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STAND ALONE SOLAR PHOTOVOLTAIC FOR RURAL ELECTRIFICATION: A CASE STUDY IN KAMPUNG SG LAH TAPAH MALAYSIA

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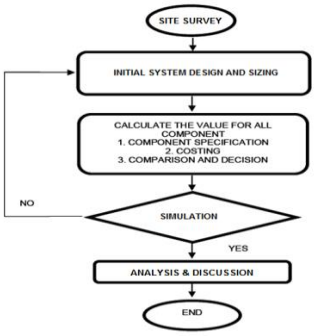
Graphical abstract



Abstract

This paper presents a case study on a rural electrification for an aborigine community in Kampung Sungai Lah, Tapah. They are isolated in the infrastructure development of society, referred to as undeserved. They are unfortunate as waited around 8 years for electricity supply and the closest transmission line terminate at the town of Chenderiang which is 20km to Kampung Sungai Lah. The site location received an average of 4.68 kWh/m2/day solar radiation with index clearness of 0.48 in average. HOMER simulation software is used for system optimization. The system consists of 8.0 kW Thin Film solar modules, four string inverters, and 32 deep cycle batteries with 250Ah capacity each. The whole system is to be ground mounted preferably in the middle of load distribution. The Stand-alone PV system offers cost effective means to electrify remote area as well as aids in the act of humanity.

Keywords: Rural electrification, HOMER, stand-alone, system sizing

1.0 INTRODUCTION

Nowadays, ensuring sustainable energy is the major challenge in most of developing countries [1]. Solar energy has become a go-to resource for rural electrification since communities live in rural areas is often isolated in the infrastructure development of society. Ever since the world initiates the word development, it has come into many territories of aspects which are believe to evolved around the terms of socioeconomic development of civilization. The prime of the development work are due to the contribution elements of electricity which acts as the imperative need for the lives of human beings. The perks of the electricity existence is in boosting a better advancement progress towards the enhancement of living conditions[2].

However, numerous issues on energy crisis become more and more aggressive throughout the years and the accumulation leads to further exploration studies and exploitation for new energy resource. The causes for this rising problem is the action of mankind as we endeavor into new countries and as year goes by, the deficiency of natural resource has become significant. The dominant controversies of confrontational threat of energy are in ensuring reliable and sustainable energy.

Developing a sustainable rural electrification project is the main challenges faced by governments and electric utilities in many countries. Rural electrification will eventually help to open up opportunities for villagers who involved in fishing and farming to use automation so as to enhance productivity, commercialisation and market penetration. Furthermore, the large scale of plantation, agriculture and agro industries can be boosted and becoming one of the important key sector in Malaysia's economy. Without electricity supply, we have not been able to bring about development and reduce poverty rates throughout the country.

Table 1 Daily energy requirement for 40 households

	Appliances	Quantity	Wattage (W)	Daily usage (hours)	Wh/day
1	Lighting point	80	8	3	1440
2	Table Fan	20	25	4	2000
3	TV	20	150	2	6000
4	Radio	20	5	5	500
5	Icebox	20	80	3	12800
					19300
	AC LOADS				2895
	Inverter losses (15%)				25635
	Battery losses (20%)				5127
	Total daily energy requirement				**30762 Wh/day**

2.0 PROJECT BACKGROUND

The selected off grid remote area for this project is Kampung Sungai Lah, Chenderiang District, Tapah. The area is located at 4° 16' 59.995"N, 101° 14'27.759"E, and has an average annual solar irradiation of 4.86 kWh/m2/day. Table 2 shows the details of Kampung Sungai Lah, Tapah.

Table 2 Details about the selected village

Particulars	
Village name	Kampong Sungai Lah
Sub-district	Chenderiang
District	Tapah
State	Perak
Country	Malaysia
Latitude	4° 16' 59.995"N
Longitude	101° 14' 27.759"E
Water wells	1
Grid electricity	No electricity
Number of houses	40
Total population	200

The community survey is carried out in order to define the community profile. A set of questionnaire is generated including number of populations, physical infrastructure/utility, type of employment, social infrastructure, health care facilities, availability of transportation, economic activities within community and government polices/programmes. This survey will eventually provide an overview of general village characteristics. Results in the survey used to assist in estimating the energy demand profile. The closest transmission line to the village terminates at the town of Chenderiang which is about 20km away, where it is very costly to extend the grid. The location is dry and hot for most part of the year and generally on flat plane with partially hilly where 40 houses are built.

