FEASIBILITY STUDY OF ELECTRIC PHOTOVOLTAIC SOLAR PANEL SET APPLICATION

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Abstract

Solar energy is a part of renewable energy sources which is it is cost-free and clean energy whereby environment impact are negligible. Photovoltaic (PV) is one of the suitable renewable energy to replace the conventional energy supplier. This project will determine the load demand by making a survey of each type of houses which are the low-cost and bungalow housing type at the urban areas based on the previous consumer electric bill. Then, the next step is to design the 'stand-alone' photovoltaic systems. The final result of the developed system will be a complete model design of the photovoltaic system including the performance of the proposed system, cost analysis and deployment strategy for the selected area. The economic factor for the whole system including payback period when using solar energy compared the conventional supply for the next 20 years is also given.

Keywords: *Solar energy, Photovoltaic, Stand-alone, Energy consumption, Solar panel sizing, Life Cycle Cost.*

I. INTRODUCTION

Malaysia lies entirely in the equatorial region and has a very high potential for utilizing electricity from photovoltaic system but currently the development is still in the early stage. A solar photovoltaic installation in Malaysia would produce energy of about 900- 1400 kWh/kWp a year depending on the locations (Jadin & Taib, 2004). Malaysia National Policy (1979) aims to have an efficient, secure and environmentally sustainable supply of energy in the future as well as to have an efficient and clean utilization of energy(Taib & Syafrudin, 2001).

Environmental phenomenon, such as global warming and depletion of the ozone layer attributed to emissions from massive fuel combustion are slowly but surely causing widespread problems to every living thing on earth. Renewable energy, particularly photovoltaic technology is one very effective solution available today (Maricar & Lee, 2003).

Like several other developing countries, in most of the remote and non-electrified sites, extension of utility grid lines experiences a number of problems such as high capital investment, high lead time, low load factor, poor voltage regulation and frequent power supply interruptions.

Traditionally, electrical energy for remote villages has been derived from diesel generators characterized by high reliability, high running costs, moderate efficiency and high maintenance. Hence, a convenient, cost-effective and reliable power supply is an essential factor in the development of any rural area. It is a critical factor in the development of the agro industry and commercial operations, which are projected to be the core of that area's economy(Muralikrishna & Lakshminarayana, 2008).

Renewable energy resources and technologies are viable for rural and semi rural electrification in Malaysia. Especially in isolated island and very remote areas, renewable energy could well be a least cost option. The technology of solar photovoltaic is available for various locations with a limited numbers in Malaysia. It is therefore reassuring to note that the idea of providing electricity to an area is tempered first with study of resources availability, socio-economic situation, electricity demand, environmental impact, market-based and ability, pay-back period and willingness of the end users to pay for the electricity. All of these criteria have to be considered for realizing the renewable energy electric power supply development(Taib & Syafrudin, 2001). Standalone solar photovoltaic energy system cannot provide reliable power during non-sunny days. Usually storage system is expensive and the size has to be reduced to a minimum possible for the renewable energy system to be cost effective (Muralikrishna & Lakshminarayana, 2008). A solar PV system not only would provide reliable, clean, and environmentally friendly energy but also could create employment opportunities in the vicinity of its operation (Ahammed & Taufiq, 2008).

This project presents a practical and standard guidelines for feasibility study of electric photovoltaic solar panel set application for low cost and bungalow housing in urban, rural area and aborigines. It describes the best steps necessary to take into account for implementing practical solar scheme successfully. This tool also considered the economic factor for the whole system including pay-back period when using solar compared to conventional supply.

II. PHOTOVOLTAIC OVERVIEW

Complementing electricity supply from photovoltaic (PV) cells is a relatively new method towards renewable energy resources and a more environmentally friendly alternative for electricity generation. The PV systems consists of solar panels which receive radiation from the sun to generate electricity, inverter which converts the DC output of the solar panels into AC electricity, controllers which synchronies the electricity generated by solar PV panels and other module mounting and wiring components.

