RENEWABLE ENERGY BASED DISTRIBUTED POWER GENERATION

by

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FINAL PROJECT REPORT

Submitted to the Electrical & Electronics Engineering Programme
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Electrical & Electronic Engineering Programme
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December 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

NOORMAYA AZREEN BT MOHAMED

ABSTRACT

The aim of the project is to carry out a study about power distribution system. An energy efficient distribution power system with the implementation of solar energy is proposed in the system. The use of distributed power generation helps to reduce the electricity transmission losses because the electricity is generated at a placed near to the electricity consumer. The finite sources of electricity generation such as fuel and natural gas will be depleted in the near future. Renewable energy is considered as an effective alternative for the issue. The distributed power generation system is design to have a sustainable supply for the load demand. The correct sizing of the solar panels will help to improve the efficiency of the system. Based on the simulation that have been done on the proposed system using HOMER software, it results in the optimize design of the renewable energy based distribution power generation system. A system is also designed using Visual Basic 2008 to help to calculate the most feasible number of solar modules and the suitable arrangement for the system. Throughout this project, the potential of renewable energy to be implemented in the power generation and distribution has been recognised as an alternative source in power system.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

This project is about the study of the potential of renewable energy to be implemented in the available power generation and distribution system. Electricity is being generated at the central power plant and uses various types of energy sources. The electricity generation sources are coal, petroleum, natural gas and nuclear power [1]. In Malaysia, electricity is generated using sources from petroleum and natural gas. The main issue nowadays is the sources mention above will be depleted in the near future. It is essential for human to find other alternative sources to replace the finite sources. One of the possible solutions is to use the renewable energy as an alternative to the power generation and distribution system. This is due to the fact that renewable energy is from the source that is constantly present, readily to be extract and most importantly it will never runs out [2].

The project involves the study focusing on the potential of renewable energy to be implemented in the available power generation and distribution system. Conventionally, there are two types of power generation approach; centralized and distributed power generation. Malaysia is using the centralized power generation approach in the industry of electricity generation. Electricity is generated using generator according to the electricity load demand and being transmitted over relatively long distance from the central power plant to the electricity consumer. Large generator with centralized station has been the main method so far in the electrical generation industry [3].

The other approach being used in power generation and distribution system is called as distributed generation. The amount of dissipated energy along the transmission line is reduced because the electricity is generated very near to electricity consumer [2]. But, the system cannot sustain large enough load for the user. For this project, the study is being done to choose the suitable power generation and distribution concept to be implemented in renewable energy based generation system.

The use of renewable energy is an effective alternative to be implemented in the power generation system. Examples of renewable energy are solar energy, wind energy, hydro energy, biomass energy and others. The renewable energy is more expensive than conventionally used supplies. But, the use of renewable energy helps to reduce pollution and conserve fossils fuels [3].The project will focus on solar energy optimization to be implemented in the power generation system. The main reason for the solar energy is chosen is due to the fact that Malaysia is located close to equator line of the earth. Basically, Malaysia received eight to ten hours of direct sunlight per day.

1.2 Problem Statement

The centralized power system that is extensively used is not energy efficient. The distribution and transmission of electricity is not energy efficient due to the power dissipated in the transmission lines. In order to reduce the power loss, an alternative is to be implemented in the system. Even in the distributed power generation method, it is not sufficient enough to reduce the power dissipated along the transmission lines. Due to this fact, it is important to find an alternative for the issue.

Due to the increase in generation cost, the need to find an efficient alternative is inevitable. The approach of using renewable energy is an environmental friendly method. An efficient renewable energy based distributed power generation can be considered as a viable solution. But, the renewable energy such as solar energy may not be available at all the time. It is important to find a solution to optimize the use of the renewable energy.

By using solar energy as the main source in the system, the issues are the cost of installing, operation and maintenance. The photovoltaic needed to be size efficiently and cost effectively. The size of the photovoltaic should be large enough to sustain the load over a period of time.

1.3 Objective of Study

The objectives of the project are:

a) To carry out a study on the present power distribution system
b) To propose energy efficient distributed power system by utilizing suitable renewable energy system
c) To design a simulation software for the proposed energy system

1.4 Scope of Study

The project is about the study of power generation and distribution system. It also includes the study for the potential of renewable energy such as solar energy, hybrid energy, geothermal energy and others to be implemented in the power generation for energy efficient distribution system. The project would start by knowledge gathering and theoretical study of the topic. Then, the issues and problem of the power generation and distribution is identified. A study was done to implement the use of renewable energy in the system as the alternative in improving the system and to reduce the power loss during power generation and distribution.

The focus is on solar energy as the energy source, a study about photovoltaic is done to know the basic criteria of the energy. The criteria would be the operating principle of the photovoltaic cells, the various types of solar energy, and efficiency of the energy. The two approaches to be considered in this project are; centralized power generation and distributed generation. The issues of both approaches were determined throughout the project. The potential of the renewable energy generation and distributed system are implemented in the chosen concept.

The project includes the study related to the sizing of photovoltaic system's components such as the photovoltaic modules, batteries, and inverter. The size of the photovoltaic cell is being determined by the amount of the load that needed to be sustained by the system. The sizing of the battery is conducted to ensure that there is enough energy stored in the battery. The energy from the battery will be used during the cloudy of rainy day in the area which means there is no sunlight on the area.

The software used for the ptohovoltaic system simulation is HOMER, renewable energy system software. Basic understanding of the software is required to perform the simulation of the designed system. From the software, the best design will be chosen to be implemented in the system. The design is considering the effective cost, life cycle of the equipment and operation and maintenance cost.

CHAPTER 2
LITERATURE REVIEW

2.1 Electricity Generation

Electricity generation is defined as the process of converting non electrical energy to electrical energy. In the process of delivery of the electricity to the consumer, electricity generation is the initial procedure which is then continued with electrical power distribution and transmission [4].The source of the electricity generation are from oil, coal, natural gases and nuclear power.

There are two major approaches being practiced in present power generation system. The approaches are; centralized generation and distributed generation. The project involves the potential of the renewable energy to be implemented in the suitable power generation concept that has been practiced in the electricity generation industry. The project will mainly focus on the use of solar energy as the source of renewable energy in power generation and distribution system.

2.2 Centralized Generation

One of the most practiced electricity generation nowadays is centralized generation. This method has been practiced since 1881 by the electricity generation industry [4]. Electricity is being generated at central stations. The generated electricity is usually being transmitted to the consumer over long distances Most of the generation power plants are built based on the factor of health & safety, economic, environmental and geographical factor. For example, a coal power plant is built far from the city to prevent the air pollution from the generation process. The coal plants are usually built near to the collieries to reduce the cost of transporting the coal [4].

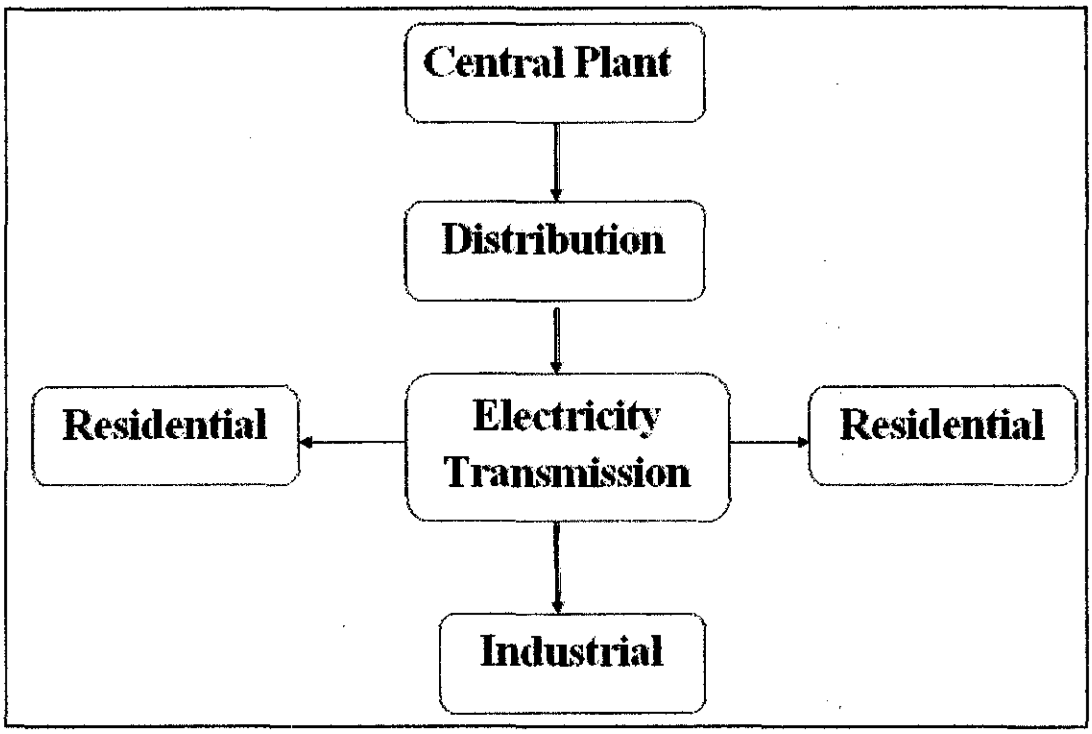


Figure 1: Centralized Power Generation

The above figure shows the illustration of centralized power generation system practiced nowadays [5]. Electricity is being generated at a central power plant using the source from oil, coal, natural gas, and nuclear power. The generated electricity is being transmitted to the electricity consumer via transmission power lines and power grid. This concept is being practice to transmit the electricity over relatively long distance.

