TECHNO-ECONOMIC FEASIBILITY OF SOLAR ENERGY SET-UP FOR LEARNING RESOURCE CENTER

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Abstract

The Techno-economic Feasibility of Solar Energy Set-Up for Learning Resource Center is a renewable energy source. That electricity was generated by converting the sun's light into a useful power source. The primary goal of this research is to determine whether this technology is necessary for the use of an alternative power source in a learning resource center, to determine if this alternative power source is preferable in providing sufficient energy backup and an alternative tangible investment with strong returns, in order to meet the center's high service standards. The solar set – up was assembled at Ssumline learning center to provide better power back-up in times of power outages. It includes the following attributes or specifications: powered of two (2) different hybrid inverters, rated 3,000 watts, 720 ampere hour gel type battery rated (expandable) 24VDC, which can be charged from either distribution utility power source or solar panels. Can power 15-20 personal computers with lights and internet connectivity (switch hubs and routers), has 1,536 watts solar panel power output, and controlled by unique control panel were can interface the presence of generator and in additions of protective solar set -ups and power monitoring system through android phones in terms of its input PV power and current, battery voltages and current, total load usages and output voltages and frequency.

Keywords: Green house, photovoltaic set-up, Energy back-up.

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1. Introduction

The demand for energy is increasing in today's world. One of most important resources for a country's development is energy. When almost everything is powered by electricity to make people's lives easier and for job's or everyday activities go faster. Energy sources should meet the requirements of creating a big amount of energy, having low costs, and having no negative environmental impact. However, for a variety of reasons, will be unable to avoid a scarcity of energy due to natural causes like bad weather conditions, equipment failures, and human error and scheduled maintenance which will result in financial losses for business sectors.

In the province of Bohol there are several career and business opportunities available. Online English tutoring, online teaching, online shopping, and online graphic design are all possibilities. However, English as a second language Centers is one of growing businesses here in the province of Bohol. Learning resource centers include English as a second language (ESL) or home-based tutorials are among the increasing online professions and business opportunities. There are various online English education companies that ESL centers use, but 51talk is a new trend and the most popular among ESL centers in the province of BOHOL. The 51 talk centers in the region include Ssumline learning center in Glovaza Street, Cogon District, Tagbilaran City, Manga 51 Talk Center in Mangga Tagbilaran City, and MN2 Teaching Center at across J&B Store 2ndloor Of Snack Shack Restaurant, Terejo Jagna Bohol.

The researcher believes that as a remedy to the problem, so he designed a Solar Energy Set-Up for Learning Resource Center, as an alternative energy backup for learning resource centers include 51 talk ESL center in times of energy shortages, because it can cause negative feedback to the center as well as to the teachers. 51 talk center or home based teachers may charge a penalty or suspensions if their classes are interrupted due to energy shortages.

Hence, the subject of power outages is also one of the most common issues faced in the province of Bohol that must not affect the ESL centers. Particularly with the super typhoon Odette 2021, that caused long power outages and disrupted gasoline supplies.

The primary goal of this study was to provide enough energy to the learning resource center in the event of a power loss and to determine whether this technology is better suitable for backup power by calculating the return on investment. The arrangement, procedures, and planning were the aspects to consider in order to achieve the desired study outcome. All of the study's resources were carefully considered and entered in order to avoid technology failure and provide ineffective power to the learning resource centers.

2. Methodology

Design

The experimental design was used in the assembly of the Techno Economic Feasibility of Solar Energy Set-Up for learning resource center. The descriptive design was also used a questionnaire as a data gathering instrument. The questionnaire was also intended to show the efficiency of the solar set -up such as accurate operation in the given time and for the acceptability level.

The researcher also had to come up with guidelines for observing the solar set-up's performance in each test. The researcher had to assess the data after receiving it. The outcome was used to determine whether or not the solar set-up effeciency is acceptable.

