Asian Journal of Multidisciplinary Studies
Vol. 1, No. 2, (2018)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

Development and Testing of Grid-Tied Solar Power System Trainer

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Abstract *- The quality of education has lasting effects on individual students. Experts have developed research-based solutions to support teachers in implementing the most successful teaching and learning strategies and best practices. Theories and principles are not sufficient for students to improve and further develop their technical skills. The shortage of learning equipment set off hurdle to the learners' hands-on practice. This developmental study was intended to design and fabricate a grid-tied solar power system trainer and to define the level of performance of the students utilizing the said trainer. The research was piloted at Pangasinan State University – Lingayen Campus particularly at the College of Technology in the First Semester of Academic Year 2017-2018. The researcher made use of the developmental type of research and followed some procedures in the assembly of the trainer. This study also utilized another method of research, specifically experimental design, wherein it determines the performance rating of the students using the mock-up trainer. The questionnaire and qualitative interview were done in the compilation of data related to the design and fabrication of the trainer. The researcher had chosen the College of Technology faculty members teaching Electrical, Electronics, and Mechanical Technology which composed of ten (10) which served as technical experts to validate the design and fabrication of the trainer. All the seventy-six (76) Fourth-year Bachelor of Industrial Technology major in Electrical, Electronics, and Mechanical Technology students underwent the pre-test and post-test to define the performance level of the students by utilizing the said trainer. Based on the outcome of the analysis utilizing the trainer, it was noticed that the student performance level was improved. It was also concluded that the trainer was an effectual and essential tool for teaching in Building Wiring Installation and Electrical and Electronics Circuits, an elective subject for Bachelor of Industrial Technology major in Electrical, Electronics, and Mechanical Technology. This could, therefore, strengthen the skills of students and improve the standard of teaching, particularly in the laboratory workshop setting.*

Keywords: *Design, Fabrication, Grid-Tie, Solar Power, Trainer.*

1. INTRODUCTION

Renewable energies are energies that came from sources that do not deplete or can be reloaded in a cycle of human existence. The utmost bulging sources are solar, wind, hydropower, biomass, and geothermal. This is in comparison with non-renewable outlets, for example, fossil fuels. Although many sustainable energy initiatives are large-scale, sustainable energies are often tailored to remote and rural places and developed nations, wherein electricity is also essential to nations' growth. As most renewable energy technologies produce power, the introduction of renewable energy is mostly seen in combination with more electrification, which has many compensations: Electricity can be transformed where it is important to produce higher temperatures than fossil fuels, another is that it can be transformed to high-efficiency mechanical energy that is renewable at the point of use. Electrification of green energies is more efficient and thus contributes to substantial cuts in the criteria for primary electricity. Any of the clean energy supplies come explicitly or indirectly from the climate. The sunshine can be collected directly using solar power. The photovoltaic

(PV) device transforms light to electrical direct current (DC) by a compelling gain of the photoelectric effect. Solar photovoltaic has become a billion, rapidly growing sector, remains to boost its viability, and has the highest promise of all renewable energy technologies. PV utilizes solar cells that are mounted into solar panels to turn sunlight and its heat into electrical energy. Solar power systems vary from a small to large residential houses, and industrial rooftop or built-in installations to massive infrastructure PV power stations. Solar photovoltaic technology has increased its power production capacity, lowered construction costs per wattage, together with its power recovery period, and produced a grid-connected network.

A grid-tied solar power system is an electrical device that helps transform sunlight into electricity by utilizing solar panels and a power inverter, along with other small devices and electrical peripherals. This occurs when a home or building stays reliant on a local grid or utility such as the Central Pangasinan Electric Cooperative (CENPELCO). Most customers depend on this service as it helps to save money on electricity costs. Using solar panels makes it possible to save energy, however, having a solar grid connection inverter doubles the ability. It is also notable that solar grid projects are capable of maintaining electricity as clean as possible. That ensures that any surplus power generated is forced back into the system, which will cause your kilowatt-hour meter to switch backward. This turns into important outcomes that could reduce energy bills. Not to mention that having solar grid connection inverters mounted in a given property improves its worth dramatically. It increases the valuation of your home or business institution, which would draw prospective customers should you do put it up for sale. This is indeed a fantastic source of solar electricity, a renewable and clean form of energy all over. The technology allows owners of houses and businesses to support to preserve the atmosphere as effectively as possible.

Because of the growing demand for the construction of solar power systems in residential and commercial buildings and the need for technical expertise such as solar PV installers, technologists, and electricians, the need for instructions, seminars, and certifications on solar PV installations became very significant. PV Systems Installation NC II is a short course offered in Technical Education and Skills Development Authority (TESDA) and other technical and vocational schools in the Philippines such as Pangasinan State University, it will train leaners to conduct site and room evaluations, track photovoltaic parts, equipment and materials enforcement, build and mandate PV systems, and plan paperwork specifications for implementation of photovoltaic systems. Since completing the TESDA assessment and certification, being a qualified solar PV installation specialist is not restricted to housing projects alone. All of these occupations are beginning to mount and troubleshoot electrical components for commercial buildings and factories in the corporate and manufacturing sectors.