2.3 Distributed Generation

The other approach that has been practices in the electricity generation is the distributed generation. This method is also known as the 'localized electricity generation'. The electricity is generated at a power generation plant using various source of energy such as oil, coal, natural gas, and nuclear power which is the same as practiced in the centralized electricity generation. The difference of both methods is the location of the power generation plant itself. In distributed generation, the power plant or generation of electricity is located at a place near to the electricity consumer. [6]. Therefore, this approach reduces the power lines and power grid to be constructed.

In the distributed power generation approach, electricity transmission loss can be reducing by using this method due to the shorter distance between the power generation and the consumer itself. The main concern in this approach is the installation cost. But, as the time past, the approach of distributing electricity is effective for electricity generation and transmission.

2.4 Renewable Energy

Renewable energy is also being called as the alternative or sustainable energy. Research and study are being conducted to implement the use of renewable energy in the electrical generation system. This is due to the fact that, the finite source that is used in the conventional electricity generation system will be depleted one day. It is essential to find the alternative energy sources to replace the finite source. The cost implementing the renewable energy as the main energy source can be reduced if the system can fully utilized the source energy efficiently. The renewable energy is environmental friendly and does not cause any pollution to the nature. Most popular renewable energy being implemented is solar energy and wind power. In Malaysia, the study of renewable energy is also being conducted nowadays. Below listed the available renewable energy sources:

2.4.1 Solar Energy

Solar energy is considered as the energy from the sun which can be converted into electricity using solar cells. The challenge of using solar energy is the sun trajectory. The earth rotates 24 hours a day, the position of the sun is changing as the earth rotates. Solar radiation intensity will be affected as the location of the sun changes.

2.4.2 Wind Power

The latest usage of this type of renewable energy is the construction of offshore wind farms, clusters of electricity generating turbines being constructed at the areas with strong winds.

2.5 Photovoltaics

Photovoltaic is a system of capturing the energy from the sun ray's and convert it into electricity. Electricity from the solar energy can supply power from small homes to large office buildings [7]. In order to capture the sunlight, photovoltaic panels are used. The energy from the sun is then being converted into electrical energy. Solar cells are made from thin semiconductor wafer such as silicon which then will produce the electrical signals. The release electron is the form of electricity being converted from sunlight [8].

The photovoltaic panel or solar panels are consisting of collection of solar cells being arrange in a panel. A number of solar cells connected together and being arranged in a mounted framed is called the solar modules. The module is design to supply electricity at certain amount of electricity. Most commonly is 12V photovoltaic modules [7]. A number of modules being wired together will form an array of photovoltaic. The modules and array being connected in combination of series and parallel connection to get the desired amount of voltage and current form the photovoltaic. The figure 2 illustrates the photovoltaic cell, module and array.

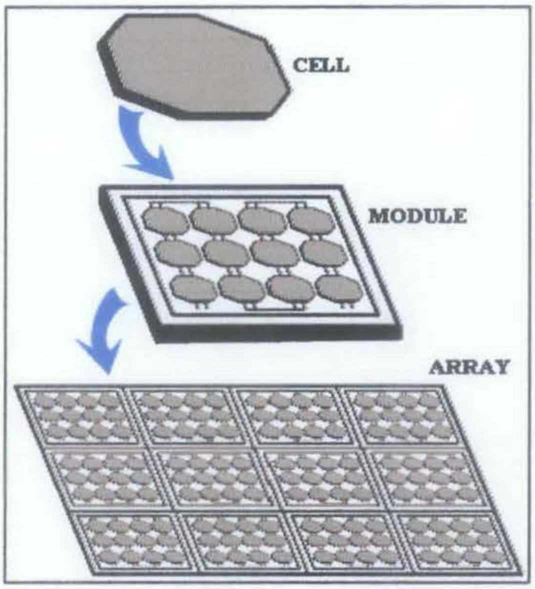


Figure 2: Arrangement of Solar Cell

2.5.1 Characteristics of Photovoltaic

The produced voltage from a solar cell is depending to the material of semiconductor being use in the cells. For a silicon based solar cells, the output voltage is approximately 0.5V. As the solar radiation intensity of the sunlight increase, the current will also increase. The maximum current that solar cell manages to produce is 2A with $100cm^2$ when being radiated with $1000W/m^2$ [9].

2.5.2 Types of Solar Cells

Three types of solar cells being used are:

(a) Monocrystalline cells
(b) Polycrystalline cells
(c) Amorphous or also known as thin film solar cell

Even though sunlight is free and abundant; the cost of solar electricity is expensive compared to the conventional way of electricity generation. The usage of solar energy is cost effective in the long term because the solar energy is an alternative to cater the issue of the depletion of finite sources in the near future. Today's technology has made solar energy as most cost effective [7].

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

The figure below describes the project work flow. Refer to Appendix A for the suggested milestone which has been planned for the project.

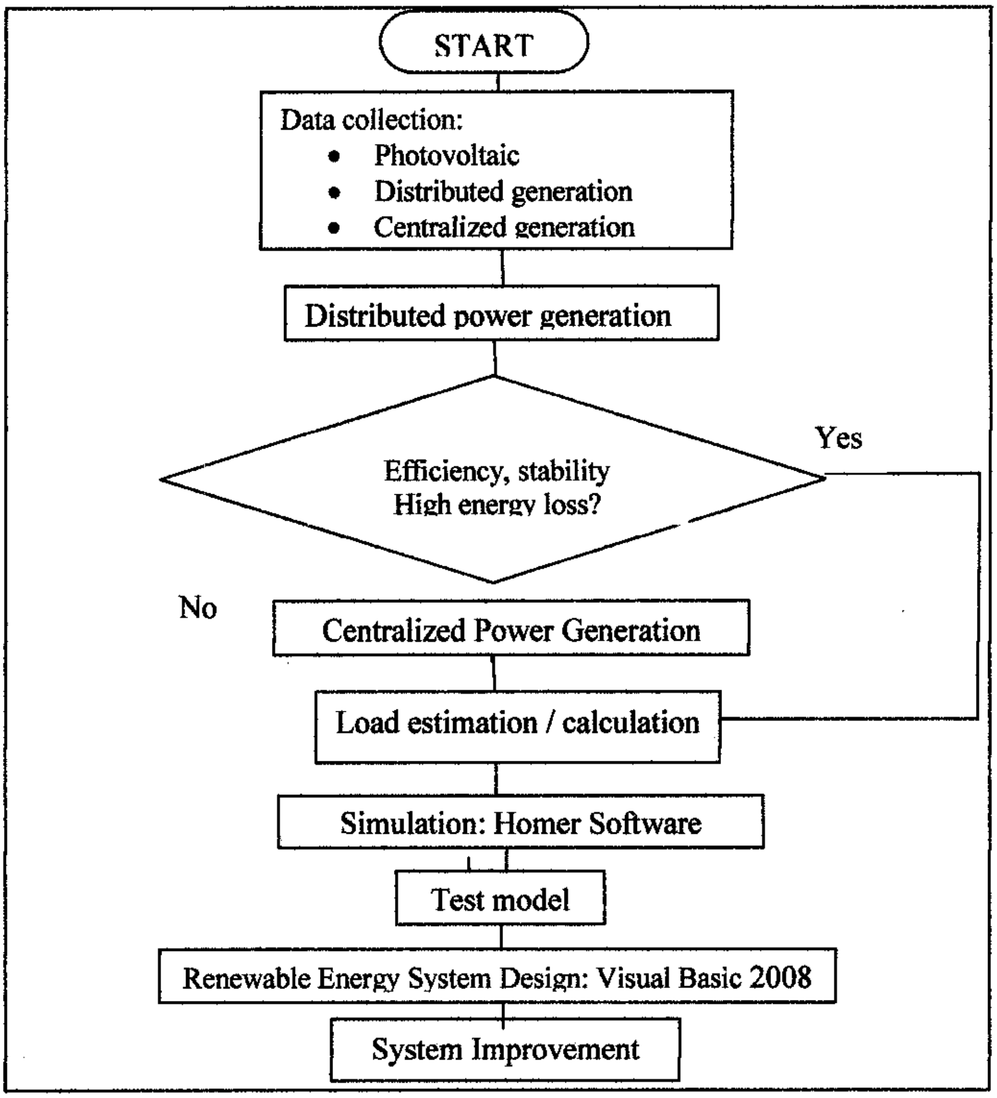


Figure 3: Project Flow Chart

3.2 Procedures

In this chapter, it explains on the methodology or flow of the project that will be carried out throughout the project completion. These are the steps involve:

3.2.1 Information Gathering

To kick start the project, research work on underlying theories of conventional method of power generation and distribution is conducted. It includes the topics of:

a) Centralized Generation

b) Distributed Generation

At the same time, study about the potential of renewable energy to be implemented in the system is also being conducted. The project is focusing on solar energy as an alternative in power generation is carried out. It involves the study of solar energy, photovoltaic cell sizing, and battery sizing.

3.2.2 Proposing the Suitable Method

After the information gathering of the available power generation and distribution system, the most suitable approach is selected to be implemented in the project. The project is then continued by checking the feasibility of material to design an effective power generation using renewable energy focused on photovoltaic from the solar energy. Figure 4 describe the proposed distributed power generation system that utilizes the use of solar energy.