III. SOLAR SYSTEM COMPONENT

The basic component of solar system consists of solar panel, solar regulator, battery and inverter (DC-AC).

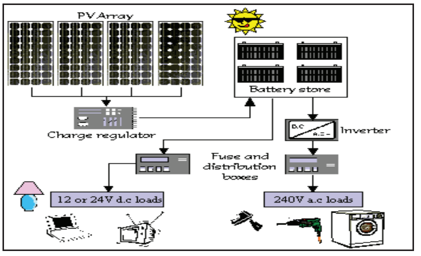

Figure 1: Solar system

A. Solar Panel

Solar panels collect solar radiation from the sun and actively convert that energy to electricity. It can be different shapes and sizes including round, square, and rectangle but their main purpose is to convert the light in order to make electricity. It can put on top of buildings and houses or standing alone in fields. When the solar cells are exposed to sunlight, the p-n junction diodes convert the energy from sunlight into electrical energy. The more solar cells in a solar panel and the higher the quality of the solar cells, the more total electrical output the solar panel can produce. The conversion of sunlight to usable electrical energy has been dubbed the Photovoltaic Effect.

B. Charge Regulator

The solar charge regulator is use to charge the battery and to protect it from deep discharging. Excessive discharge is avoided by monitoring the battery voltage and disconnecting the load from the battery if the voltage falls below a pre-set minimum value. The regulator will not reconnect the load until the battery voltage has risen to a value significantly higher than this minimum value. This is necessary to ensure that the load is not reconnected until some charge has been returned to the battery.

C. Battery

Batteries are used to save the energy produced during the day, which was not consumed by loads. Saved energy can be used at night or during the days with bad weather conditions. The size of the battery bank required will depend on the storage capacity required, the maximum discharge rate, the maximum charge rate, and the minimum temperature at which the batteries will be used. A battery in a solar power system should have sufficient amp hour capacity to supply needed power during the longest expected period "no sun" or extremely cloudy conditions.

D. Inverter

Solar Panel inverters are used to change direct current (DC) to alternating current (AC) via an electrical switching process. For solar system, one single inverter is dedicated to a rooftop array of panels for a homeowner. Selecting an inverter for solar system based on the maximum load that will be powering, the maximum surge required, output voltage required, input battery voltage and optional features needed. The good inverter that use in solar system can reduce the power losses around ±2% and can supply the maximum electric energy.

IV. POWER CAPACITY DEMAND AND ELECTRIC USAGE

Determination of housing power capacity demand will include the average of total KWh and RM and it will proceed by making a survey of each house. Energy storage systems will be required for each of these systems in order to satisfy the power demands.10 houses are chosen for every type of houses to calculate the electricity usage in KWh and value in Ringgit Malaysia for one month, a year and the average in next 20 years. An electric bill survey is conducted on 2 types of houses which is the low-cost and bungalow housing in the urban. Taman Cendrawasih at Nibong Tebal has been chosen for low-cost housing area and for bungalow types of houses, Bukit Jawi Golf Villa has been chosen. The electric bills data for each type of houses are obtained from Tenaga Nasional Berhad, Nibong Tebal. For each types of house, the electric bill is examined from the past 25 month bill. The data that have been taken from 10 consumers for each house are analysed into tabular form. Then, the average of the electricity usage in KWh and value in Ringgit Malaysia for one month are calculated.