The Pangasinan State University – Lingayen Campus, in particular the College of Technology, is offering a Bachelor's degree in Industrial Technology (BIT) with nine (9) main areas of concentration in which three (3) major programs have an elective emphasis on Renewable Energy, namely Electrical Technology, Electronics Technology, and Mechanical Technology. Increasing the standard of student learning outcomes of BIT majoring in Electrical Technology, Electronics Technology and Mechanical Technology, the trainer's creator is seeking learning innovation that focuses on the design and manufacture of a grid-connected solar power system trainer that may be used during classroom time for student practicum and the Pangasinan State University, especially the Lingayen Campus, will soon be offering a training and assessment center in the field of Solar PV System Installation NC II, the very first in the province and Region I.

2. LITERATURE REVIEW

One of the biggest prospects for developing solar energy usage in the Philippines is the growth in solar power production potential in numerous large-scale establishments and industries throughout the country. Universities and colleges also have a variety of buildings with large roofs that will be ideal for solar power installations. Many factories, processing firms, and businesses, both domestically and overseas, are also beginning to generate solar energy. A university or college has several non-financial benefits correlated with solar power systems, the first gain is a raise to the institutional rating of universities and colleges following a green policy and a low environmental impact. Adding to this, the usage of solar energy generated on campuses serves as a sign of the University's contribution to the climate. This move allows teachers, professors, employees, and other partners to embrace and foster sustainable change through the campuses' day-to-day

operations. Finally, the deployment of solar electricity on campuses offers valuable training and learning resources, especially for the students. A university with solar energy technologies will provide students, in particular engineering and technology students, with realistic training in solar energy. In turn, classes and curricula should be integrated to enhance the potential for direct exposure to the solar power grid. The solar power system would offer an enormous starting point for this call to raise awareness of environmental problems and to introduce sustainable practices. Based on these promising benefits, Pangasinan State University may suggest using solar energy to constitute a significant portion of its electricity.

In the study of (Pulok et al., 2013), Solar water heater is a system or combination of equipment used to heat water, so this solar water heater project does not require the usage of any other electricity. A lot of research has been done on these things, but the key purpose of the authors is to create a better version of the current one in case of output quality, size, and so on. In the case of design-alignment, the width of the absorber tubing, the absorbing surface study has been stressed further. More focus has been put on the substance – heat absorption ability, insulation quality, radiation efficiency, etc. As a consequence, the level of production has increased. In the event of maintaining the same results, the size is also reduced relative to the previous collectors. Thanks to its reduced scale, it, therefore, needed fewer resources and lowers prices, even if the components used in this project are more costly [1].

According to the study entitled "Development of an electrical wiring installation trainer" offers trainees with technical applications and understanding of the subject and the course as a whole, as well as presentations by instructors and assessment of student results during laboratory hours. The project study used a developmental method of research. All the parts of the trainer were fully visible and bare for quick deployment and getting used to. The trainer was fitted with a low-current circuit breaker to promote secure operation and prevent harm to all parts and equipment. It was capable of treating, troubleshooting, and commissioning domestic, business, and industrial-like electrical wiring installations. The electrical wiring installation simulator was run on a 220VAC (Volts-Alternative Current) power supply and aided by an instructional module in the electrical wiring system. After demonstrating, interviewing and collaborating with the Pangasinan State University - Lingayen Campus, College of Technology faculty members, teaching Bachelor in Industrial Technology, Major in Electrical Technology, said that the trainer can carry out all the technical exercises described in the electrical wiring installation module, which is parallel to the actual building wiring installation. An Industrial Design patent was awarded to an electrical wiring installation trainer by the Intellectual Property Office of the Philippines while awaiting a corresponding formality review report for the awaiting action for a Utility Model patent by the same national bureau.

Training is the secret to achievement that brings people a happy existence. It drives people to create and build tools that make things simpler. Theories and principles were inadequate to improve the students' technical skills. Lack of school equipment is now a barrier to the realistic teaching of learners. The research study of (Tejano, 2018) meant to design and develop an Off-grid Solar Power Mock-up and to define the level of its performance and its acceptability. The research was performed at the Main Campus of Bohol Island State University located at Tagbilaran City, during the school year of 2015 - 2016. The study used the experimental method and adopted a certain protocol in the construction of the unit. The validated questionnaire was utilized to collect and gather data relating to the acceptability of the mock-up. The degree of success was reached through an evaluation guide. The researcher selected twenty (20), technological experts, to verify the quality of output and to determine the degree of acceptability of the mock-up. Twenty (20) BS Electrical Engineering and BS Electrical Technology students conducted a skill check to assess the level of performance of the mock-up. Based on the results of the study utilizing the solar off-grid mock-up, the student success evaluation was improved by 25.92 percent. It also emerged that the mock-up device was an important guidance method in the fields of BS Electrical Engineering and BS Electrical Technology. The off-grid solar power system had a high output rate and worked well. It may also develop the skills of students and increase the standard of teaching in the laboratory setting [2].

