



Photovoltaic Cell Installation and Load Demand Assessment Skills Needed by Electrical/Electronic Technology Graduates for Self Reliance in Northern Nigeria

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ABSTRACT

This study aimed to identify the essential photovoltaic cell installation and load demand assessment skills required by graduates of Electrical/Electronic Technology (EET) Education for self-reliance in northern Nigeria. It raised two research questions and formulated two hypotheses to guide the study, employing a descriptive survey research design. The study involved a total of fifty-two (52) respondents, comprising twenty-nine (29) EET lecturers, six (6) EET technologists, and seventeen (17) PVC installers. No sampling was conducted as all respondents were included in the study. The data collection instrument, named "Photovoltaic Installation and Load Demand Assessment Skills (PVC-ILDAS) Needed Questionnaire," was developed by the researcher and validated by experts in electrical/electronic technology education. The instrument's reliability coefficient was determined to be 0.93 using Cronbach's Alpha. The collected data was analyzed using Statistical Package for the Social Sciences (SPSS) version 23. The findings indicated a high demand for photovoltaic installation and load demand assessment skills among graduates for self-reliance. While there was no significant difference among the respondents regarding photovoltaic cell installation, a significant difference was observed in their ratings of photovoltaic cell load demand assessment skills needed by ETG. The study recommended a curriculum review by the government to incorporate practical skills such as photovoltaic cell installation and load demand assessment. It also suggested the development of comprehensive and standardized training programs by universities, focusing on practical installation and load demand assessment skills, and the promotion of standardization in training and certification for photovoltaic cell systems. Furthermore, the study recommended the creation of focused training programs emphasizing continual learning to keep trainees updated on evolving technologies.

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INTRODUCTION

Technology Education (TE) is a type of education that prepares its graduates to possess technical skills and knowledge in their various

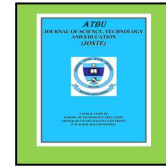
areas of specialization for self-reliance and national economic development. The Federal Republic of Nigeria (FRN) defines TE as post-secondary education that imparts the necessary

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skills and knowledge required leading to the production of skilled human resources relevant to the needs of the labor market. Specifically, the broad aim of TE is the production of an enterprising and self-reliant technicians and technologist.

Also, TE in Nigeria was established to pursue the following goals to include; providing courses of instruction and training in engineering, technologies, applied science, business and management, leading to the production of skill graduates; providing technical knowledge and entrepreneurial skills necessary for agricultural, commercial and economic development; give training and impart the necessary entrepreneurial skills for the production of technicians, technologists and other skilled graduates who shall be enterprising and self-reliant; train graduates who can apply scientific knowledge to solve environmental problems for the convenience of man; and give exposure on professional studies in the technologies (FRN,2013). Electrical/ electronic is among the technical and scientific knowledge that can be possessed for self-reliance.

Specifically, according to Arya, et al., (2023) electrical/electronic is the process of applying scientific knowledge in the design, selection of materials, construction, operation, and maintenance of electrical/electronic products. In the view of Chinyere, and Afeez (2022) electrical/electronic technology is the study of techniques, materials, devices, and electrical/electronic principles. The electrical/electronic technology education program is one of the courses offered in universities in Nigeria. It is designed to prepare its graduates as technologists in the following areas of electrical/electronic maintenance of equipment and appliances, electric power and machine installations, maintenance and installation of domestic, commercial, and industrial wiring.

Unfortunately, the rates of teeming graduate unemployment is hugely increasing at an alarming rate among all graduates including electrical/electronic technology education graduates as being reported by the National Bureau of Statistics (NBS, 2022) on youth

unemployment rates where about more than half of youths in Nigeria including graduates and electrical /electronic technology are unemployed. This statistic is very huge and scary compared with some of the developing countries like India and Brazil which stood below quarter.

An emerging skill but neglected to be incorporated into the curriculum of electrical/electronic is the renewable energy including photovoltaic cells energy system, also known as solar cells. Photovoltaic Cells (PVC) are devices that convert sunlight directly into electricity using the photovoltaic effect. There are key components of solar panels and are used to harness solar energy for various applications, including electricity supply generation. PVC are typically made of a semiconductor material, such as silicon. Silicon is chosen for its ability to efficiently absorb photons (particles of light) from the sun.

Absorption of photons is done when sunlight hits the surface of a photovoltaic cell, photons are absorbed by the semiconductor material. This absorption process transfer's energy to the electrons in the material, allowing them to break free from their atomic bonds and become mobile which leads to Generation of Electron-Hole Pair where the absorbed energy causes the creation of electron-hole pairs within the semiconductor. Electrons are negatively charged particles, while holes are positively charged. Both the electrons and holes are now free to move within the semiconductor. Hence, electricity supply is said to be generated.