The aborigine community is placed in houses provided by Jabatan Kemajuan Hal Ehwal Orang Asli (JAKOA) of Tapah as shown in Figure 1.

Figure 1 Aborigines houses provided by JAKOA

According to the interview with their head of community, they have waited nearly 8 years for electricity supply ever since they were placed in this village (Figure 2). They are preparing themselves for electricity supply which highly shows their interest in improving their quality of life.

Figure 2 Interview with the head of community

The closest transmission line to the village terminates at the town of Chenderiang which is about 20km away, where it is very costly to extend the grid. The location is dry and hot for most part of the year and generally on flat plane with partially hilly where 40 houses are built. Figure 3 shows that the village is connected to the nearest town with proper road but grid extension seems impossible due high investment cost.

Figure 3 The nearest town is located 20 km away from the village

3.0 PROJECT DESCRIPTION

3.1 System Sizing

The demand for electricity in rural village is not as high as in urban area. Electricity is needed for domestic purposes such as lamps, ceiling fans, radio, TV and small fridge. The system design is based on daily energy requirements for 40 households approximately 30 kWh/day with 5.52 kW peak demand as shown in Table 1. Research area is highligted in Figure 4.

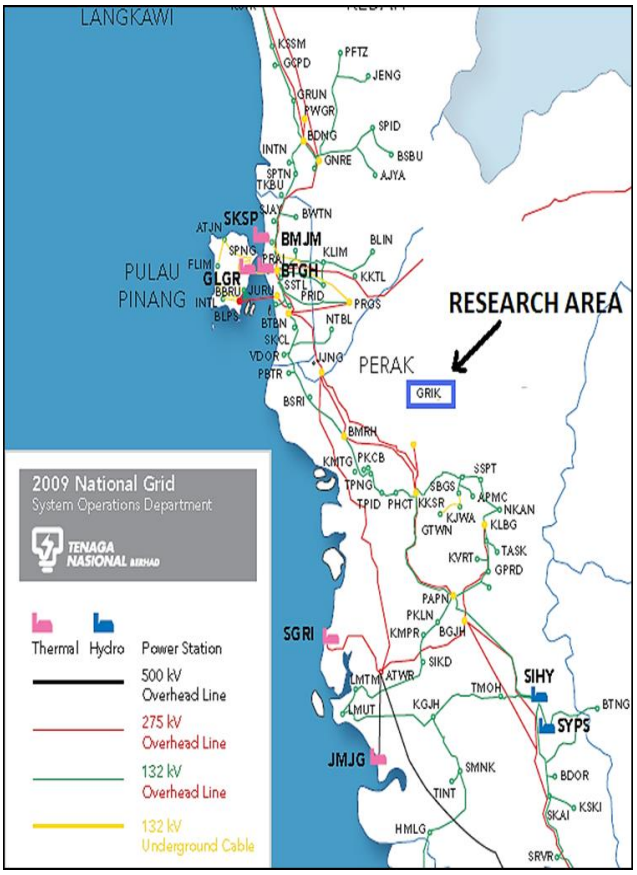


Figure 4 Research area

The monthly solar iirradiation data in Tapah, Perak as shown in Figure 5 used to decide on the optimum angles of solar panel orientation as well as to select the design month based on lowest irradiation value.

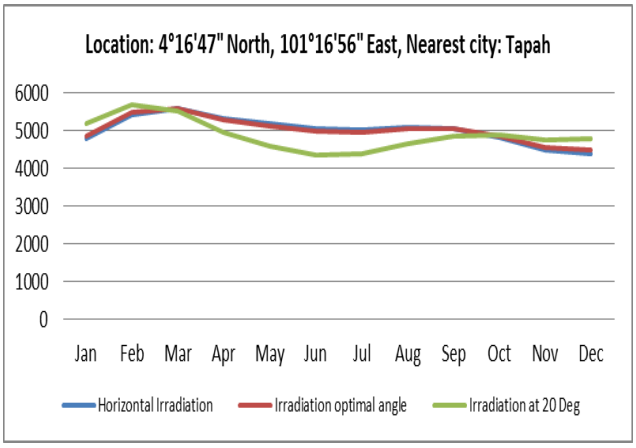


Figure 5 The monthly solar irradiation in Tapah, Perak

3.2 System Design

HOMER is a simulation tool developed by National Renewable Energy Laboratory (NREL) used for assisting in the system design and planning. The measured communities daily load profile is simulated using HOMER that produces one year of hourly load data as shown in Figure 6.

