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Development of Instructional Module for Solar Energy Installation Training Programme in National Directorate of Employment in Akwa Ibom State-Nigeria.

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Abstract
The study sought to develop and validate Solar Energy Installation Instructional Module for the Training of National Directorate of Employment (NDE) Trainees in Akwa Ibom State. Four specific objectives and four research questions guided the study. The design of the study was Research and Development (R&D) The population of the study was 89, comprising 17 NDE instructors and 72 installation technicians drawn from six solar energy installation companies in Akwa Ibom State. There was no sampling due to the small population size. An instrument titled "Solar Energy Installation Tasks Checklist" (SEITC) developed by the researchers was used for data collection. The instrument was subjected to face and content validations by three experts from the Department of Industrial Technology Education, University of Uyo, whose specialty is in Electrical and Electronic Technology. The Mean, Standard Deviation and Lawshe's Validity Ratio (LVR) statistics were used in answering the research questions posed in the study. The reliability test of the instrument was done using the 25 respondents who were not part of the main study. They were drawn from the neigbouring Cross River State. Cronbach's Alpha reliability technique was used in determining the reliability ratio; the correlation coefficient index of .93 was obtained. The findings of the study revealed that 11 specific mounting tasks, nine specific connections tasks, 13 specific maintenance tasks, 19 training methods, were appropriate for inclusion in the instructional module. On the basis of these findings, some recommendations were made, among them are that the NDE should adopt all the identified installation tasks in the module for NDE programme in Akwa Ibom State and that Akwa Ibom State Technical Schools Board should recommend the developed module for use in Technical Colleges in Akwa Ibom State.

Keywords: Instructional Module, Solar Energy, Mounting Tasks and Connection Tasks.

Introduction

Energy is important to man, animals and plants and also for the economic development of a nation. Many functions necessary for the present-day living grind to a halt when the electricity supply from the National Grid (NG) stops. It is not possible to estimate the actual magnitude of the part that energy has played in the building up of the present-day civilization. The availability of energy in the modern times has resulted in the high agricultural, domestic and industrial production, healthy and balanced diet and good transportation facilities. The greater the per capita consumption of energy in the country, the higher is the standard of living of the people. In actual fact, there is a close relationship between the energy used per person and his standard of living in this present time (Mehta & Mehta, 2014).

In this modern world, the dependence on electricity is so much that it has become an aspect of people's way of life. The ever-increasing use of electricity for domestic, industrial and commercial purposes necessitates providing bulk electrical power to meet the demand of the consumers for domestic, commercial and industrial use. This is achieved with the help of suitable power producing units, known as electric power generating stations. The expectation of the people is that these power generating stations should function efficiently to deliver enough electric power to a large number of consumers to meet their requirements. As it is the case in Nigeria with the population of over 190 million people, the demand for electric power is so high that the few electric power generating stations do not meet the consumer's demand, and even the few ones in existence do not generate to its full capacity because of the shortage of gas supply (Abubakar, 2022). This inadequacy in the supply of electrical energy calls for an alternative power supply to compliment the country's energy production capacity one of which is solar energy. Energy is convertible from one form to other, for instance electrical energy to mechanical energy.

Electrical energy is produced from energy available in various forms in nature. Out of these sources, the energy due to the sun is one of the sources. The heat energy radiation by the sun can be focused over a small area by means of reflectors (Metha & Metha, 2014). This heat can be converted into electrical energy with the help of photovoltaic (PV) arrays. This form of energy can be used as quickly as it is produced. This energy from the sun is known as solar energy. Solar electrical energy production is not associated with smoke, noise, fumes or poisonous gases. Therefore, its use ensures cleanliness, convenience, healthy condition and environments. National Electrical Code (2015) stated that conventional fuel source of power generations has created myriad environmental problems, such as global warming, acid rain, smog, water and air pollution, rapidly filling waste disposal sites, destruction of natural resources. Solar energy generation does not require the use of combustive fuel but the use of heavy-duty batteries for storing electrical energy for later use. Furthermore, electric currents and voltages produced from solar energy installation do not surge and fluctuate because it has no moving parts. This means that appliances, equipment, components and accessories feeding from the installation will operate safely and efficiently.