Environment and Participants

This research was conducted at the main campus of Bohol Island State University during the school year 2021-2022. Technical courses such as Electrical, Electronics, Automotive Technology, and other related courses are provided at this University, which is located in Poblacion 2 Of Tagbilaran City's #76 Carlos P. Garcia North Avenue. The solar energy set-up was assembled at Ssumline learning center, Located Lope Glovasa Street Cogon District Tagbilaran City, Bohol because the facility offers English tutorials, such as 51 talks, and it also had available tools and equipment needed for the project's assembly..

This study was participated by ten (10) electrical technology experts and five (5) learning resource center owner namely Ssumline learning center in Glovaza Street, Cogon District, Tagbilaran City, Bohol, Manga 51 Talk Center in Mangga Tagbilaran City, MN2 Teaching Center at across J&B Store 2ndloor Of Snack Shack Restaurant, Terejo Jagna Bohol, Carl Balita Review Center Bohol at 3rd floor QVC Business Plaza CPG North Avenue Tagbilran City, Bohol, Tagbilaran City, Powerhouse Training And Review Center at JVW4+C5V, Tagbilaran City, Bohol. They were purposoively chosen as the respondents of the study to assess and validate the efficiency and acceptability of the Solar Energy Set-up.

Instrument

The researcher utilized a series of test that was necessary in getting data for the level of performance of the solar set-up as an innovative study. A questionnaire was used to gather data for the acceptability level of the solar set-up. The researcher also utilized an observation guide during the assembly of the solar set -up in order to record data during trial and error process. The researcher used the same observation guide until the unit is operational.

3. Result And Discussion

This contains the presentation of data gathered by the researcher on Techno Economic Feasibility of Solar Energy Set-Up for Learning Resource Center. The presentation of data is supported with tables which illustrated the responses of the study on the performance of the Techno Economic Feasibility of Solar Energy Set-Up for Learning Resource Center. The gathered data had undergone thorough statistical treatment before these were interpreted.

Table 1
per of the Solar Panel of Energy Set-Up for Learning Resource Center

Solar panel		Weather Condition	Average generated power (watts)	Generated Power (watts)	Output		Total hours	Total power Generated (kwh)	Interpretation
					Current	Voltage (DC)			
Power Output (watts)	1,536.5watts	Sunny	768W–1,536.5W	1,110w	5.43	204.42	5 hrs.	5.55kwh	Operational
		Cloudy	307.3w - 768.2w	744.7w	3.8	195.97	2 hrs.	1.49kwh	Operational
Voltage Output (Max. volts)	240.43 Volts	Rainy	153.63-307.3w	298w	1.46	187.97	1 hrs.	.289kwr	Operational
Power generated per day/8 hours									**7.32 kwh**
Power generated per day/8 hours in Watt hour									7.32 kwh x 1000 watts = **7,320 Wh**
Power generated per day/8 hours in Ampere hour									7,320 Wh / 240.43 Volts = **30.44 Ah**
Number of hours to charge the battery rated 720Ah									720 Ah/ 30 Ah

	=23.65 hrs.
Interpretation	Operational

Table 1 shows the result of the efficiency of the solar panel. Under different weather conditions based on 8 hours daytime charging. On a regular day with an average of five (5) hours sunny condition, the total power generated by the solar panel was 1,110 watts with a result of a total current 5.43 Amperes, which is enough current to charge the battery and the input voltage generated was 204.42VDC which meets the voltage requirements of the solar inverter as measured using power meter instruments by the researcher. Thus, the total power generated on sunny hours was 5.55kwh. Hence, the researchers found that the solar panel's efficiency was operational during Sunny conditions because it met the solar inverter's power requirements of 768W–1,536.5W to charge the battery.

Moreover, having 2 hours of cloudy condition on a day the total power generated by the solar panel was 744.7 watts with a result of a total current 3.8 amperes, which enough current to charge the battery and the input voltage generated was 195.97 VDC which meets the voltage requirements of the solar inverter as measured using power meter instruments by the researcher. The total power generated on cloudy hours was 1.49 kWh. The researchers found that the solar panel's efficiency was operational during cloudy conditions because it met the solar inverter's power requirements of 307.3w-768.2w to charge the battery.