PVC have so many advantages over the conventional sources of electricity generation to include; its promising technology in addressing global challenge of climate degradation and meeting the pressing need for green renewable energy. Additionally its availability and lack of Green House Gases (GHG) emission or other pollutants during operation. Also, they do not produce much sound as compared with conventional sources of electricity; this make them silent producers and require little maintenance as compared with the conventional method of electricity generation (Hannan, et al.,2019). But electricity supply generation through PVC can only

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be sufficiently and adequately harnessed by carrying out effective Photovoltaic Cell Installation (PVC-I). PVC-I is the ability to select, install, and configure PV panels, charge controller and to wire and connect battery to capture sunlight and convert it into electricity.

This knowledge is very fundamental for creating independent and sustainable electricity energy sources. Another important aspect in the PVC electricity supply generation industry is Photovoltaic Cell Load Demand Assessment (PVC-LDA). PVC- LDA is the knowledge for ensuring that the solar PV system meets the specific energy needs of a household or business.

Thus, these are among the innovative, emerging and technical skills that can be possessed for self-reliance, even to be an employer of labor and make meaningful contribution to the society. Therefore, photovoltaic cell system skills are part and parcel of entrepreneurship skills that need to be possessed for self-reliance. However, the unemployment level in Nigeria has persistently keep increasing at alarming rates, this is a worrisome development which requires an urgent attention such as developing a course of training for self-reliance. But this course of training can only be developed through assessment of innovative and technical skills required to excel in such course among which is photovoltaic cell installation and load demand assessment skills. That was why it was pertinent to conduct this study in order to find out the skills needed in installation and load demand assessment of photovoltaic cell by electrical/electronic technology education graduates for self-reliance in northern Nigeria.

Statement of the Problem

One of the primary objectives for the establishment of technology education programmes at tertiary levels including universities, is that after successful completion of the program, the trainees and/or graduates should be able to acquire employability and practical skills that earn a good and comfortable living (self-employed) and even an employer of labor. However, this objective seems not to be adequately achieved, because according to a

report by the National Bureau of Statistics (NBS, 2022) which said the rate of unemployment among teeming youths including graduates of technology education and electrical/electronic technology education is increasing on a quarterly basis.

The graduates' unemployment (including EET graduates) is due to lack of adequate employability skills needed in the world of work (Olojuolawe et al., 2022; Madubuike & Dimnajiye, 2023 and Olubusoye et al., 2023). Despite photovoltaic cell system having numerous skills components that can be possessed for self-reliance, but schools are yet to incorporate these vital components into the curriculum of EET in universities in Nigeria. This assertion is being supported by Aboagye, et al., (2022) who said that essential components failure of the photovoltaic system in Nigeria is caused by installation and load demand assessment. These problems are associated with inadequate training on photovoltaic cell system installation and load demand assessment. The cause of this inadequate training is associated with a complete absence of it in the curriculum of electrical/electronic technology education in universities in Nigeria.

Therefore, one of the ways to curb the menace of unemployment among the teeming unemployed graduates including EET graduates is by incorporating photovoltaic cell installation and load demand assessment skills course into the curriculum of electrical/electronic technology education so that graduates will possess relevant innovative practical skills needed to become self-employed and even the ability to employ others. Hence, it was imperative to conduct this study.

Purpose of the study

The main purpose of this study was to find out the photovoltaic cell installation and load demand assessment skills needed by electrical technology graduates for self-reliance in northern Nigeria. Specifically, the study determined the following skills needs:

- 1) The photovoltaic cells installation skills needed by electrical technology graduates for self-reliance in northern Nigeria.

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- 2) The photovoltaic cell load demand assessment skills needed by electrical technology graduates for self-reliance in northern Nigeria.

Hypotheses of the Study

H₀₁: There is no significant difference of the responses among the respondents on photovoltaic cell installation skills needed by electrical technology graduates for self-reliance in Northern Nigeria.

H₀₂: There is no significant difference among the respondents of the responses on photovoltaic cell load demand assessment skills needed by electrical technology graduates for self-reliance in Northern Nigeria.