All over the world, unemployment is a serious problem that disturbs the normal life of the people. In this circumstance, every country is applying various strategies to reduce unemployment to the barest minimum level. In Nigeria, unemployment concerns all level of governments. In order to cope with this ugly situation, the Federal Government has established the National Directorate of Unemployment (NDE), which one of its aims is the training of Nigerian youths male and female to acquire skills in various technical, commercial and hospitality trades, including electrical installation. The role of NDE therefore includes unemployment reduction, skills acquisition, poverty reduction and entrepreneurship development. In Akwa Ibom State, the NDE training programme is tagged "Basic National Open Apprentice Scheme" (B-NOAS) (NDE, 2021). This scheme consists of programmes such as computer programming, electrical installation work, fabrication and welding, catering and fashion design, among others. Today's world of solar energy technology depends largely on the high level of skilled manpower for increased productivity. National Directorate of employment therefore has a major role to play in the production of competent man power for solar energy installation for both domestic and industrial use.

Gillard (2015) defined installation as the whole of a system of machines, apparatus and accessories, when set up and arranged for practical working, as in electric lighting and transmission of power. In order words, solar energy installation shall be the hop of salvation of the society and individuals from the threats of poverty, unemployment, youth restiveness and other vices such as kidnapping, armed robbery, drug abuse and prostitution. It is expected that the NDE trainers that would carry out the training on solar energy installation should utilize a well-developed and validated training module to enable them perform better, ensure effective training that would be beneficial to themselves, the trainees and the society.

The term development means having something done through a gradual process. It entails evolution or progression from a simpler or lower state to a more advanced, mature or more complex state (Udoudo, 2014). In education, several things can be developed, including research and assessment instruments as well as training module. A training module, according to Russel (2015), is an instructional package dealing with a single conceptual unit of subject matter. Modules are deigned to help the trainees accomplish certain well defined objectives. With the use of module, instruction can be conceptualized, the learners can go through the material at their own pace and at their own time. Module also compliment instruction. Alexander (2022) stated that the role of training module for teaching solar installation work is to facilitate the acquisition of knowledge and practical skills for effective and efficient performance in electrical field for life-long learning.

In addition, Ogbuanya and Idris (2014) stated that a training module should include several components such as the objective of the training, contents, teaching strategy, training materials and method of evaluating the trainees. The objective of any educational process determines the content, teaching method and materials needed for achieving such objectives.

Furthermore, the objectives are usually stated in a precise, clear and measurable terms in order to achieve the goal for which it is meant to achieve. The objective of this instructional module is to develop adequate skills necessary for smooth transition of National Directorate of Employment Trainees to become competent solar energy installation technicians.

The contents of the solar energy installation training module are tasks that must be done to support and complement power supply to domestic and commercial houses, small and medium scale enterprises (SMEs) and other such places that need electricity. A task, according to Gillard (2015), is a piece of work to be done, especially one done regularly or with difficulty. It is a discrete learning item having a definite starting and ending point. Teaching methods are the various strategies adopted and used by teachers in transferring knowledge, skills and attitudes to learners in a classroom teaching learning process. There are several researches based and time-tested teaching methods that could be used by teachers such as lecture, demonstration, discussion, questioning, project and field trip, among several others. According to DeBell (2020) evaluation is the process of determining the adequacy of the training programme. Evaluation is done at two levels: formative and summative. Formative evaluation takes place during the planning and instruction phases and assesses what instructors and students are doing. Summative evaluation occurs after instruction have taken place. Evaluation can be achieved by using various instruments such as performance tests, checklist, rating scales, essay tests, objective tests, rubric and subjective tests, among others.

The need for the development of solar energy installation instructional module is based on the fact that solar energy installation would enhance the people's comfort and boost the State economy. The installation instructional module, which is a self-contained unit that focuses on a specific learning goal usually contains documents, experiences, discussions and information for the trainees to use. Vibhakar (2021) stated that instructional module provides the core information that trainees will experience, learn and apply during a course. The modules hold the power to engage the trainees and motivate them, and let trainees navigate from one content to the next without confusion and distraction but keep the trainees focused on the lesson.

Among the States in Nigeria, Akwa Ibom appears to be fast growing in terms of road network, small and medium scale businesses, infrastructural development and urbanization. This trend in infrastructural development calls for the solar energy installation training modules that will help the NDE trainees to perform better. The researcher has observed that there are installation of solar energy in few places in Akwa Ibom State such as in the Government Technical Colleges, Abak, Ikot Akata, Ikot Uko Ika, Ekemini Poultry farm at Ekpene Ikpan Nsit and few petrol filling stations in Uyo metropolis. It can also be seen in few domestic buildings, shopping malls and barbing saloons. The Central Bank of Nigeria at Udo Udoma Avenue and few commercial banks at Udo Udoma banking layout are using solar energy for alternative power supply to feed their electronic equipment, computers and elevators or lift.