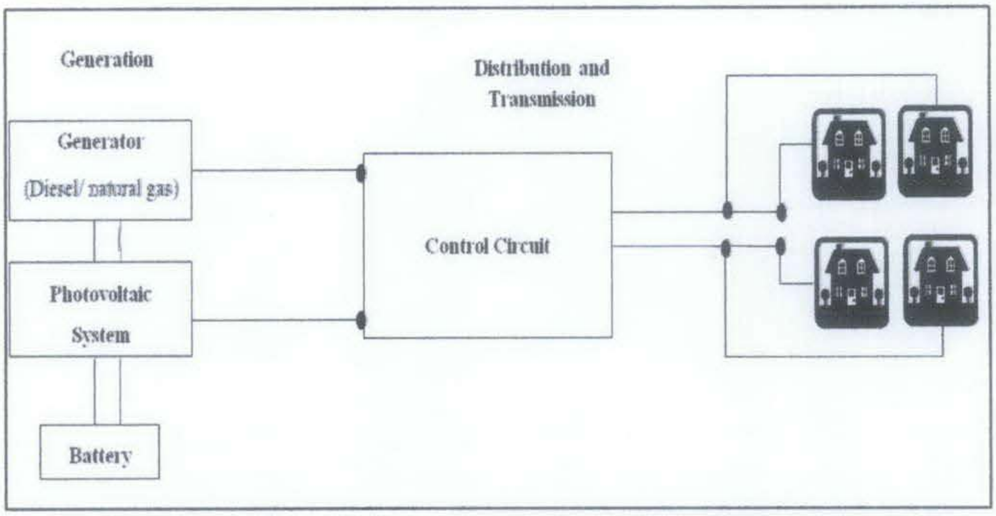


Figure 4: Renewable Energy Based Distributed Power Generation

In this system, electricity is generated at the generation station which is situated closer to the electricity consumer and reduced the transmission loss. In this project the residential electricity usage is considered as the electricity consumer. Electricity is generated using photovoltaic system and generator in case of shortage of solar intensity radiation during the rainy or cloudy days in the area. Energy generated by the photovoltaic system is also being stored in the battery for the usage of electricity during at night. The control circuit consist of the selector and inverter. The selector is use to chose the between phovoltaic alone or including the generator. The inverter is used to convert the electricity in photovoltaic system in DC into AC power.

3.2.3 Load Estimation

In this part, the value of the load to be used in the system is to be estimated. The method used is by gathering the Tenaga National Berhad electricity bills of various types of houses that are available in Malaysia. Then, the load average value is considered as the load reference value for the simulation to utilize the use of the renewable energy in power generation and distribution system.

3.2.4 Simulation

Then the simulation is done to test the system. The simulation is done by using HOMER, the Micropower Optimization Model software. HOMER is a software that can design for both off-grid and grid connected power system with the implementation of renewable energy as the source the in the system. The simulation is done by considering 8760 hours in a year. The simulation will result in the electric in an hour that the system can supply.

The main objectives to be achieved are to utilize the renewable energy source, to improve the system efficiency and the stability of the energy source to be implemented in the system. The load value calculated earlier is being implemented in this part of the project.

3.2.5 System Design

Next, a system is being design using software called Visual Basic 2008. This is the user-interface software. In the designed system, the user can enter the amount of load required by the user. Then, the system will provide the user with the most suitable renewable energy system design for the user focusing on the solar energy. The system will provide the user with the most feasible design of solar modules arrangement according to the load requirement.

3.3 Tools/Software Required

In order to complete the project, several software is used.

3.3.1 Microsoft Excel

Microsoft Excel is used to do the sizing of the equipment and devices to be considered in the renewable energy system design. The sizing is done based on the required amount of load to be sustained by the system over a specified period of time.

3.3.2 HOMER software

HOMER is micropower optimization model software that provides the most feasible design of the renewable energy system. The equipment and the devices that have been sized earlier are to be implemented in this stage of simulation. The solar radiation intensity value is different from one area to another area. The simulation will also consider the installing, maintenance and operating cost for the system. The final output of the software is the most feasible design of the renewable energy system based on the specified requirement.

3.3.3 Visual Basic 2008

Visual Basic 2008 is used in the final stage of the project. A user interface system will be design. The user has to provide the amount of load that needed to be sustained using the renewable energy system. Then, the designed software from Visual Basic 2008 will provide the user with the suitable renewable energy system to be use by the user.

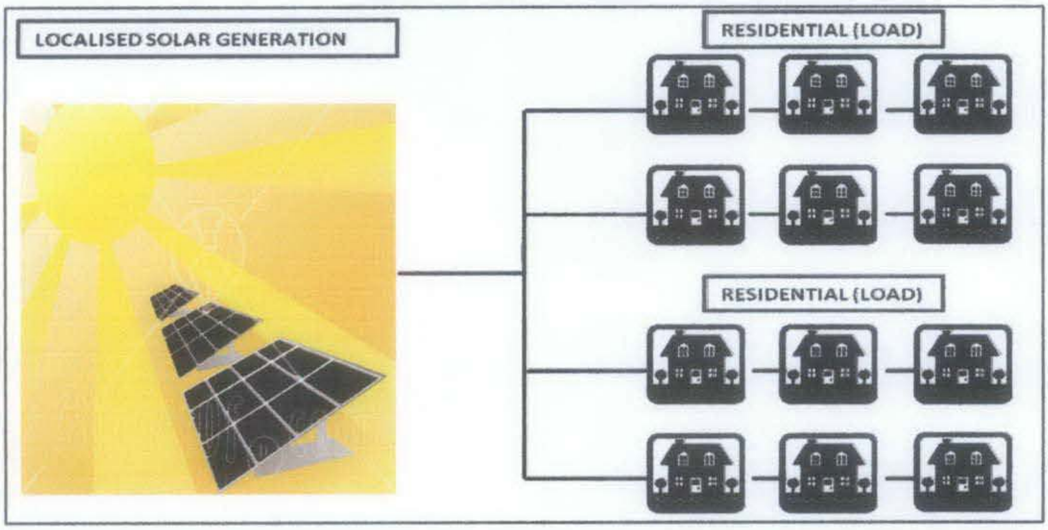
CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Centralised and Distributed Power Generation

Based on the information gathering on centralised and distributed power generation and distributed system, the best approach has been chosen after analysing the criteria of both of the approach. The chosen approach is the distributed power generation system instead of centralised system.

In distributed power generation, the distance of the power plant and the electrical consumer is near. The electricity loss during the transmission is reduced. This method has been chosen as the suitable approach to be implemented in the photovoltaic system. This is due to the instability of the solar energy. The figure below shows the illustration of the project. The solar energy is being generated at a place near to the consumer. In this case, the residential electricity demand is considered as the electricity load

Figure 5: Project Illustration



4.2 Electrical Energy Usage

In this part of the report discuss the electrical energy usage for various types of houses that are available in Malaysia. Based on the collection of the Tenaga Nasional Berhad (TNB) electrical bill of six houses, total usage of electrical energy is being determined. The electricity bills are attached at the Appendix B. The purpose of the action is to know the average of electrical energy being consume for a month.

Table 1: Electrical Energy Consumption

Type of house	Energy usage, kWh
Squatter	69
Flat	182
Terrace – one storey	263
Terrace – double storey	293
Semi detach – one storey	463
Semi detach – double storey	521
Total	**1791**

The average energy consumed is:

1 month = 298.50 kWh

1 hour = 414.6W (in a month)

This value is use as the reference value in the photovoltaic system. The electrical usage of various types of houses is then being plotted in the graph as in Figure 6.

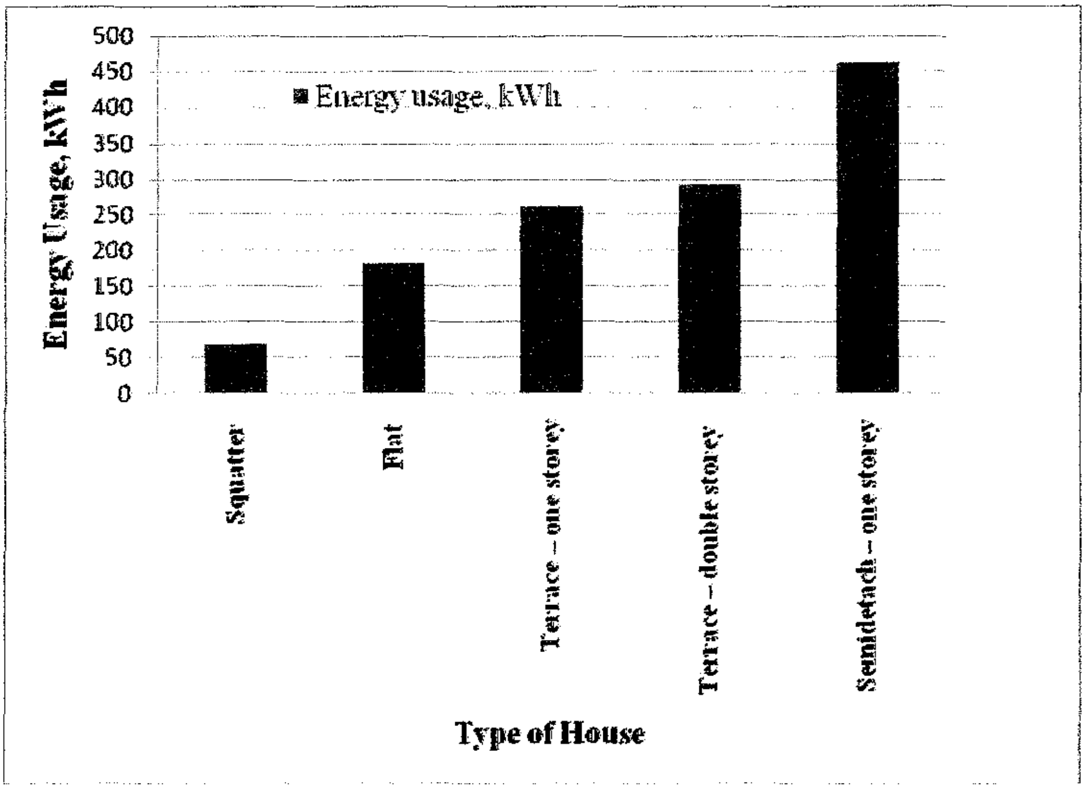


Figure 6: Energy usage Vs Type of house graph

Based from the graph obtained, different type of house consume different amount of electricity. The highest electricity consumption is from the semidetached-house and the lowest is from the squatter house. Eventhough it has different amount of electricity consumption, the main important part is to have clean sustainable electricity. If the electricity is not stable, it may damage the electrical equipment of the households.

