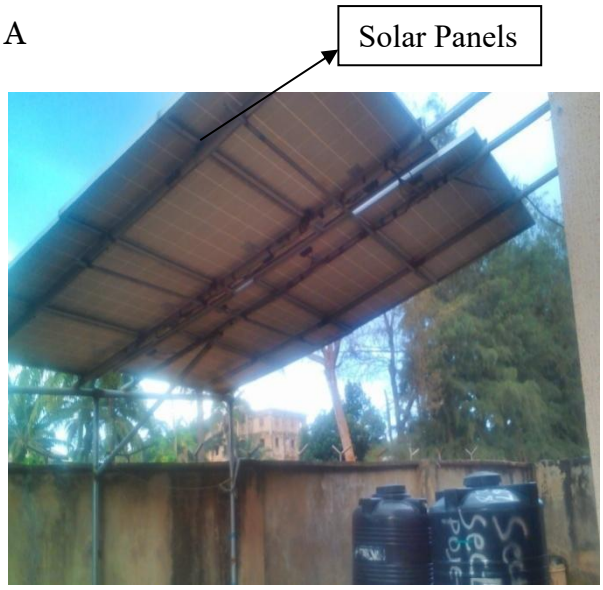

C

B

D

ABCD= SOLAR PV PANELS AT SOME RESIDENTIAL BUILDINGS IN NSUKKA

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Solar PV reading lamp

4. CONCLUSION

The research has revealed that solar energy plays a great role in promoting the socio-economic life of dwellers in Nsukka local government because it supports office work and household chores by providing cheap lighting system which has led toextended working hours in their houses, classrooms and offices.Users enjoy more comfortable environment in the form of reduced noise and air pollution which can be detrimental to one's health. . Solar energy has improved on education by providing lighting system for reading, where by student's studies at night without any interference of power fluctuations. Workers also benefitted from increased income as a result of improved productivity arising from uninterrupted power supply.

Household chores were made easier since it could be undertaken at anytime without fear of power failure. It has improved on security in the form of uninterrupted security lights within the residential premises and school environment. In addition, Solar energy promoted uninterrupted access to water resources as witnessed at Queen of the Rosary Secondary School, (QRSS) Nsukka and has improved on communication system by making charging of phones easier.

However, despite these great roles of Solar PV system in the zone, the utmost performance of some of these systems have remained poor owing to some constraints/challenges experienced in their usage such as non durable batteries and solar panels, high cost of installation and maintenance, among others. The poor performance have resulted in underutilisation of these facilities as well as discouragement of morale of the users. Thus, prompt and adequate policy interventions are needed in order to maximise the potentials of Solar PV applications in the zone.

ACKNOWLEDGEMENT

The research team would like to express its gratitude to the management of National Centre for Energy Research and Development, University of Nigeria, Nsukka and the German

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Volume: 5; Issue: 04,
July-August, 2022
ISSN: 2853-4387
Impact Factor: 3.184
Advance Scholars Publication
Published by International Institute of Advance Scholars Development
https://aspjournals.org/Journals/index.php/iijess

Ministry of Education and Research (BMBF) for the technical guidance and financial support they provided for the successful completion of this study. Most importantly, to the German Ministry of Education and Research for availing it the opportunity to contribute towards the promotion of renewable energy in Nigeria, particularly in general and solar energy.

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