The researcher believed that the absence of a well-developed and validated solar energy installation training modules would lead to haphazard training by the trainers. Based on the foregoing background information it has become imperative to develop and validate a solar energy installation training module for the training of National Directorate of Employment trainees in Akwa Ibom State, Nigeria.

Statement of the Problem

Solar energy installation is a veritable and versatile means of alternative power source for domestic, industrial and commercial use. This source of power generation, installation and storage for later use is quite new in Nigeria and in Akwa Ibom State in particular. The need to equip Nigerian youths with adequate skills made the Federal Government of Nigeria to establish the National Directorate of Employment (NDE) with offices in all the States and the Federal Capital Territory (Abuja) for the purpose of training the youths to possess the competencies to create jobs and to earn a living through the application of the acquired training for self-reliance.

The researcher observed that in National Directorate of Employment (NDE), the main emphasis for those specialized in solar energy installation trade is the ability to perform tasks required for photovoltaic arrays mounting, connections and maintenance of the installation are not well known to the trainees. Presently, the NDE master trainers and instructors use different installation modules within their reach to train the trainees posted to their establishments (Alexander, 2022). Some of the instructors do not even have any approved instructional module to follow. In this circumstance, the trainees are engaged in any manual activity as may be decided by the instructor. This means that, the NDE instructors do not follow any particular order in training the trainees. Hence, the introduction of solar energy installation instructional module in NDE training programme is very important so that all the instructors would use a common module to enable all the trainees have the same training content. To the best of the researcher's knowledge, no previous study has focused on the development and validation of a training module in solar energy installation for the NDE in Akwa Ibom State. In consideration of the problems facing the NDE, that rendered the trainees ineffective, the researcher becomes interested in the development of instructional modules in solar energy installation for NDE in Akwa Ibom State, Nigeria.

Purpose of the Study

The purpose of the study was to develop and validate solar energy installation instructional module for training the National Directorate of Employment (NDE) trainees in Akwa Ibom State. Specifically, the study sought to:

i. Determine the specific solar system mounting tasks for inclusion in solar energy installation instructional module for National Directorate of Employment in Akwa Ibom State.
ii. Determine the specific solar system circuit connections tasks for inclusions in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State.
iii. Determine the specific solar system maintenance tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State.
iv. Determine the appropriate training method for the training of National Directorate of Employment trainees on solar system installation

Research Questions

The following questions were answered in the study:

i. What are the specific solar system mounting tasks for inclusion in solar energy installation instructional module for National Directorate of Employment in Akwa Ibom State?
ii. What are the specific solar system connections tasks for inclusions in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State?
iii. What are the specific solar system maintenance tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State?
iv. What are the appropriate training method for the training of National Directorate of Employment trainees on solar energy installation?

Methodology

The study adopted research and development (R and D) design. The study was conducted in National Directorate of Employment (NDE) in Akwa Ibom State. The population of the study was 89, comprising 17 NDE instructors and 72 installation technicians drawn from six solar energy installation companies in Akwa Ibom State. There was no sampling due to the small population size. An instrument titled "Solar Energy Installation Tasks Checklist" (SEITC) developed by the researcher was used for data collection.

The instrument was subjected to face and content validations by three lecturers (experts) from the Department of Industrial Technology Education, University of Uyo, whose specialty is in Electrical and Electronic Technology. The Mean, Standard Deviation and

Lawshe's Validity Ratio (LVR) statistics were used in answering the research questions posed in the study. The reliability test of the instrument was done using the 25 respondents who were not part of the main study.

They were drawn from the neigbouring Cross River State. Cronbach's Alpha reliability technique was used in determining the reliability ratio; the correlation coefficient index of 0.93 was obtained. The real limits of the mean statistic; Very Highly Appropriate (4.50-5.00), Highly Appropriate (3.50-4.49), Moderately Appropriate (2.50-3.49), Lowly Appropriate (1.50-2.49) and Not Appropriate (1.00-1.49) was used in deciding the extent to which a particular task was appropriate. For the Lawshe's Validity Ratio (LVR), items with LVR of 0.5 and above were considered appropriate while items with LVR below 0.5 were regarded as inappropriate.