V. POWER CONSUMPTION

The energy requirements of consumers are determined when the power consumption of each appliances and the number of hours per day used by each appliance are known. Two types of house which low-cost and bungalow at urban area have been choose to make a power consumption survey. The first step is determining all the electrical equipment in the house. Then, estimate the time that consumer use for each day. These step is use to calculate the daily WattHour usage of each item. This is done by multiplying the item wattage by the number of hours used each day.

$$\text{WattHours} = \text{Wattage} \times \text{Number of Hours Used Each Day}$$

For the aborigines houses at rural area, these hamlets are very much associated with the aborigines or also known as Orang Asli resident. In this case, the survey cannot be done because it is difficult to go and there are no facilities. So, for these types of house, the assumption have been made to determine the WattHour usage by refer to the Nasional Power and Energy Conference (PECon) 2003 (Ismail & Omar, 2003). Lastly, to determine the power consumption for the bungalow houses at rural area, the assumption also has been made because it is also difficult to go and there are no facilities. It will assume that the average of power usage is same as bungalow at urban area. The electric load varies with time depending on human and economic activity. The customer factors of electricity consumption are primarily the number, type and size of the electrical equipment of the customer. While the electrical equipment and installations vary from customer to customer there are recognised types of customers which have similar properties.

VI. CALCULATION OF ELECTRIC BILL

The entire electric bill is charge by TNB. TNB Company charge consumers for the use of electricity base on its own set of tariff. Household or residential consumers has been provided under A's Tariff. To calculate the electric bill, it is necessary to calculate the exact power consumption of a piece of electrical equipment. In this project, it just showed the calculation of power usage per day for low cost and bungalow housing. The total amount of electricity used for a month of 30 days is assumed that the electricity usage is the same every day for all 30 days.

Total Watt Hour per Day
= Quantity × Average Watt × Hour per Day

Total of demand (30days)
= Total watt hour per day × 30days

VII. DESIGNING SOLAR SYSTEM

Schemes of stand-alone photovoltaic system can be defined by the combination of its major components, photovoltaic panel, battery, charge controller, inverter and the load. The selection of optimal capacities for various components such as the panels and the battery arise due to the uncertainty associated with the available solar radiation and the load behavior. As is true with any means of producing power, a variety of performance, technical, reliability, safety, environmental, legal, cost and practical consideration heavily influence the design of a photovoltaic (PV) system. The first step to design the solar system is determining the power usage for each day for types of houses. These power usages are determined by the power consumption that have made. Then, the amounts of solar panel needed to use in the system are determined by using the power usage that has been calculated.

$$\text{Real Power, P} = \frac{\text{Energy (kWh)}}{24\text{hours} \times 30\text{days}}$$

$$\text{Solar Panel (75W)} = \frac{\text{Real Power per Day}}{75}$$

The second step is to determine the rating of solar charge regulator needed to use in the system. The suitable solar charge regulator is use to charge the battery and to protect it from deep discharging. The selection of battery ampere-hour is one of the most important parts. In a solar application, battery life is highly dependent on the number and depth of discharge cycles the battery is subjected to. Finally, the selection of inverter is determined by making a declaration of electric component that use the highest power in AC. This is important to make sure that the entire electric component will get the supply from solar system.

VIII. ECONOMIC ANALYSIS

From the economical point of view, the photovoltaic system is differ from conventional energy system because it has high initial cost and low investment for PV system is an important factors in this analysis. The components include in the investment cost are the prices of PV modules, inverter and other auxiliary cost. In this case, the result of the electric survey for the total power and amount of electricity use for that type of house that has been done will be compare to the cost for the implementation of solar power energy system. Life cycle cost of the system will be considered for 20 years life span. The final result of economic analysis and payback period of the whole system will be present.

Total amount of electricity bill in RM
=Average per month (RM) ×12months×20years

Total power in Watts
=Average power (Watt) ×30days×12months×20years

IX. RESULT AND DISCUSSION

From this survey, the power capacity demand, the total kWh and RM of housing are determine. For the aborigines houses at rural area, the assumption have been made to determine the WattHour usage by refer in National Power and Energy Conference (Ismail & Omar, 2003). Conservatively, generator sets are installed by TNB to provide basic electricity to each aborigines houses and it is free. The electric supply is from 7.00pm to 11.00pm which is surely insufficient for the residents. The current electricity supply is from an 18.6kW powered generator sets and it cover for 22 houses. From this, the power usage for each house can be determined.