4.3 Calculation

In this part, the calculation is done to determine the size of the load which is needed to be sustained by the system, to calculate the battery size and to know the array sizing for the system. All of the value obtained is used as the reference value in the simulation using HOMER software.

4.3.1 Load calculation

Step 1:

The average energy consumed is: 298.50 kWh (in a month). Considering 20 houses in a residential area:

= 298.50 kWh x 20

= 6000kWh

The watt hours per week:

= 1500 kWh / Wk

The load is the summation of AC and DC loads.

Step 2:

Consider;

Inverter Loss	20%
Generator Contribution	30%

The load is:

1260 kWh Weekly

180 kWh (15000 AH) Daily

The sizing of the Photovoltaic components is based on this value. The system voltage is 24V.Load value is divided by the system voltage to get the ampere-hours.

4.3.2 Battery Sizing

In order to size the battery, have to consider number of expected cloudy of rainy day in the area and percentage of system breakdown. It is estimated to have 2 days of the autonomy day and 50% of the system breakdown. Battery chosen for the system is described in the Table 2[10].

Table2: Battery Specification

Type	Trojan SCS225
Nominal voltage	12V
Nominal capacity	225 Ah

Required battery capacity for the system;

= 15000 AH x 2days

= 30000 AH / 50%

= 60000 AH

Arrangement of the battery;

Parallel: 60000 AH / 225 AH = 267

Series : 12 V / 12 V = 1

Total : 267 batteries

4.3.3 Photovoltaic Array sizing

Solar module chosen for the project is described in the table below:

Table3: Solar Module Specification

Voltage	34V
Current	4.4 A

Considering sunshine hours in the area is 6 hours. This is the time the solar module energize to convert solar energy to electricity. The amount array current required for the system according to the load is given by:

Total daily AH / number of sunshine hours

= 15000 AH / 6 hours

= 2500 A

Arrangement of the solar modules;

Parallel: 2500 A / 4.4 A = 569

Series : 12 V / 34 V = 1

Total : 569 modules

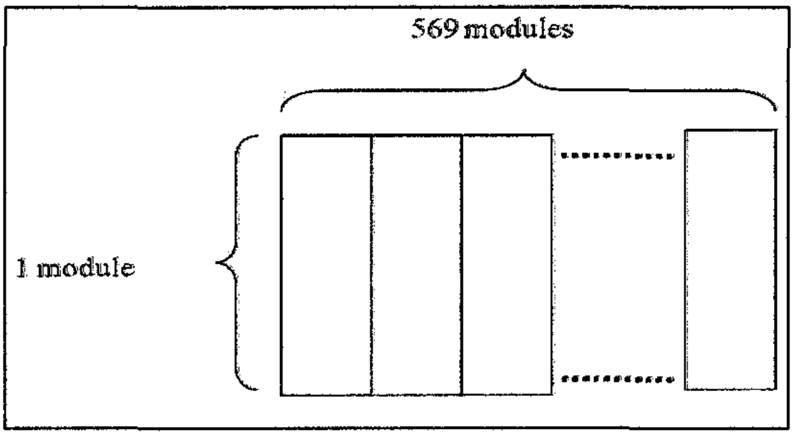


Figure 7: Solar Array for the Photovoltaic System

4.3.4 Solar Modules Output

The method of calculating the solar modules output will consider the efficiency of the modules and the solar radiation intensity at the location of study. In this project, the area of the study is in Ipoh, Perak. Refer to the Appendix D for the solar radiation data in Ipoh from the Jabatan Meteorologi Perak. Solar radiation intensity is in the unit of (Wm^{-2}).

Efficiency is given by;

$$\eta = \frac{output}{input};$$

$$output = \eta \times input$$

Input	:	800 Wm^{-2}	value of solar radiation intensity, refer Appendix C
Efficiency	:	15%	according to the Solar panel specification, refer Appendix D
Area	:	1.31m^2	according to the Solar panel specification, refer Appendix D

The area or the size of the array required is:

$$output = \eta \times input\ (A)$$

$$= 0.15 \times \left(\frac{800W}{m^2}\right) \times 1.31\ m^2$$

= 158 W per module

The above value shows the output produce from each of the solar modules depending on the solar radiation intensity at the location of study. In this project, solar radiation intensity is 800 W/m^2. Refer to Appendix C for solar radiation data. In order to have higher output value, for the solar modules, efficiency of the modules should be increase. The graph in the next section discusses the relation of number of solar modules and the efficiency of the modules.

4.4 The Relationship of Efficiency and Number Of Modules

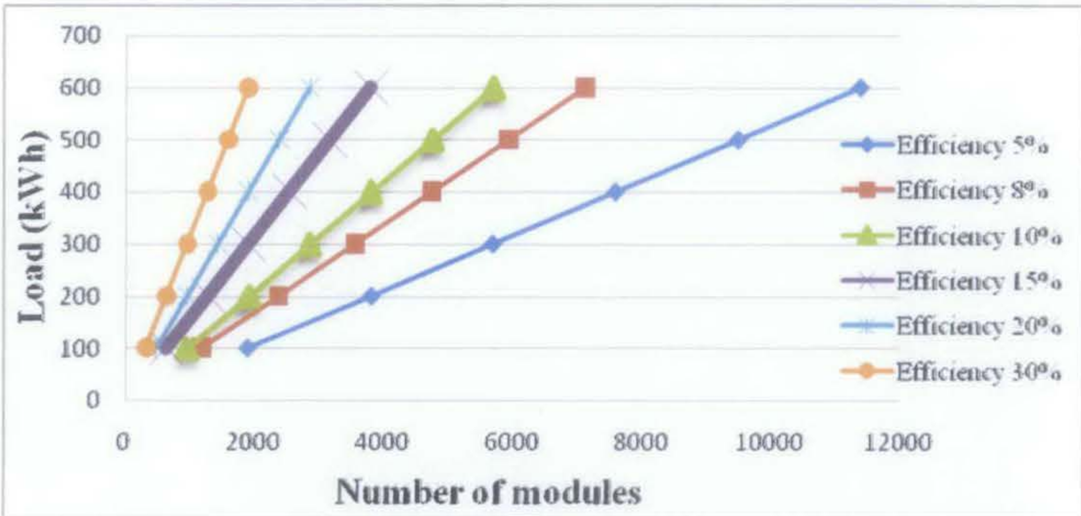


Figure 8: The Relationship of Number of Modules and the Efficiency

Based on the graph above, it shows that, at the same amount of load the higher efficiency of the photovoltaic module, the number of the modules is decreased. But as the efficiency of the modules is increased, the cost of the system is also increased. The project uses the photovoltaic with the efficiency of 15% which is described in the purple line.

4.5 Simulation : HOMER

At this stage, a simulation of the renewable energy system is performed using HOMER software. There are few stages involves in the simulation.

4.5.1 Choosing equipment

The equipment to be used in the renewable energy system is chosen. In this simulation the equipments are:

a) Generator
b) Load
c) Converter
d) Photovoltaic modules
e) Batteries

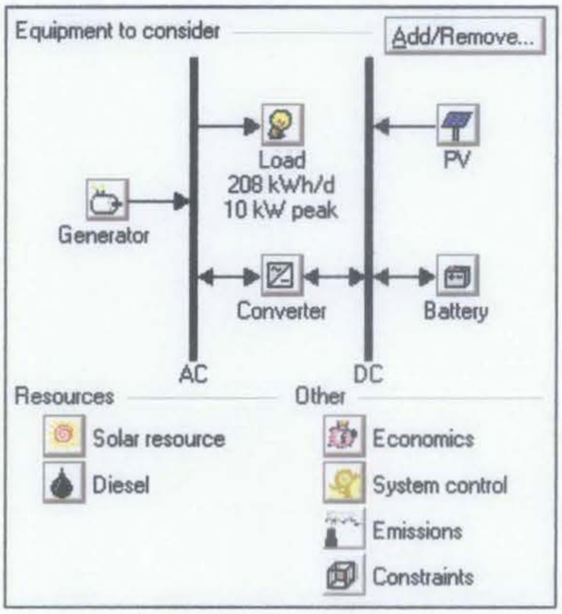


Figure 9: Equipment Used

4.5.2 *Load Details*

Based on the calculated value of the load, the average value is taken to be the reference for the simulation which is 208 kWh /day. The average load is then being distributed for every hour. Refer to Figure 10.