Results

Research Question 1: What are the specific solar energy mounting tasks for inclusion in solar energy installation instructional module for National Directorate of Employment in Akwa Ibom State?

Table 1: Mean responses on specific solar energy mounting tasks for inclusion in the solar energy installation instructional module (n=89)

S/N	Items	$\bar{X}$	SD	Remarks
1	Select appropriate site to mount photovoltaic arrays (solar panel)	2.99	0.53	MA
2	Select tools for mounting PV arrays, e.g. spanners, hammer, ladder, safety belt, etc.	3.39	0.49	MA
3	Determine where to mount, e.g. pole, roof etc.	3.69	0.68	HA
4	Determine the position of sun rise, sun set, position of the house	4.02	1.20	HA
5	Position of ladder in a safe angle	1.75	0.57	LA
6	Climb the roof and secure yourself	1.66	0.63	LA
7	Mount the PV arrays	3.96	0.75	HA
8	Position the PV arrays to absorb the sunlight	4.47	0.72	HA
9	Adjust the PV arrays	4.15	0.66	HA
10	Fasten the PV arrays	4.22	0.90	HA

11	Observe the mounting and positioning	3.30	0.46	MA
12	Connect PV wires correctly	3.74	0.44	HA
13	Come down safely	1.54	0.54	LA
14	Remove the ladder	2.99	0.53	MA

HA= Highly Appropriate; MA =Moderately Appropriate LA = Less Appropriate

Table 1 presents a summary of the responses on the specific solar energy mounting tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. Table 1 shows that the mean responses on seven items fall within the range 3.50 and 4.49 indicating that they are highly appropriate. Four items have mean responses that ranged between 2.50 and 3.49 indicating that they are moderately appropriate. Moreover, the mean responses of three items fall within the range 1.50 – 2.49 indicating that they are less appropriate for inclusion in the solar energy installation instructional module. Generally, 11 items are appropriate while three are not appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State.

Research Question 2: What are the specific connections tasks for inclusions in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State?

Table 2: Mean responses on specific connection tasks for inclusion in the solar energy installation instructional module (n=89)

S/N	Items	$\bar{X}$	SD	Remarks
1	Select hand tools for connections e.g. screw driver, spanners, pliers	3.72	0.70	HA
2	Select test instrument e.g. multimeter (AVO)	3.29	0.45	MA
3	Mark the PV terminals e.g. positive and negative (+), (-)	4.79	0.48	VHA
4	Mark batteries terminals e.g. positive and negative (+), (-)	4.18	0.64	HA
5	Connect PV arrays in series, i.e. negative to positive	3.37	0.89	MA
6	Connect batteries in series, i.e. negative to positive	4.14	0.66	HA
7	Solder PV connections using soldering iron	4.50	0.78	VHA
8	Test each connection for continuity	4.12	0.65	HA
9	Cover the battery terminals after connection	1.67	0.63	LA

10	Label the battery terminals, positive (Red), negative (Black)	3.42	0.49	MA

VHA= Very Highly Appropriate; HA= Highly Appropriate; MA =Moderately Appropriate LA = Less Appropriate

The result in Table 2 is a summary of the responses on the specific solar energy connection tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. Table 2 shows that the mean responses on two items fall within the range 4.50-5.00 indicating that they are very highly appropriate. Four items have mean responses that ranged between 3.00 and 4.49 indicating that they are highly appropriate. Moreover, the mean responses of three items fall within the range 2.50 – 3.49 indicating that they are moderately appropriate while one item have mean response of 1.67 indicating that it is less appropriate for inclusion in the solar energy installation instructional module. Generally, nine items are appropriate while one is not appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom state.

Research Question 3: What are the specific maintenance tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State?

Table 3: Mean responses on specific maintenance tasks for inclusion in the solar energy installation instructional module (n=89)

S/N	Items	$\bar{X}$	SD	Remarks
1	Inspect the PV arrays (panels) once in a month	4.31	1.16	HA
2	Select type of maintenance schedule, e.g. preventive	4.71	0.45	VHA
3	Read manufacturer's instruction manual	3.70	0.71	HA
4	Wash the PV panels with cold clean water. Use only soft sponge, not metal brush two to three times per year	4.30	0.68	HA
5	Inspect the mounting structure once in a month	4.56	0.49	VHA
6	Clean battery compartment/ventilation	3.82	0.63	HA
7	Clean battery top and smear with petroleum jelly	3.70	0.69	HA
8	Top up battery with distilled water	2.98	0.55	MA
9	Measure the specific gravity with hydrometer	3.13	0.64	MA
10	Take battery terminal voltage reading and record it	4.41	0.49	HA
11	Fix wire guards to protect battery bank	1.61	0.53	LA
12	Record maintenance work done in a log book	3.24	0.71	MA
13	Prepare maintenance cost	3.71	0.70	HA