Lastly, for the bungalow houses at rural area, the assumption also has been made because it is also difficult to go and there are no facilities. It will assume that the average of power usage is same as bungalow at urban area. The electric load varies with time depending on human and economic activity. The customer factors of electricity consumption are primarily the number, type and size of the electrical equipment of the customer. While the electrical equipment and installations vary from customer to customer there are recognised types of customers which have similar properties.

Table 1: The total power and amount of electricity use for houses at urban area.

PERIOD	LOW COST		BUNGALOW	
	kWh	RM	kWh	RM
1 day	7.17	1.56	38.60	11.04
1 month	215.03	46.88	1157.96	331.18
12 month	2580.36	562.56	13,895.52	3974.16
20 years	51, 624.00	11, 232.00	263, 520.00	79, 488.00

Table 2: The total power for low cost and bungalow houses at rural area.

PERIOD	ABORIGINES	BUNGALOW
	kWh	kWh
1 day	0.85	38.60
1 month	25.36	1157.96
12 month	302.36	13,895.52
20 years	5, 400.00	263, 520.00

Often it becomes necessary to calculate the exact power consumption of a piece of electrical equipment. The electric load varies with time depending on human and economic activity. Table 3 and Table 4 show the calculation of power usage per day for low cost and bungalow housing.

Table 3: Average power usage for low cost housing at urban area

EQUIPMENT	QUAN -TITY	AVERAGE WATT	HOUR PER DAY	WATT HOUR PER DAY
Fluorescent lamp	3	36	5	540
Table fan	1	35	3	105
Television	1	150	4	600
Radio	1	16	2	32
Total Watt Hour				1277

Total watt hour per day
=quantity × average watt × hour per day
Total of demand for one month (30days)
= 7177.50 × 30 day =211.325kWh

Table 4: Average power usage for bungalow housing at urban area

EQUIPMENT	QUANTITY	AVERAGE WATT	HOUR PER DAY	WATT HOUR PER DAY
Decorate lights	20	16	7	2240
Fluorescent lamp	5	36	7	1260
Table lamp	2	60	0.2	24
Ceiling fan	6	60	12	4320
Radio	2	16	2	64
Iron	1	1000	0.2	200
LCD Television	2	122	4	976
DVD player	1	8	0.5	4
Blender	1	300	0.2	60
Washing machine	1	1080	1	1080
Refrigerator	1	550	24	13200
Rice cooker	1	600	1	600
Sandwich maker	1	700	0.2	140
Microwave	1	1300	0.2	260
Water heater	1	2000	0.5	1000
Cook tops	1	185	0.5	92.50
Air conditional	7	745.70	4	20,879.60
Exhaust fan	3	16	4	192
Freezer	1	330	24	7920
Hair dryer	1	1850	0.2	370
Vacuum cleaner	1	1000	1	1000
Laptop	3	65	3	195
Total Watt				56,467.10

Total watt hour per day
= quantity × average watt × hour per day
Total of demand for one month (30days)
= 56,467.10 × 30day = 1,694.01 kWh

Table 5: Average power usage for aborigines

EQUIPMENT	QUAN-TITY	AVERAGE WATT	HOUR PER DAY	TOTAL WATT HOUR PER DAY
Fluorescent lamp	7	36	7.0	1764.00
Ceiling fan	3	60	12.0	720.00
Radio	1	16	1.0	16.00
Iron	1	1000	0.2	200.00
Television	1	90	4.0	360.00
VCD player	1	35	0.5	17.50
Blender	1	300	0.2	60.00
Refrigerator	1	150	24.0	3840.00
Rice cooker	1	200	1.0	200.00
Total Watt Hour				7177.50

Total of demand for one month (30days)
= 1277 × 30 day =38.31kWh

The first step to design the solar system is determining the power usage for each day for types of houses. These power usages are determined by the power consumption that have made.