Furthermore, having rained for one hour in a day, the total power generated by the solar panel was 298 watts with a result of a total current 1.6 amperes, which can still charge the battery and the input voltage generated was 187.97 VDC which meets the voltage requirements of the solar inverter and measured using power meter instruments by the researcher. The total power generated on cloudy hours was .289 kWh. The researchers found that the solar panel's efficiency was operational during rainy conditions because it met the solar inverter's power requirements of 153.63W-307.3W to charge the battery.
Based on the data gathered, the researcher found out the total generated power by the solar panel per 8 hours of daytime was an average of 7.32 kWh based on the data acquired. That is, the total power generated each day under various weather conditions.

In connection, with the total 7.32 kWh power generated each day under various weather conditions the total number of hours to charge the 720 Ah battery was 23.65 hours 1 day of charging under low battery capacity. The solution was shown in the table 1. The researchers found out that the battery charging time was operational because it met the normal period of hours in charging the 720 Ah battery rated.

Table 2
Battery Efficiency of solar energy set-up for learning resource center

Type of loads	Number of loads	Specific Loads for power back-up	Total load consumption (watts)	No. Of hours used	Power consumption (wh)	Gel type battery	
Resistive	16	Computers	1120 W	8 hrs.	8,960 Wh	Battery ampere hour Battery voltage	720ah 24v
	20	Lighting	280 W	8 hrs.	2,240 Wh	Battery voltage	24v

	3	Network	80 W	24hrs.	1,920 Wh	Percentage battery deep of discharge	50%
						Battery (watt)	720 ah X 24v = 17,280 watts
Inductive	18	Ups	270 W	8 hrs.	2160 Wh	Total battery dod(in ampere hour)	720 ah X 50 % = 360 ampere hour
	1	Electric fan	60w	8 hrs.	480 Wh	Battery capacity run time	360 ah 71.64ah
Average total watt/8 hours			1,810 W	**Total Wh /day**	15, 760 Wh	**Number of hours of battery run time**	**= 5.2 hrs.**

Table 2 shows the efficiency of the battery in terms of sustaining the loads in times of power outages. Where there are two types of loads the resistive and the inductive loads. Where the total load consumption was 1,810 watts with an eight hours of daily operation. 1,810 watts was multiplied by number of hours used in every load consumptions to get the total power consumption in kWh. The result was 15.760 watts and considering the number of hours for switches and routers.

The researcher conducted a calculation to determine the efficiency of the battery in terms of the number of hours of battery run time considering the percentage of battery deep of discharge which is 50%. To get the battery deep of discharge in ampere our, battery ampere hour multiply by 50% DOD. The result was 320 ampere hour.

While the computation in acquiring the number of hours to sustain the total power output 15, 760 Wh or 71. 64 Ah through multiplying the total power output to the rated voltage 220v. To compute the number of hours of battery run time, total battery DOD divided by total power consumption in ampere hour. The result was 5.2 hrs. Of sustaining the loads

Table 3
Load profile of Solar Energy Set-Up for Learning Resource Center

Loads	**Total power consumption Kwh**	**BOHECO/BLCI bill per kilowatt hour**	**Daily bill (8 hrs./day)**	**Monthly bill (30days)**
Computers	8.96 kwh		P116.48	P3,494.40
Lighting	2.24 kwh		P29.12	P873.60
Network	1.92 kwh	P13.00	P24.96	P806.40
Ups	2.16 kwh		P28.08	P748.8
Electric fan	.480 kwh		P6.24	P187.2
Total	**15.76 kWh**	**P13.00**	**P204.88**	**P6,110.40**

Table 3 shows the result of the electrical consumption (electrical bill) daily/monthly bill/ load x hours consumed. With an eight-hour daily operation, the entire load consumption was 1, 810 watts. Including the network was 24 hours in operation. By multiplying 1,810 watts by the number of hours consumed in each load consumption (referring to table 4), the total power consumption in kWh was computed.