14	Clean the environment	1.60	0.59	LA
15	Return all tools and measuring instruments to store	4.14	0.83	HA

VHA= Very Highly Appropriate; HA= Highly Appropriate; MA =Moderately Appropriate
LA = Less Appropriate

The result in Table 3 is a summary of the responses on the specific solar energy maintenance tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. Table 3 shows that the mean responses on two items fall within the range 4.50-5.00 indicating that they are very highly appropriate. Eight items have mean responses that ranged between 3.00 and 4.49 indicating that they are highly appropriate. Moreover, the mean responses of three items fall within the range 2.50 – 3.49 indicating that they are moderately appropriate while two items have mean response that fall within the range 1.50 -2.49 indicating that they are less appropriate for inclusion in the solar energy installation instructional module. Generally, 13 maintenance tasks are appropriate while two are not appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State.

Research Question 4: What are the appropriate training methods for the training of National Directorate of Employment trainees on solar energy installation?

Table 4: Mean responses on the appropriate training methods for the training of National Directorate of Employment trainees on solar energy installation (n=89)

S/N	Items	$\bar{X}$	SD	Remarks
1	Demonstration method	4.12	0.65	HA
2	Discussion method	4.45	0.73	HA
3	Field trip/excursion method	3.53	0.50	HA
4	Work-based learning	4.03	0.74	HA
5	Using video clips	4.13	0.85	HA
6	Group project method	3.83	0.52	HA
7	Learning by imitation	3.72	0.89	HA
8	Learning by doing	4.31	1.16	HA
9	Discovery method	4.72	0.45	VHA
10	Questioning method	3.70	0.71	HA
11	Team teaching	4.30	0.68	HA
12	Cooperative learning method	4.56	0.49	VHA
13	Simulation and games	3.82	0.63	HA
14	Programmed instruction	3.71	0.69	HA
15	Lecture method	2.98	0.55	MA

16	Scaffolding method	3.13	0.64	MA
17	Role play method	4.42	0.49	HA
18	Inquiry method	3.83	0.66	HA
19	Use of task instruction sheets	3.25	0.71	MA

VHA= Very Highly Appropriate; HA= Highly Appropriate; MA =Moderately Appropriate

The result in Table 4 is a summary of the responses on the appropriate training methods for the training of National Directorate of Employment trainees on solar energy installation. Table 4 shows that the mean responses on two items fall within the range 4.50-5.00 indicating that they are very highly appropriate. Fourteen items have mean responses that ranged between 3.00 and 4.49 indicating that they are highly appropriate. Moreover, the mean responses of three items fall within the range 2.50 – 3.49 indicating that they are moderately appropriate. Generally, all the 19 listed training methods are appropriate for the training of National Directorate of Employment trainees on solar energy installation in Akwa Ibom State.

Discussion of Findings

Mounting tasks for inclusion in the solar energy installation instructional module

The study further found that 11 specific mounting tasks are appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. These include selecting appropriate site to mount photovoltaic arrays (solar panel); selecting tools for mounting PV arrays, e.g. spanners, hammer, ladder, safety belt, etc.; determining where to mount, e.g. pole or roof; . determining the position of sun rise, sun set, position of the house; mounting the PV arrays and positioning the PV arrays to absorb the sunlight. Others are: adjusting the PV arrays; fastening the PV arrays; **observing** the mounting and positioning; connecting the PV wires correctly and removing the ladder.

This finding supports the views of the Government of India, Ministry of Railways (2013) which listed some of the items among the procedures for installation/ mounting of solar systems. These include Assembly and fixing of support structure: Mounting of Solar Modules on the Support Structure; Installation of Battery Bank; Interconnection of SPV panel in series and parallel configuration, Charge Control Unit and FJB; Connection of Battery Bank and Load and Earthing of Lightning Protection Unit. The ministry added that for mounting the solar panels, the person should first determine the mounting method, whether roof mount or ground mount. While mounting the solar modules, the following points should be considered for getting maximum output from the solar modules: (a) Modules should be oriented south facing to receive maximum sunlight. (b) The Modules produce more power at low temperature and full sun (c).