Table 6: Real power, electric bill and power usage for each type of houses

TYPES	RURAL AREA		URBAN AREA	
	ABORIGINES	BUNGALOW	LOW-COST	BUNGALOW
kWH	0.85	38.60	7.17	38.60
RM	Free	11.04	1.56	11.04
Real Power	35.22	1608.30	298.65	1608.30

Briefly, the actual power for one day supply from TNB for these types of can be conclude to this table:

Table 7: Quantity of solar panel

TYPES	RURAL AREA		URBAN AREA	
	ABORIGINES	BUNGALOW	LOW-COST	BUNGA-LOW
Solar Panel 75W (Units)	1	22	4	22

The size of solar regulator for each types of house can be concluding to this table:

Table 8: Rating of solar panel chosen

TYPES		Size of Solar Regulator $= \text{Quantity of Solar Panel} \times 5.51$ (Amp)	Rating of Solar Regulator Chosen (Amp)
RURAL AREA	ABORIGINES	= 5.51	10
	BUNGALOW	= 121.22	120
URBAN AREA	LOWT-COST	= 22.04	30
	BUNGALOW	= 121.22	120

Table 9: Size of battery

TYPES		Size of Battery $= \frac{\text{Total Electric Energy per Day (kWh)}}{\text{Rating of Voltage Battery} \times 0.9}$ (AmpHour)
RURAL AREA	ABORIGINES	= 78.70
	BUNGALOW	=3574.07
URBAN AREA	LOWT-COST	= 663.89
	BUNGALOW	= 3574.07

Specifications for the appropriate inverter actually should refer to the sum of total watt for electrical components used in the house. In this case, it will set the highest number of watts by reference to the components of the highest in a house. In this project, the low-cost houses at urban area will use inverter 1500W while the bungalows house at urban and rural area will using inverter 2000W. Inverter values can exceed twice or 1.5 times the value of continuous power for daily use of electricity.

Table 10: Overview of the components needs to build Solar PV Technology

MODEL	TYPES OF HOUSE			
	URBAN AREA		RURAL AREA	
	LOW-COST (model A)	BUNGA-LOW (model B)	ABORI-GINES (model C)	BUNGA-LOW (model D)
Power usage per day (W)	298.65	0.05	1608.30	1608.30
Solar Panel	4	22	1	22
Solar Regulator (Amp)	30	10	120	120
Solar Battery (Ah)	663.89	78.70	3574.07	3574.07
Inverter (Watt)	1500	350	2500	2500

After analyzing all the steps above, economic studies in mathematics comprehensive to all types of domestic users to see whether consumers where appropriate using solar energy to electricity distributing the burden of housing them is carried out. This calculation will involve all components for a period of 20 years life expectancy of solar panels that have been set. In this case, the surveys have been done to several solar companies in Malaysia such as Green Age, RS Malaysia and Farnell to choose the best component and price.

Table 11: Types of component and price

	MODEL	A	B	C	D
TYPES	Solar Panel	BP-275F	BP-275F	BP-275F	BP-275F
	RM	1,600.00	1,600.00	1,600.00	1,600.00
	Solar Regulator	Green Age Solar Regulator 30A	SUNSEI 10Amp	XANTRE X C60	XANTR EX C60
	RM	590.00	178.29	567.53	567.53
	Battery	Trojan-LI6RE 325Ah	Green Age BATT121 00	Trojan-LI6RE 1110Ah	Trojan-LI6RE 1110Ah
	RM	1,128.60	680.00	1,254.00	1,254.00
	Inverter	Inverter UK 1500W	Inverter UK 350W	Green Age Inverter 3000W	Green Age Inverter 3000W
	RM	2793.00	1317.53	6700.00	6700.00

Table 12: Model A (Low-Cost Housing at Urban Area)