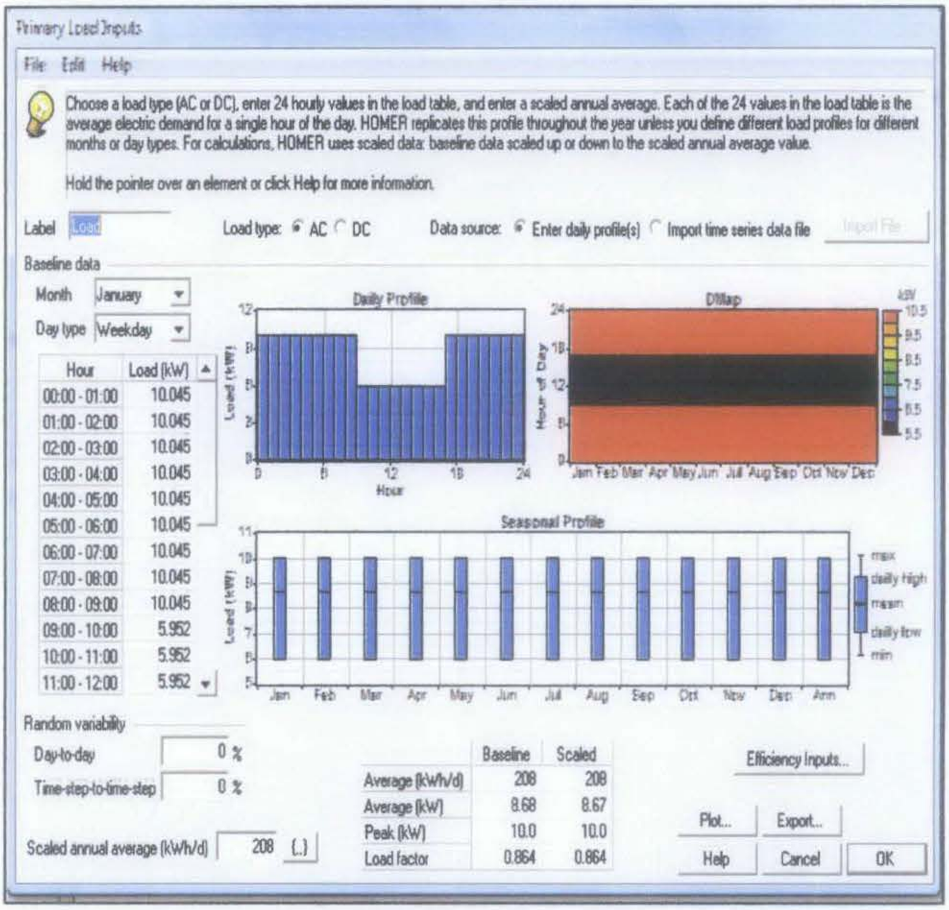


Figure 10: Primary Load Inputs

4.5.3 *Components Details*

The details of the component specified are being determined. The details include the size, cost of installing replacement and operation and maintenance. The component involves in this stage as describes in figures below.

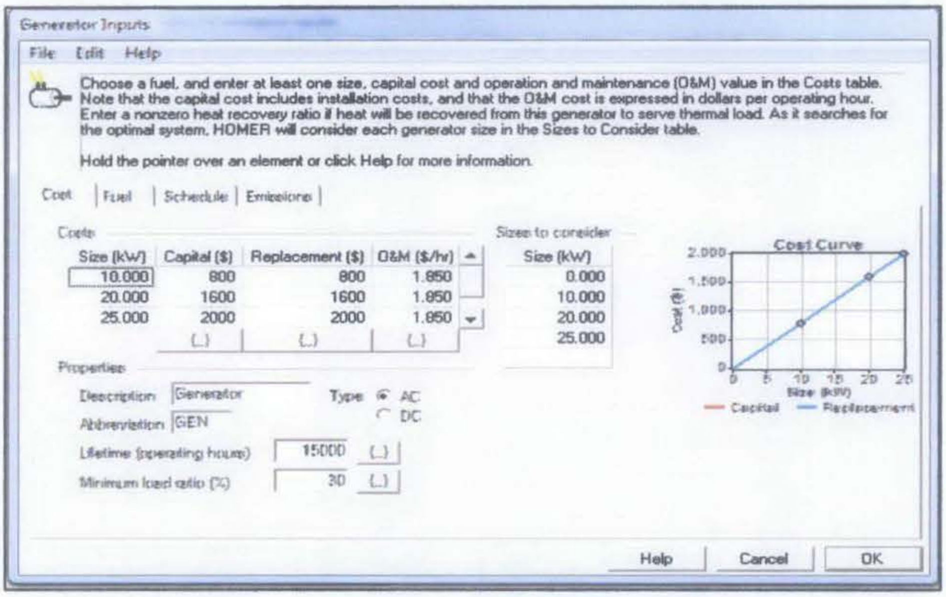


Figure 11: Generator Inputs

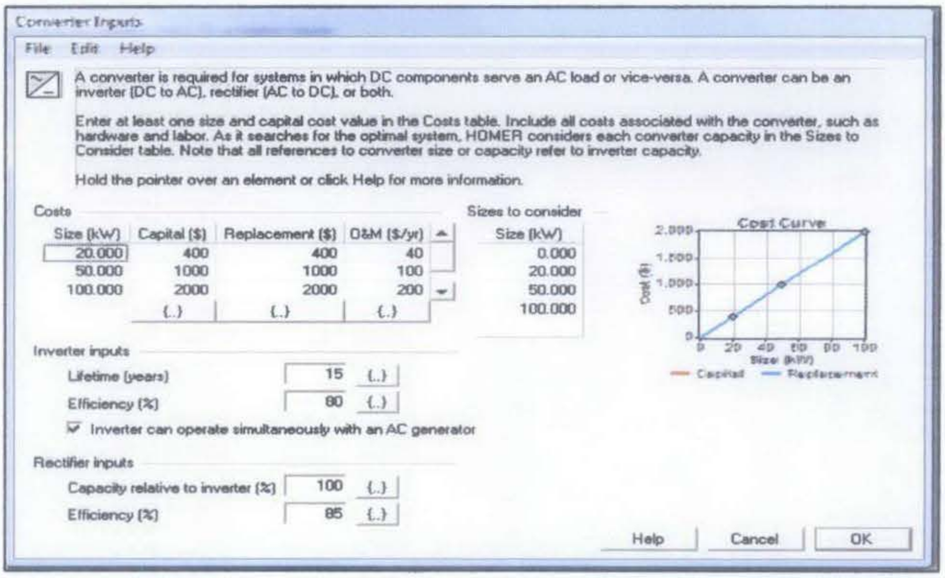


Figure 12: Converter Inputs

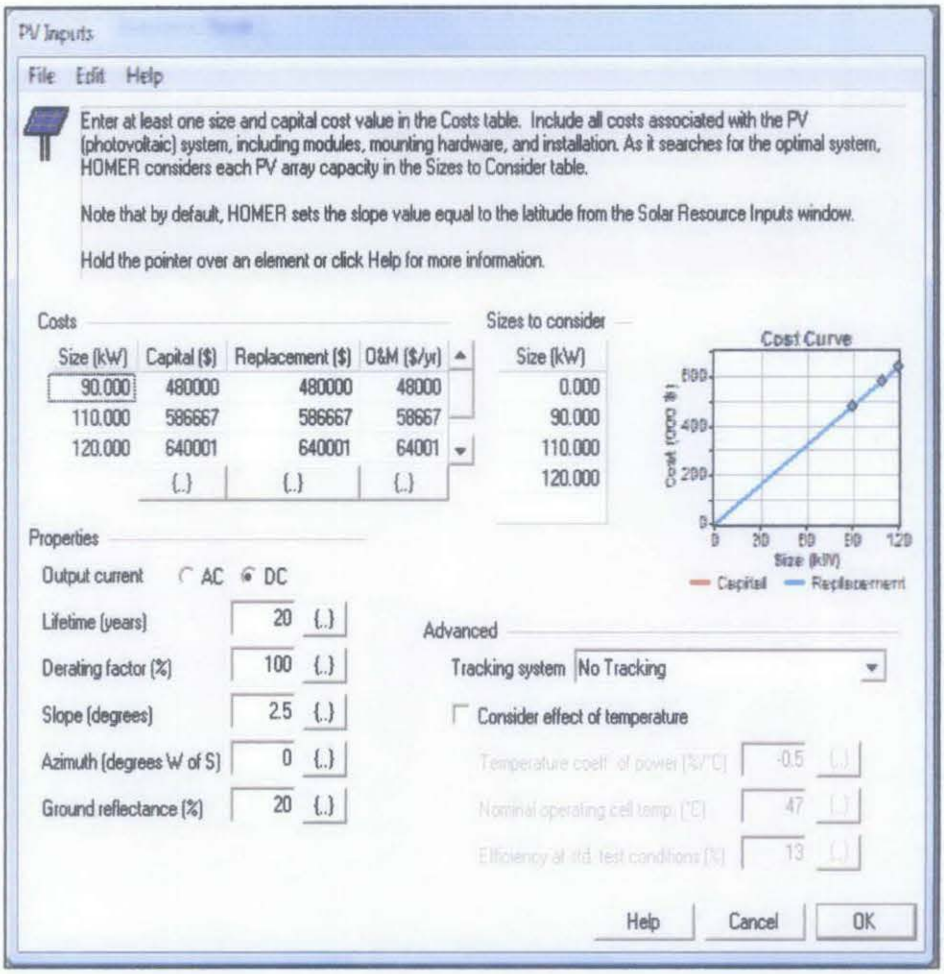


Figure 13: Photovoltaic Inputs

4.5.4 *Resource Details*

There are two source involve in the system which are solar resource and diesel for the generator. For solar resource input; the globalization radiation is being generated from the software by entering the location of the system. The location consist of the latitude and longitude of the area and as well as the time zone. Figure below show the globalization radiation graph for Malaysia, Latitude: 2° 30' Longitude 112° 30' [11].

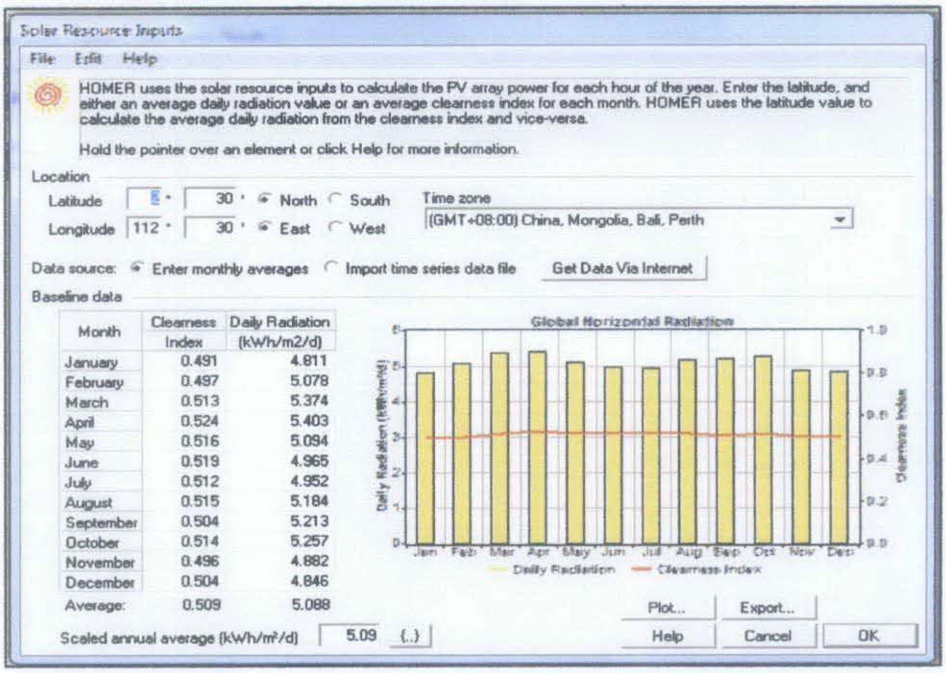


Figure 14: Source Resource Inputs

For diesel source input; the price of diesel price per litre is required. In Malaysia diesel price per litre is RM 1.70 per litre which is equal to the USD 0.48.Refer figure 15.