Tracking the sun increases the amount of power from an array. They noted that the solar panels are generally installed in such a way that they can receive maximum direct sunlight

without shade from any building/trees nearby falling on them at any part of the day. The finding also lay credence to the views of AE Solar GmbH (2018) which outlined some of the steps in solar panel installation and mounting to include site selection, tilt angle selection, mechanical installation/ mounting with bolts and mounting with clamps.

Solar system connections tasks for inclusion in the solar energy installation instructional module

Nine specific solar system connections tasks are appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. These are: Selecting hand tools for connections; selecting test instrument; marking the PV terminals; mark batteries terminals and connecting PV arrays in series, i.e. negative to positive. Others are connecting batteries in series, i.e. negative to positive; soldering the PV connections using soldering iron; testing each connection for continuity and labeling the battery terminals, positive (Red), negative (Black).

The finding of this study regarding the solar system connection tasks for inclusion in the instructional module supports the views of the Government of India, Ministry of Railways (2013) which listed some of the items among the procedures for connecting solar systems. The Government of India, Ministry of Railways specifically outlined the tasks in solar system connection to include connection of module to module; module to charge controller; charge controller to battery and finally, from battery to the loads. The present finding also support the views of Washington State University (2019) which also identified similar tasks in connecting solar system components.

Solar system maintenance tasks for inclusion in the solar energy installation instructional module

Thirteen specific maintenance tasks were found to be appropriate for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State. These include the following: Inspecting the PV arrays (panels) once in a month; selecting type of maintenance schedule; reading manufacturer's instruction manual; washing the PV panels with cold clean water; inspecting the mounting structure once in a month; cleaning battery compartment/ventilation and cleaning battery top and smear with petroleum jelly. Others are topping up battery with distilled water; measuring the specific gravity with hydrometer; taking battery terminal voltage reading and recording it; fixing wire guards to protect battery bank; recording maintenance work done in a log book and preparing maintenance cost.

The finding of the present study with respect to maintenance tasks for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State supports the views of Australian Business Council for Sustainable Energy

(2020) which some of the tasks among the steps involved in a typical solar battery maintenance. Some of the steps specified by this source include: Isolating the system for maintenance by Shutting down (turning off) all loads on the system starting from the household appliances and working back to the inverter; disconnecting (turning off) all energy generation devices such as solar or wind generators; shutting down the battery bank by either switching off circuit breakers or removing fuses on the battery control circuit; removing the front mechanism to prevent it being closed while you are working; cleaning the cells, checking the charge and condition of the battery and using a hydrometer to check the specific gravity of the electrolyte in the battery.

Training methods for solar system installation training

The study found 19 methods that are appropriate for training the trainees in solar system installation. These methods include demonstration method; discussion method; field trip/excursion method; work-based learning; using video clips; group project method; learning by imitation and learning by doing. Others are discovery method, questioning method, team teaching, cooperative learning method; simulation and games, inquiry method and use of task instruction sheets.

This finding could be attributed to the fact that the respondents acknowledge these methods as being good for skills training programmes. This finding supports that of Ogbuanya and Idris (2014) who found similar strategies appropriate for training Technical College students on automobile battery charging and maintenance.

Conclusion

Based on the findings of the study, it could be concluded that the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State have been well developed. Specific tasks in several areas such as photovoltaic arrays mounting, connections, maintenance tasks and training methods have been identified for inclusion in the solar energy installation instructional module for National Directorate of Employment trainees in Akwa Ibom State.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

1. The National Directorate of Employment should henceforth use the developed solar energy installation instructional module for training her trainees in Akwa Ibom State.
2. Basic Electronics teachers and instructors in public Technical Colleges in Nigeria can also adopt the developed solar energy installation instructional module for training her students

3. The National Board for Technical Education (NBTE) should use the specific tasks identified in this study in various areas of solar energy installation to develop instructional modules in design, inverter construction, photovoltaic mounting, connections, trouble shooting, earthing and maintenance of solar energy installation for Technical Colleges in Nigeria.
4. The Akwa Ibom State Ministry of Education and State Technical Schools Board should recommend the developed solar energy installation instructional module for use in Technical Colleges and Innovative Enterprise Institutions in Nigeria
5. The Ministry of Education in collaboration with the Technical Schools Board should organize retraining programmes for Basic Electronics teachers and instructors in all public Technical Colleges in the State on how to effectively use the developed solar energy installation instructional module for training students in Technical Colleges.

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