METHODOLOGY

A descriptive research design was employed and questionnaire instrument was

administered to 52 respondents, which comprised lecturers, technologists and solar installers (PVC-ILDAS) Needed Questionnaire instrument was used for data collection. The instrument for data collection was validated by experts, and their inputs were used for improving the instrument. The instrument was pilot tested outside the study area having the same characteristics with the study area and .93 coefficient was obtained. The instrument was administered by the researcher and two research assistants. Data collected was analyzed using mean and standard deviation.

Results and Discussions

Research Question 1:

What are the photovoltaic cells installation skills needed by electrical/electronic technology education graduates for self-reliance in Northern Nigeria?

Table1: Mean and Standard Deviation of Respondents on Photovoltaic Cell Installation skills needed by ETG for Self-Reliance

S/N	Items on Installation Skills Required	\bar{X}_L		\bar{X}_T		\bar{X}_S		\bar{X}_{TA}		Remark
		N	SD _L	N	SD _T	N	SD _S	N	SD _{TA}	
		=29		6		N=17		52		
1.	Ability to place a solar panel at a tilt angle of 15° with the help of an inclinometer a compass facing true south or north.	4.02	1.123	4.13	1.211	4.22	1.21	4.12	HN	
2.	Ability to measure the solar panel output open circuit voltage	3.88	.974	3.90	1.211	4.12	.931	3.96	HN	
3.	Ability to measure short circuit current of the solar panel.	3.41	1.181	3.33	1.033	3.29	.966	3.36	N	
4.	Ability to ensure that a solar array already generates its full voltage even with minimal sunlight.	3.52	.911	4.26	.753	3.98	.862	3.92	HN	
5.	Ability to measure up from the solar panel chalk line to the desire module length to form the array.	3.45	.870	3.33	1.033	3.24	1.17	3.34	N	
6.	Ability to ensure that a solar array already generates its full voltage even with minimal	4.03	.778	4.00	.894	3.76	.964	3.93	HN	

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7.	sunlight. Ability to choose a main feeder cable from the array to the charge controller to keep the voltage drop below 3%.	4.03	.731	4.25	.837	3.99	.748	4.08	HN
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Key; Highly Needed (HN), Needed (N)

The result in table 1 provides the information for answering research question 1 which reveals the mean and standard deviation of the responses of electrical technology lecturers, technologist and PVC installers on solar photovoltaic cell installation skills needed. Six items had means between 350- 4.49 respectively. This indicates that their rating scale fall within 3.50 – 4.49 real limit. Therefore, the items were highly needed as skills needed by ETG for self- reliance. Furthermore, these items include item 1,2,3,4, 6 and 7 respectively and considering their standard

deviations which fall within the same range (0-1) indicated that the responses of the respondents across all the items do not vary much. Consequently, these items are needed by ETG for self-reliance.

Research Question 2:

What are the photovoltaic cell load demand assessment skills needed by electrical/electronic technology graduates for self-reliance northern Nigeria?

Table 2: Mean and Standard Deviation of Respondents of Photovoltaic Cell Load Demand Assessment Skills Needed by ETG for Self-Reliance.

S/No	Items on Load Demand Assessment Skills Needed	\bar{X}_L		\bar{X}_T		\bar{X}_S		\bar{X}_{TA}	Remark
		N =29	SD _L	N = 6	SD _T	N=17	SD _S		
1.	Ability to size correctly and accurately the solar panels	3.28	1.09	3.12	1.169	3.12	1.21	3.60	HN
2.	Ability to divide the average amp- hour per day by the load of the estimated battery energy efficiency.	3.48	.911	3.65	1.033	3.65	.931	3.55	HN
3.	Ability to divide the average peak sun-hour per day available.	3.48	1.08	3.94	1.049	3.94	.966	3.68	HN
4.	Ability to select a particular solar panel of the system.	3.45	1.02	3.35	.753	3.35	.862	3.62	HN
5.	Ability to use the specifications for the module to complete further calculations.	3.48	.983	3.06	.894	3.06	.966	3.21	N
6.	Ability to determine the peak sun hour per day.	3.59	.974	3.47	1.049	3.47	.943	3.53	HN
7.	Ability to determine the number of required solar panels to be connected in parallel.	3.34	.871	3.41	1.329	3.41	.712	3.76	HN
8.	Ability to determine the number of required solar	3.48	.903	3.41	.816	3.41	1.17	3.74	HN

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panels to be connected in series.