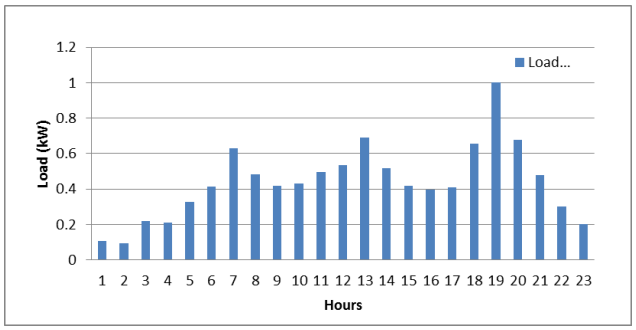


Figure 6 Hourly load data

The system consists of CIGS thin film PV array of 8.0 kWp selected for its high efficiency and less affected due to shading. A total of 32 deep cycle lead acid batteries with capacity of 250Ah are used in series and parallel connection for storage system. Four string inverters with rated power of 230W are used. The SMA inverter is chosen due to its easy to install nature and future system expansion.

The whole system is to be mounted in the middle of load distribution and a local person will be trained for operation and maintenance of the system. The proposed stand alone solar system is shown in Figure 7.

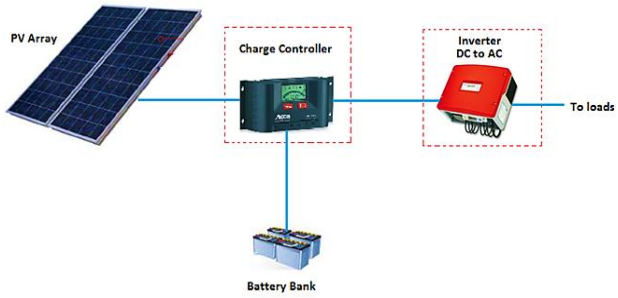


Figure 7 Proposed stand alone solar PV system

3.3 Research Significance

This study may be used for future references especially for those involve in this solar project as well as the energy providers. It provides an investigating function and will be a major information source in making a decision. It addresses the question of "Is this a viable project venture?"

However, the results of this research do not suddenly become positive or negative. There is no clear answer as information being accumulated and alternatives being investigated; neither a positive nor negative outcome may emerge. The feasibility study will help to assess the trade-off between risks and rewards of moving forward with the project. It is hoped that this study will give insight for humanitarian purposes as the target group is unable to pay high upfront cost.

4.0 DISCUSSION

Based on the simulation data collected from HOMER, the annual system yield is 10,500 kWh with average daily electricity production is 28.8 kWh and system array energy production as shown in Figure 8. The nominal power of the PV system is 8.0 kWp with estimated losses due to the temperature and low irradiance is 13.3%.

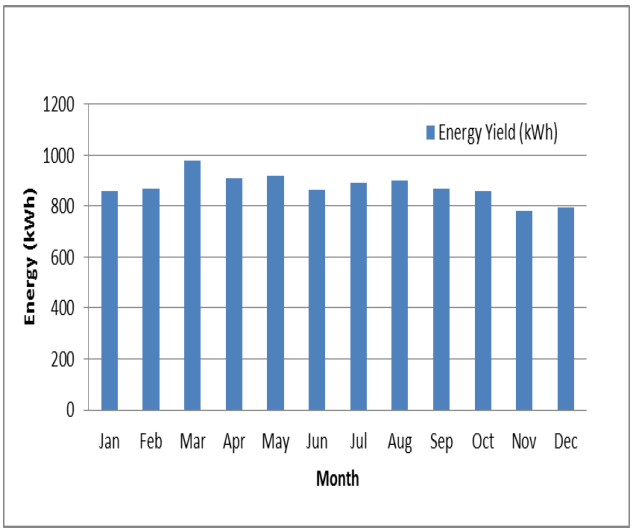


Figure 8 System array energy production

5.0 CONCLUSION

Rural electrification of isolated places is vital especially in developing countries and deserves special attention for rural economic growth and improving living conditions. The study shows, the communities are preparing themselves for electricity supply in order to improve their lifestyle. Stand-alone PV system shows promising technology option due to its reliability and safety since the current options used by aborigine's community provide poor quality lighting and hazardous to health. The system is not only reliable but aids in the act of humanity. Focusing on country's development is important but might as well not to be overlooked upon these undeserved communities.

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