The result was 15.76 kWh, as shown in the table. To get the daily bill, the total power consumption was multiplied by 13 pesos BOHECO/BLCI rated bill per kWh and the result was P204.88 pesos. The monthly bill, it was calculated by multiplying the daily bill by 30 days, and the result was P6, 110.40 pesos. This implies that the daily bill was P204.88 pesos and for the monthly bill was P6, 110.40 pesos.

Table 4
Return of Investment of Solar Energy Set-Up for Learning Resource Center

Return of Investment of Solar Energy Set-Up for Learning Resource Center	
Total power saved	3110.8 kw/year
Money Saved	P40,440.00/year
Payback Time	6.7 years

Given:
Price of electricity per kilowatt = <u>Php. 13.00/kW</u>
Power output of a 720ah battery x 50%(DOD) = <u>8.64 kW</u>
Total cost of Solar Energy Set-Up for Learning Resource Center <u>= Php. 272,004.60</u>
Percentage of sunny day per year <u>= 70%</u>

Solution:
Total power saved per year = <u>power output of a 720ah battery x 50 %(dod) x number of days per month x number of months per year</u>
Total power saved per year = <u>8.64 kW x 30 days x 12 months</u>
Total power saved per year = <u>259.2 kW x 12 months</u>
Total power saved per year = <u>3,110.8kw/year</u>

Solution:
Money saved from solar energy set-up for learning resource center /year =<u> price of electricity/kw x total power saved per year</u>
Money saved from solar energy set-up for learning resource center/year = <u>php. 13.00/kw x 3,110.8kw/year</u>
Solar energy set-up for learning resource center /year =<u> Php. 40,440.00</u>

Solution:
Payback time = <u>total price of solar energy set-up for learning resource center/year.</u>
Payback time = <u>php. 272,004.60/ Php. 40,440.00</u>
Payback time = <u>6.7 years</u>

This calculation demonstrates how to calculate the return on investment of a solar energy set-up for learning resource center. The researcher gathered the information needed to calculate the number of years it would take to pay off the overall cost of the solar system.

The first step is to calculate the total annual electricity savings. The total power saved per year is calculated using the power output of a 720ah battery multiplied by 50% (DOD) multiplied by the number of days per month, then multiplied by the number of months per year. Utilizing this method, the researcher was able to generate an estimated 3,110.8kw of power per year for the solar energy set up for learning resource center using off-grid solar energy. After finding the total power saved per year, the next step is to find the money saved from solar energy set-up for learning resource system/year. By finding the money saved from it is needed to multiply the price of electricity/kw which is Php. 13.00/kw and the total power saved per year. In the previous calculation we already get the total power saved per year which is 3,110.8kw.

After calculating the given values, the result of finding on the money saved from using off grid of solar energy set-up for learning resource /year is Php. 40,440.00. This is the estimated savings every year. After calculating the money saved from solar energy set-up for learning resource/year. The researcher proceeded to the main goal which was finding the return of investment or the payback time solar energy set-up for learning resource.

In finding the return of investment or the payback time, the total price of solar energy set-up for learning resource center was divided to the money saved from solar energy set-up for learning resource /year. The total cost of solar energy set-up for learning resource center is php.272, 004.60 while the money saved every year from the said system is Php.40, 440.00. After a long procedure of calculation, the researcher determined the payback time of a solar energy set-up for learning resource center which 6.7 years

4. Conclusion

According to the findings, of the solar energy set-up for learning resource center is efficient due to its performance and the solar energy set-up is effective in its course of application; however, the power is proportional to its size, so the more power is needed, the bigger the panel and the higher the cost.

Recommendations

Upon the recommendations of the researchers, the following shall be done:

1. To gain more power from the solar panels, the researcher recommends using high efficiency solar panels with same, rated power, size and type such as Monocrystaline solar panel.
2. Magnetic contactors should be utilized instead of selection switches for better switching solar set -ups.
3. The researcher suggests that technicians and future researchers have to get involved in solar installation set-up to enhance their knowledge.
4. Instead of using gel type batteries, lifepo4 batteries have to use to achieve excellent battery efficiency in terms of capacity run time and charging time. It has also long lifespan compared to other type of batteries.

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