Key; Highly Needed (HN), Needed (N)

The result in table 2 provide the information for answering research question 2 which revealed that the mean and standard deviation of the responses of electrical technology lecturers, technologist and PVC installers on solar photovoltaic cell load demand assessment skills needed. Seven items had means between 3.50-4.49 respectively. This indicates that their rating scale fall within 3.50 – 4.49 real limit. Therefore, the items were highly needed as skills needed by ETG for self-reliance. Furthermore, these items include item 1, 2, 3, 4, 6, 7 and 8 respectively and

considering their standard deviation which fall within the same range (0-1) indicated that the responses of the respondents across all the items do not vary much. Consequently, these items are needed by ETG for self-reliance.

H₀₁: There is no significant difference among the responses of electrical/ electronic lecturers, technologists and PVC installers on photovoltaic installation skills needed by electrical/electronic technology graduates for self-reliance

Table 3: ANOVA Responses of Electrical/Electronic Technology Lecturers, Technologists and PVC Installers on Photovoltaic Installation Skills Needed

	Sum of squares	df	Mean squares	F	Sig.
Between Groups	.068	2	.30	.485	.617
Within Groups	3.045	49	.062		
Total	3.105	51			

The result of the analysis of variance in table 3 suggests that the mean responses of the respondents namely; electrical/electronic technology lecturers, technologists and PVC installers do not differ significantly $F = .485, p = .617$. Therefore, the hypothesis is accepted. Accordingly, this result suggests that there is no significant difference among the three

respondents on the photovoltaic installation skills needed by the ETG for self -reliance.

H₀₂: There were no significant differences among the respondents on photovoltaic cell load demand assessment skills needed by electrical technology graduates for self-reliance in Northern Nigeria.

Table 4: ANOVA Responses of Electrical/Electronic Technology Lecturers, Technologists and PVC Installers on Photovoltaic Load Demand Assessment Skills Needed

	Sum of squares	df	Mean squares	F	Sig.
Between Groups	15.7	2	1.790	6.54	.004
Within Groups	14.484	49	.296		
Total	18.063	51			

The result of the analysis of variance in table 4 suggests that the mean responses of the respondents namely; electrical/electronic technology lecturers, technologists and PVC installers do not differ significantly $F = 6.54, p = .004$. Consequently, this hypothesis is rejected.

This result shows that there are no significant differences of responses among the electrical/electrical lecturers, technologists as well PVC installers on photovoltaic load demand assessment skills needed by the ETG for self-reliance.

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Table 5: Post Hoc Comparison (BONFERRON)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.579	2	1.790	6.054	.004
Within Groups	14.484	49	.296		
Total	18.063	51			

Since the p value in table 5 indicated that there is significant difference among the responses of the respondents. The Post Hoc comparison in table 5 showed where the differences lie. Therefore, there is significant differences between lecturers and technologists (p value = .41) and there is significant difference between lecturers and solar installers (p value = .016). But there is no significant difference between technologists and solar installers (p value = 1.00).

DISCUSSION OF FINDINGS

Findings from research question one reveals that the respondents rated most of the items as highly needed skills needed for the installation of photovoltaic cell, particularly by placing a solar panel at a tilt angle of 15° , choosing a main feeder cable from the array to the charge controller to keep the voltage drop below 3%. And measure the solar panel output open circuit voltage just to mention few among others. This finding was supported by Iroegbu (2017) who viewed that the technical education plays in skills acquisition and self-reliance. Therefore, he advocated for needs of TE curriculum review with more emphasis and attention on practical and innovative employability skills for self-reliance.

Findings from research question two reveals that the respondents rated most of the items as highly needed skills needed for the load demand assessment of photovoltaic cell, particularly by sizing correctly and accurately the solar panel, dividing the average amp-hour per day by the load of the estimated battery, determining the energy efficiency of the system just to mention few among others. This finding was supported by Okolie, et al., (2020) who noted that the TVET curriculum needs to be reviewed toward the acquisition of technical and employability skills for self-employment.

CONCLUSION

Most of the items on photovoltaic cell installation and load demand assessment skills were highly needed by ETG for self-reliance. Therefore, they should be included into electrical/electronic technology education curriculum of universities in Nigeria.

RECOMMENDATIONS

- i. Government should consider a curriculum review and upgrade toward the acquisition of practical skills among which is the photovoltaic cell installation and load demand assessment.
- ii. Government should also make provision of well-equipped and functional workshops with state-of-the-art facilities.
- iii. Universities should develop a comprehensive and standardized training program for photovoltaic installation to meet the unanimous demand across all respondent categories.
- iv. Universities should adapt training modules in photovoltaic cell installation and load demand assessment.
- v. Universities should promote standardization in training and certification for photovoltaic cell in installations and load demand assessment.

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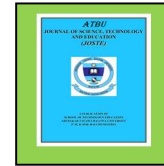
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