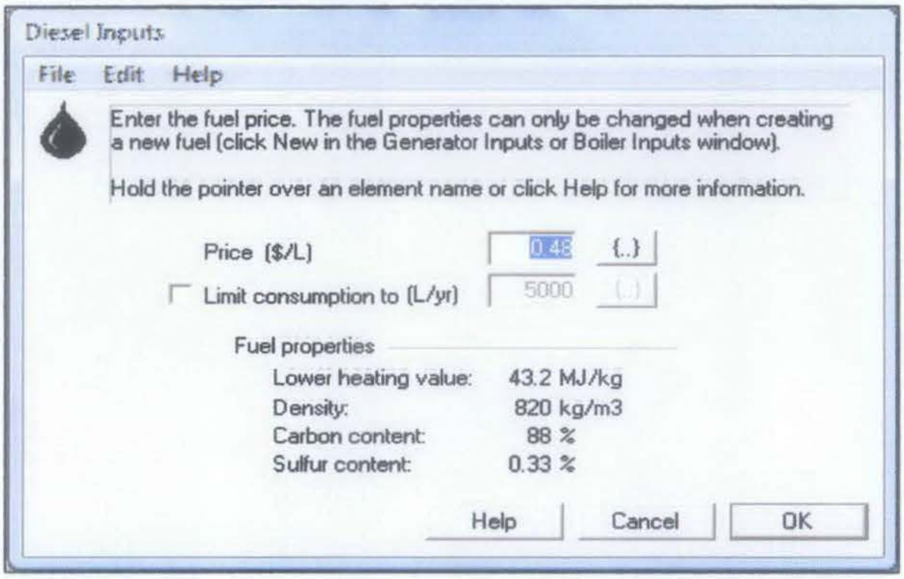


Figure 15: Diesel Inputs

4.5.5 *Examine Simulation Result*

Figure below show all the listed size of equipment that are possible to be considered in the renewable energy system.

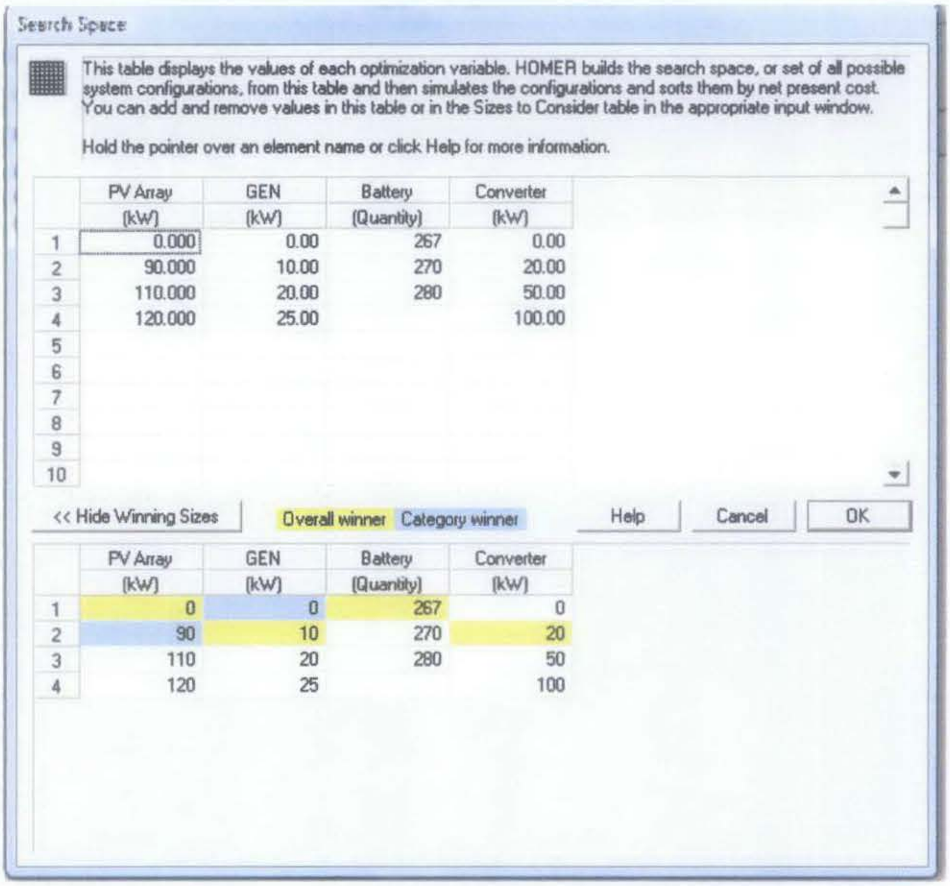


Figure 16: Possible Size of Equipments

The figure shows the resultant of the simulation. The most suitable design for each category is displayed.

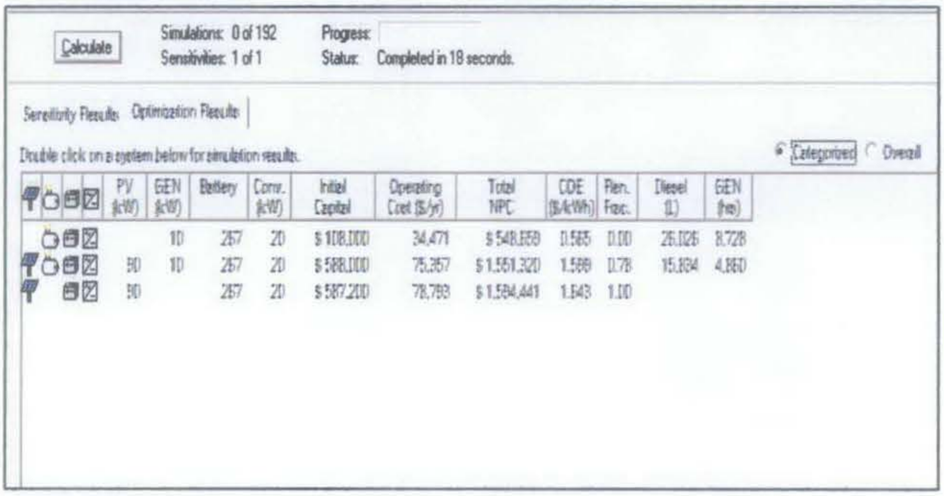


Figure 17: Simulation Result

Based on the simulation the most suitable design to be considered in the renewable energy system with the determine load value is the system that uses photovoltaic cell of 90kW, diesel generator of 10kW, 267 batteries and converter of 20kW.

4.6 Photovoltaic Sizing System

This is the system design using Visual basic 2008. Based on the load demand of the system, the calculator can calculate the most feasible arrangement of the solar modules and batteries of the distributed power generation. The user needs to enter the specified parameter in order to yield the desired result. Figure below show the designed system.