MODEL A	TYPES				
COMPO-NENTS	LIFE SPAN	PRICE (RM)	PRICE FOR 20 YEARS (RM)	QUAN TITY	TOTAL (RM)
Solar Panel	20	1600.00	1600.00	4	6400.00
Solar Regulator (Amp)	5	590.00	2360.00	1	2360.00
Solar Battery (Ah)	10	1128.60	2257.20	2	4514.40
Inverter (Watt)	6	2793.00	11,172.00	1	11,172.00
Mounting frame	20	669.00	669.00	1	669.00
30 foot output wire	20	170.00	170.00	1	170.00
Battery inter-connector	20	15.15	15.15	1	15.15
Battery temperature panel	20	90.00	90.00	1	90.00
Remote display installation	20	217.25	217.25	1	217.25
Installation and maintenance	20	2000.00	2000.00	1	2000.00
Multimeter	20	355.48	355.48	1	355.48
TOTAL					28,632.28

Table 13: Model B (Bungalow Housing at Urban Area)

MODEL B	TYPES				
COMPON ENTS	LIFE SPAN	PRICE (RM)	PRICE FOR 20 YEARS (RM)	QUAN TITY	TOTAL (RM)
Solar Panel	20	1600.00	1600.00	22	6400.00
Solar Regulator (Amp)	5	567.53	2270.12	2	4540.24
Solar Battery (Ah)	10	1254.00	2508.00	4	10,032.00
Inverter (Watt)	6	6700.00	26,800.00	1	26,800.00
Mounting frame	20	669.00	669.00	12	8028.00
30 foot output wire	20	170.00	170.00	1	170.00
Battery inter-connector	20	15.15	15.15	1	15.15
Battery temperature panel	20	90.00	90.00	1	90.00
Remote display installation	20	217.25	217.25	1	217.25
Installation and mainte-nance	20	2000.00	2000.00	1	2000.00
Multi-meter	20	355.48	355.48	1	355.48
TOTAL					58,648.12

Table 14: Model C (Aborigines Housing at Rural Area)

MODEL C	TYPES				
COMPO-NENTS	LIFE SPAN	PRICE (RM)	PRICE FOR 20 YEARS (RM)	QUANT ITY	TOTAL (RM)
Solar Panel	20	1600.00	1600.00	1	1600.00
Solar Regulator (Amp)	5	178.29	178.29	1	178.29
Solar Battery (Ah)	10	680.00	680.00	1	680.00
Inverter (Watt)	6	1317.53	5270.12	1	5270.12
Mounting frame	20	669.00	669.00	1	669.00
30 foot output wire	20	170.00	170.00	1	170.00
Battery temperature panel	20	90.00	90.00	1	90.00
Remote display installation	20	217.25	217.25	1	217.25
Installation and mainte-nance	20	2000.00	2000.00	1	2000.00
Multimeter	20	355.48	355.48	1	355.48
TOTAL					12,623.30

Table 15: Model D (Bungalow Housing at Rural Area)

MODEL D	TYPES				
COMPON ENTS	LIFE SPAN	PRICE (RM)	PRICE FOR 20 YEARS (RM)	QUAN TITY	TOTAL (RM)
Solar Panel	20	1600.00	1600.00	22	6400.00
Solar Regulator (Amp)	5	567.53	2270.12	2	4540.24
Solar Battery (Ah)	10	1254.00	2508.00	4	10,032.00
Inverter (Watt)	6	6700.00	26,800.00	1	26,800.00
Mounting frame	20	669.00	669.00	12	8028
30 foot output wire	20	170.00	170.00	1	170.00
Battery inter-connector	20	15.15	15.15	1	15.15
Battery tempe-rature panel	20	90.00	90.00	1	90.00
Remote display installation	20	217.25	217.25	1	217.25
Installation and mainte-nance	20	2000.00	2000.00	1	2000.00
Multi-meter	20	355.48	355.48	1	355.48
TOTAL					58,648.12

Table 16 below shows the total amount of electricity bills to be paid during the twenty years that will be borne by all users should use home full-time supply of electricity distributed by TNB.