All previously mentioned reviewed studies relate to the existing research project as directed at understanding the importance of training facilities and the need for a creative teaching mock-up device.

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3. OBJECTIVE OF THE STUDY

The goal of this study was to develop and produce a grid-tied solar power system trainer and to evaluate the level of performance of the students utilizing the said trainer. The study was piloted at Pangasinan State University – Lingayen Campus, in particular at the College of Technology in the first semester of the 2017-2018 academic year. The said trainer will be used for the training and assessment of learners on the competency and mostly in certification for solar PV system installations.

4. METHODOLOGY

The study used the developmental method of research (Jeff G Pereyras, 2018) [3] and observed a certain protocol in the assembly of the mock-up trainer. This research also employs the experimental design to determine the performance level of the students when it regards to the utilization of the said trainer device. The questionnaire and the qualitative interview were conducted to gather the data relevant to the design and development of the trainer, and by having a pre-test and a post-test to define the performance rating of the students. The researcher had chosen the College of Technology faculty members teaching in Electrical, Electronics, and Mechanical Technology, which consisted of 10 faculty members, and has acted as professional expertise to verify the concept, production, and output quality assessment of the said trainer. The seventy-six (76) fourth-year Bachelor of Industrial Technology majors in Electrical, Electronics, and Mechanical Technology students undertook a skills test, by way of pre-test and a post-test, to assess the level of performance on the use of the said grid-tied solar power system trainer.

4.1 MATERIALS SELECTION AND THE DESIGN

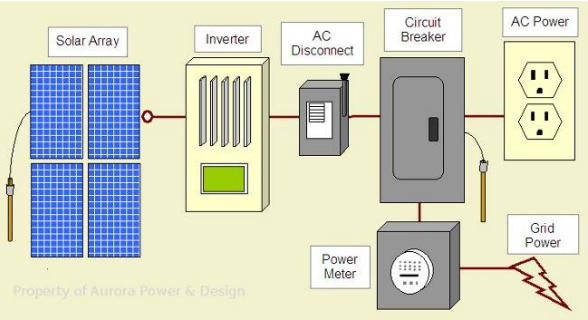

Figure 1: Physical Layout of the Grid-Tied Solar Power System Trainer

4.2 PERFORMANCE LEVEL OF THE STUDENTS

This research used the comparative nature of the pre-skill evaluation and the post-skill examination. Upon construction and installation of the trainers' facility, parts and accessories, the pre-test and the post-test were utilized to measure the variation of the result before and after the students' utilized the mock-up trainer. The purpose of the pre-test and the post-test procedure was planned to determine whether the trainer can enhance students' performance. The author verified the level of performance of the students through actual skills demonstration in the grid-tied solar power system installation using a self-made rubrics. Seventy-six (76) fourth-year Bachelor of Industrial Technology students underwent the skill test.

5. RESULTS AND DISCUSSION

The grid-tied solar power system trainer was used most widely for PV installation training and skills development. The trainer used both direct current and alternating current to operate where the sunlight became the primary source of energy and the main supply. After completing this research project, after mounting solar panels and inverters, and installing different electrical devices and parts, providing electrical connections, and getting appropriate current and voltage rating, the output was found to function at 220 VAC. No short circuit was found when running on either of the electrical wirings. After the presentation, conversation and consultation with the Pangasinan State University – Lingayen Campus, College of Technology faculty members teaching Bachelor of Industrial Technology major in Electrical, Mechanical and Electronics Technology, the said mock-up trainer would carry out all the required technical exercises and activities concerning solar PV installations, these were often similar to the real-world solar installation sector.

All the seventy-six (76) Fourth-year Bachelor of Industrial Technology major in Electrical, Mechanical, and Electronics, Technology students underwent the pre-test and post-test to define the l performance level of the students by utilizing the said trainer. Based on the outcome of the study utilizing the trainer, it was noticed that the student performance level was improved. It also emerged that the trainer was a successful guidance

device for solar PV system installation, an elective topic for the Bachelor of Industrial Technology major in Electrical, Mechanical, and Electronics Technology.

6. CONCLUSION

The key objective of this study is the design and fabricate a solar PV system installation trainer and to determine the performance level of the students. Upon completion of this research, it is concluded that the trainer can improve the skills of trainees and learners and upgrade the class of teaching, especially in the laboratory workshop area. It also concluded that the trainer was an essential and practical mock-up device for teaching in Building Wiring Installation and Electrical and Electronics Circuits, an elective subject for Bachelor of Industrial Technology major in Electrical, Electronics, and Mechanical Technology.

7. RECOMMENDATION

Taking into consideration, the study points out that it builds on the findings of this research, the present project suggested that the particular trainer be used for teaching and learning activities, line in the higher education institutions and technical and vocational skills development centers that offers electrical technology and that the proprietary trainer is developed for commercialization purposes. Another, for potential studies, this analysis will be undertaken to develop the grid-tied solar power system trainer.

ACKNOWLEDGMENT

Thank you so much to the Pangasinan State University – Lingayen Campus. Finally, a huge thank you and thanks to Dr. Randy Joy Magno Ventayen for supporting and most especially mentoring the author.

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