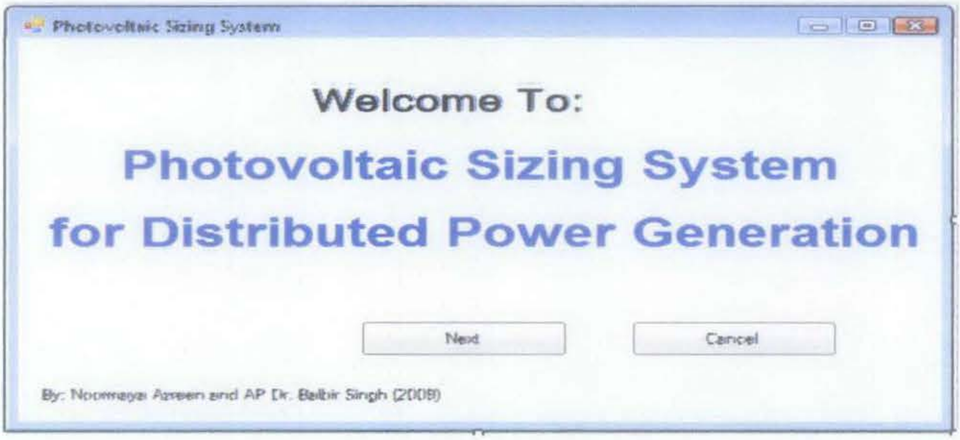


Figure18: Photovoltaic Sizing System

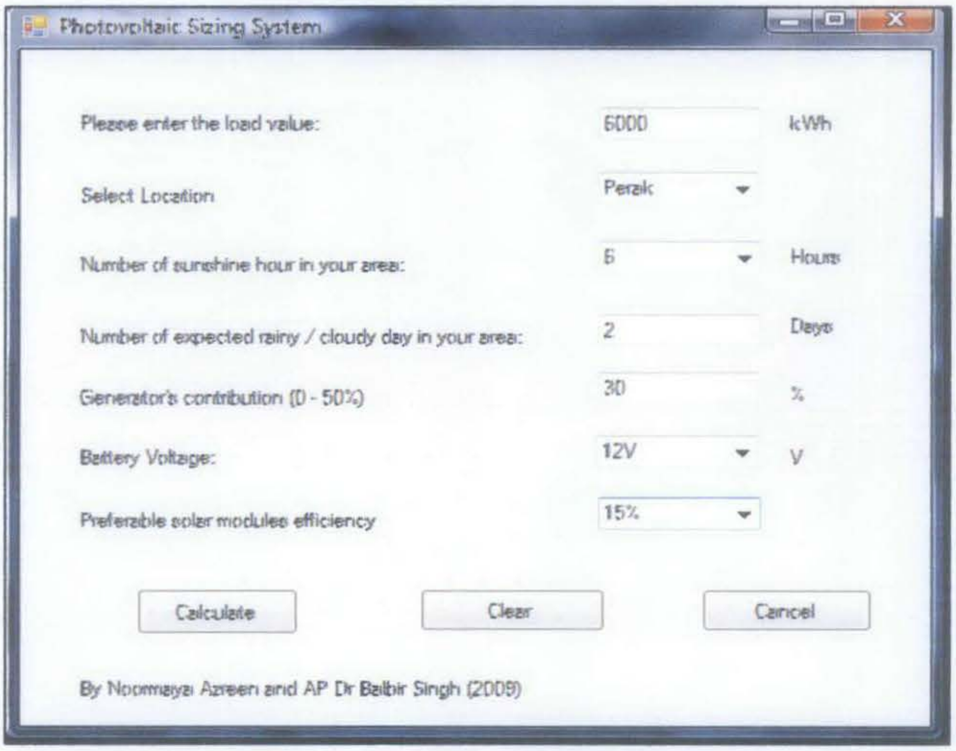


Figure19: Photovoltaic System Input

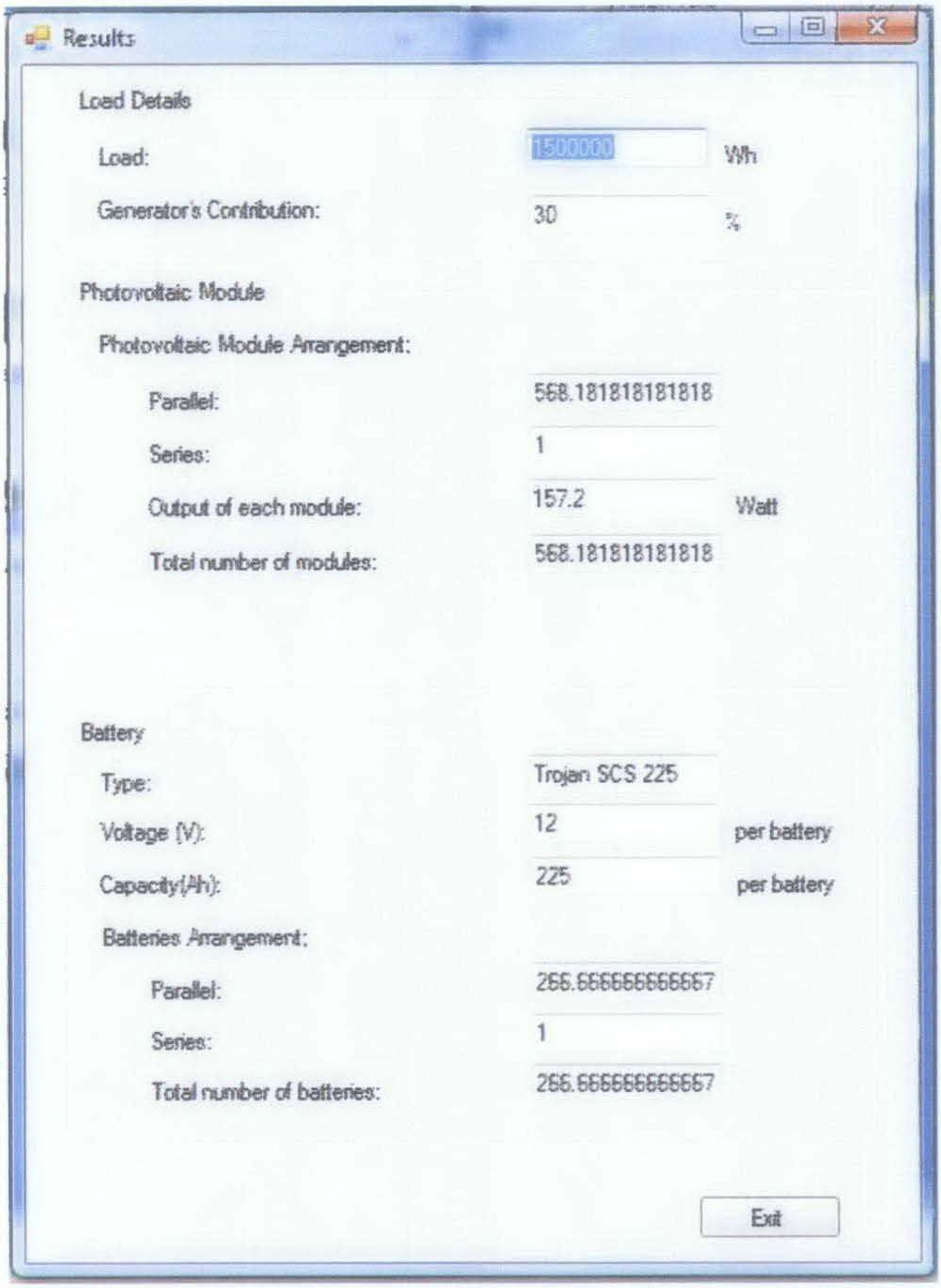


Figure20: Photovoltaic System Output

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, renewable energy is an effective alternative to replace the finite sources in electricity generation. This is due to the fact that finite energy sources such as petroleum and natural gas will be depleted in the near future. The objectives of this project are achieved by proposing renewable energy based distributed power generation by utilising the use of solar energy. The distributed or localised power generation and distribution system has been chosen as the most suitable method in the project. This type of approach reduces the electricity transmission losses because electricity is generated near to electricity consumer. Solar energy has been chosen as the main source of renewable energy for the system due to the fact that Malaysia is located near to the equator line of earth. The correct sizing of the photovoltaic system helps to increase the efficiency of the system by providing the optimize design of the system. As the value of efficiency increased, number of solar modules also increases. Simulation done using HOMER provides in the most feasible and optimize design for the renewable energy based distributed power generation. The designed software using Visual Basic 2008 results in the most feasible solar panel arrangement for the renewable energy system. The arrangement is based on the load demand of the system itself.

5.2 Recommendation

The recommendation made for this project is by considering the use combination of many renewable energy sources such as the solar energy, wind energy and geothermal energy in the distributed power generation system. The can be considered as the green energy. The system will reduce the pollution to the earth. The correct sizing of the sources is required in order to have a clean and sustainable system. Further development of the system will help to enhance the use of renewable energy efficiently in the electricity generation. Figure below illustrates the system described:

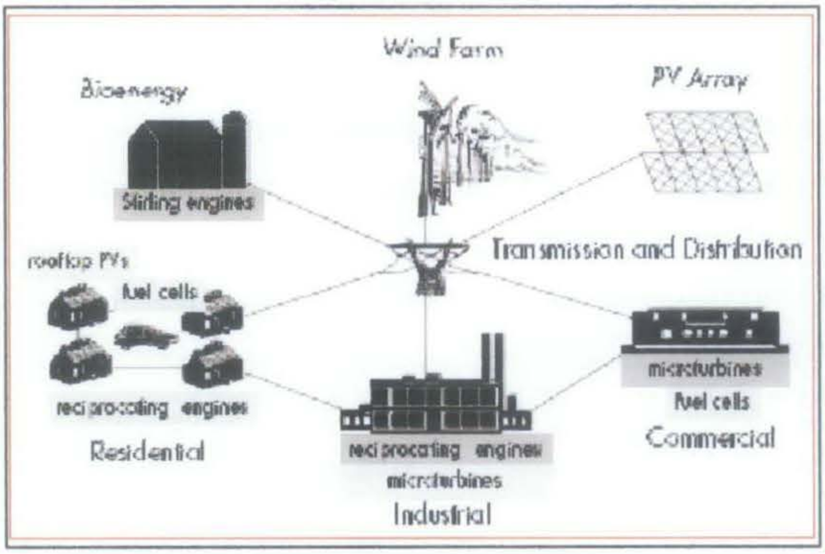


Figure 21: Combination Renewable Energy Sources

Appendix A

Suggested Milestone for Second Semester of Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7	Mid-Semester Break	8	9	10	11	12	13	14
1	Simulation Designing	■	■													
2	Simulation : HOMER			■	■	■										
3	Improvement and Testing The Model						■	■								
4	Submission of Progress Report									■						
5	Seminar									■	■					
6	Lab Work Continues: Visual Basic 2008									■	■	■	■			
7	System Development											■	■			
8	Poster Exhibition												■			
9	Submission of Dessertation (soft bound)													■		
10	Submission of Interim Report Final Draft														■	
11	Oral Presentation															

■ Task Completed

□ Task Planned

APPENDIX B

Tenaga Nasional Berhad Electricity Bills 1

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0316 00563946 05	88333	TUNAI	350.00	02892115

BDUL RAZAK B ABDUL RAHMAN RU 62
7946 JLN KOLAM AIR PANAS
G KESANG JAYA 77000 KESANG MELAKA

03160056394605 02892115

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARIF
IL AKHIR	15-01-2009	134.00	N	013
AYARAN AKHIR	02-02-2009	134.00		