Table 16: Total amount of electricity bills to be paid during the twenty years

PERIOD	URBAN AREA				RURAL AREA			
	LOW-COST (model A)		BUNGALOW (model B)		ABORIGINE S (model C)		BUNGALOW (model D)	
	kWatt	RM	kWatt	RM	kWatt	RM	kWatt	RM
1 day	7.17	1.56	36.60	11.04	0.85	Free	36.60	11.04
1 month	215.10	46.80	1,098.00	331.20	22.50	Free	1,098.00	331.20
1 year	2,581.20	561.60	13,176.00	3,974.40	270.00	Free	13,176.00	3,974.40
20 years	51,624.00	11,232.00	263,520.00	79,488.00	54,00.00	Free	263,520.00	79,488.00

From the table above, it shown that for the consumer Models B bear the highest electricity bill payments for 20 years that is RM79, 488.00 compared with the consumer of Model A. User C will not be charged because they get subsidies from the government of Malaysia under the Rural Electrification Program. Figure 2 shows the comparison of electricity bills that will be pay by the models A and B if using 100% supply electricity from TNB and total cost of solar system.

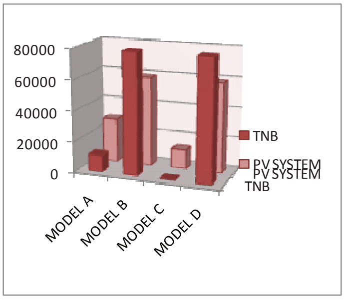

Figure 2: Comparison of electricity bills and total cost of solar system.

The cycle cost of the system will be considered for 20 years life span. Consumer A needs to pay RM11, 232.00 if using 100% electricity supply from TNB and it need RM 28, 632.28 to setup the solar system. From the economical point of view, the photovoltaic system is differing from conventional energy system because it has high initial cost to setup this system. From the economical point of view, the photovoltaic system is differing from conventional energy system because it has high initial cost to setup this system.

Consumer B needs to pay RM79, 488.00 if using 100% electricity supply from TNB. Consumer B need RM58, 648.12 to setup the solar system. Payment of electricity bill is more expensive if use electricity supply from TNB. This indicates that the user model B can save 26.22% of the cost of electricity bill payment if using solar system. From the economical point of view, the photovoltaic system is differing from conventional energy system because it has high initial cost to setup this system. Consumer C need RM12, 623.30 to setup the solar system.

Consumer D need RM RM58, 648.12 to setup the solar system. As it is very expensive to provide electricity supply from the grid to the rural area, stand-alone solar PV systems were recognized as a cost-effective option to electrify the remote villages.

X. CONCLUSION

These researches show that this system is not suitable for low cost housing at urban area. This is because the high set-up cost for the solar system. Continuing to electricity from TNB will only cost RM11, 232.00 for next 20 years in compare with the use solar system that will cost RM28, 632.28. The result shows that people living in bungalows houses there is a benefit in using solar energy because although they use the alternative energy to supply the electricity to their house, they also can save RM20, 839.88 after they use the system for 20 years. This is meant that this consumer can save 26.22% of the cost of electricity bill payment for 20 years if using solar system. The result shows that only consumer that have high income can apply this system because it has high initial cost to setup it. From the analysis of solar system for aborigines at rural area, it is shown that the solar technologies are more effective and necessary and these independent systems can replace generator set for Rural Electrification Program.

XI. ACKNOWLEDGMENT

This project would not have been a success without the help and attention of many parties. Firstly, I am heartily thankful to my supervisor, Dr. Norizah Binti Mohammad and Dr Ir Syafrudin Bin Masri, whose encouragement, guidance supervision and constant attention throughout the period of the project. Secondly, I would like to thank En Hassan bin Azmi from TNB Nibong Tebal for his help in providing the electric billing data and Siang Sdn Bhd, electrical shops for allowing me to make a survey. Finally, I wish to thank my parents, my friends and whoever that had supported and motivated me throughout the completion of this project.

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