CAGARAN TAMBAHAN	TUNGGAKAN	TARIKH KEMASKINI
0.00	0.00	12-02-2009

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
0447286	1.00	69313	69834	521 KWH

CAJ	UNIT	KADAR	AMAUN
ILOK KEGUNAAN ELEKTRIK	500	0.300	RM 150.00
	21	0.390	RM 8.19
/JALAN INDIVIDU			RM 10.00

AMAUN ELEKTRIK	: RM	158.19	BIL SEMASA	: RM	168.19
LAIN-LAIN CAJ	: RM	10.00	TUNGGAKAN	: RM	0.00
PELARASAN ANGGRN.	: RM	0.00	CAGARAN TAMB.	: RM	0.00
PELBAGAI	: RM	0.00	JUMLAH	: RM	168.19
PENALTI	:		PENGGENAPAN	: RM	0.01
			JUM. PERLU DIBYR.	: RM	168.20

TRKH BACAAN	DAHULU: 15-01-2009	SEMASA: 14-02-2009	JENIS: N

NO. TELEFON PERTANYAAN/ADUAN : 15454
NO. TELEFON KEDAI TENAGA : 5292132
NO. TIANG PK33 18/1
JB 3636 JLN MELAKA 77000 JASIN

P. POS BEMBAN 17022009 1235 0102915
MJUUITEN 03160056394605 T$***168.20

MRID: 0004

APPENDIX B
Tenaga Nasional Berhad Electricity Bills 2

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0232 00155610 08	770724	TUNAI	60.00	06367584

CHE NAH BT OSMAN
2846 JLN VICTORIA
LDG VICTORIA 14300 NIBONG TEBAL PULAU PINANG

RU 249

02320015561008

06367584

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARIF
BIL AKHIR	21-01-2009	-3.00	N	013
BAYARAN AKHIR	17-10-2008	8.95		

CAGARAN TAMBAHAN	TUNGGAKAN	BAYARAN DITERIMA SETAKAT
0.00	-3.00	16-02-2009

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
046073	1.00	30625	30694	69 KWH

CAJ	UNIT	KADAR		AMAUN
BLOK KEGUNAAN ELEKTRIK	69	0.218	RM	15.04
DIBIAYAI OLEH KERAJAAN MALAYSIA			RM	-15.04

	RM	0.00		RM	0.00
AMAUN ELEKTRIK :	RM	0.00	BIL SEMASA	: RM	-3.00
LAIN-LAIN CAJ :	RM	0.00	TUNGGAKAN	: RM	0.00
PELARASAN ANGGRN. :	RM	0.00	CAGARAN TAMB.	: RM	-3.00
PELBAGAI :			JUM. PERLU DIBYR.	: RM	0.00
PENALTI :				: RM	-3.00

TRKH BACAAN | DAHULU: 21-01-2009 | SEMASA: 21-02-2009 | JENIS: N

NO. TELEFON PERTANYAAN/ADUAN : 15454
NO. TELEFON KEDAI TENAGA : 5931606
NO. TIANG:
3364 JLN NURI TMN SENTOSA NIBONG TEBAL

MRID: 0012

TUNGGAKAN PERLU DIJELASKAN SERTA MERTA UNTUK MENGELAKKAN PEMOTONGAN BEKALAN 23-03-2009
BIL SEMASA PERLU DIJELASKAN DALAM MASA 30 HARI IAITU SEBELUM

-300

TENAGA NASIONAL BERHAD (200866-W)

NO. AKAUN PENGGUNA	NO. BIL	JUMLAH BAYARAN
0232 00155610 08	06367584	-3.00

CHE NAH BT OSMAN
2846 JLN VICTORIA
LDG VICTORIA 14300 NIBONG TEBAL PULAU PINANG

APPENDIX B
Tenaga Nasional Berhad Electricity Bills 3

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0340 00402506 02	1107086	TUNAI	280.00	30782435

ANER BIN MOHAMED ARIFF
1 JLN PENDEKAR 5
THN UNGKU TUN AMINAH 81300 JOHOR BAHRU JOHOR

RU 1550

03400040250602

30782435

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARIF
BIL AKHIR	04-02-2009	138.00	N	013
BAYARAN AKHIR	10-02-2009	138.00		

CAC	I	TUNGGAKAN	TARIKH KEMASKINI
		0.00	01-03-2009

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
30072195709	1.00	11960	12423	463 KWH

CAJ	UNIT	KADAR	AMAUN
BLOK KEGUNAAN ELEKTRIK	90	0.286	RM 25.74
BLOK KEGUNAAN ELEKTRIK	373	0.300	RM 111.90

AMAUN ELEKTRIK	: RM	137.64	BIL SEMASA	: RM	137.64
LAIN-LAIN CAJ	: RM	0.00	TUNGGAKAN	: RM	0.00
PELARASAN ANGGRN.	: RM	0.00	CAGARAN TAMB.	: RM	0.00
PELBAGAI	: RM	0.00	JUMLAH	: RM	137.64
PENALTI	:		PENGGENAPAN	: RM	0.01
			JUM. PERLU DIBYR.	: RM	137.65

TRKH BACAAN | DAHULU: 04-02-2009 | SEMASA: 07-03-2009 | JENIS: N

NO. TELEFON PERTANYAAN/ADUAN : 15454
NO. TELEFON KEDAI TENAGA : 2192220
NO. TIANG:
WISMA TNB JLN YAHYA AWAL JOHOR BAHRU

MRID: 0013

TUNGGAKAN PERLU DIJELASKAN SERTA MERTA UNTUK MENGELAKKAN PEMOTONGAN BEKALAN
BIL SEMASA PERLU DIJELASKAN DALAM MASA 30 HARI, IAITU SEBELUM: 06-04-2009

13765

TENAGA NASIONAL BERHAD (200866-W)

NO. AKAUN PENGGUNA	NO. BIL	JUMLAH BAYARAN
0340 00402506 02	30782435	137.65

ANER BIN MOHAMED ARIFF
1 JLN PENDEKAR 5
THN UNGKU TUN AMINAH 81300 JOHOR BAHRU JOHOR

APPENDIX B
Tenaga Nasional Berhad Electricity Bills 4

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0260 00329522 04	965484	TUNAI	100.00	28992941

MOHAMED BIN ISHAK RU 422
BLK2479-6D JLN GAOL
10460 GEORGETOWN PULAU PINANG

02600032952204 28992941

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARIF
BIL AKHIR	05-12-2008	29.20	N	013
BAYARAN AKHIR	19-12-2008	29.20		

* CAGARAN TAMBAHAN	TUNGGAKAN	BAYARAN DITERIMA SETAKAT
0.00	0.00	03-01-2009

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
95815129	1.00	23696	23913	217 KWH

CAJ	UNIT	KADAR		AMAUN
BLOK KEGUNAAN ELEKTRIK	200	0.218	RM	43.60
	17	0.345	RM	5.87

AMAUN ELEKTRIK	: RM	49.47	BIL SEMASA	:RM	44.88
LAIN-LAIN CAJ	: RM	0.00	TUNGGAKAN	:RM	0.00
PELARASAN ANGGRN.	: RM	0.00	CAGARAN TAMB.	:RM	0.00
PELBAGAI	. RM	-4.59	JUM. PERLU DIBAYR.	:RM	44.88
PENALTI	:		PENGGENAPAN	: RM	0.02

TRKH BACAAN | DAHULU: 05-12-2008 | SEMASA: 07-01-2009 | JENIS: N

NO. TELEFON PERTANYAAN/ADUAN JUM. PERLU DIBAYAR : RM 44.90
NO. TELEFON KEDAI TENAGA : 2224000
NO. TIANG:
30 WISMA TNB JLN ANSON OFF JLN WESTLAND

P.P03 D.KRAMAT 23012009 1519 0333524 MRID: 0045
MD001TEN 02600032952204 T$****44.90

TUNGGAKAN PERLU DIJELASKAN SERTA-MERTA UNTUK MENGELAKKAN PEMOTONGAN BEKALAN
BIL SEMASA PERLU DIJELASKAN DALAM MASA 30 HARI, IAITU SEBELUM: 06-02-2009

APPENDIX B
Tenaga Nasional Berhad Electricity Bills 5

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0142 00358038 04	791084	TUNAI	95.00	09811361

AYOB B MARZUKI RU 84
399 JLN BUNGA
BT 7 KG SIJANGKANG 42500 SIJANGKANG SELANGOR

01420035803804 09811361

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARI
BIL AKHIR	24-11-2008	97.90	N	013
BAYARAN AKHIR	19-12-2008	97.90		

CAGARAN TAMBAHAN	TUNGGAKAN	TARIKH KEMASKINI
0.00	0.00	21-12-2008

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
AT99A 008928	1.00	14252	14545	293 KWH

CAJ	UNIT	KADAR	AMAUN
BLOK KEGUNAAN ELEKTRIK	200	0.218	RM 43.60
	93	0.345	RM 32.09
L/JALAN INDIVIDU			RM 10.00

AMAUN ELEKTRIK	: RM 75.69	BIL SEMASA	: RM 85.93
LAIN-LAIN CAJ	: RM 10.00	TUNGGAKAN	: RM 0.00
PELARASAN ANGGRN.	: RM 0.00	CAGARAN TAMB.	: RM 0.00
PELBAGAI	: RM 0.00	JUMLAH	: RM 85.93
PENALTI	: RM 0.24	PENGGENAPAN	: RM 0.02
		JUM. PERLU DIBYR.	: RM 85.95

TRKH BACAAN	DAHULU: 24-11-2008	SEMASA: 24-12-2008	JENIS: N

NO. TELEFON PERTANYAAN/ADUAN : 15454
NO. TELEFON KEDAI TENAGA : 31872020
NO. TIANG: JBU16/1
LOT 4 JLN BUNGA PEKAN 42700 BANTING

MRID: 0014
KA001 NB 01420035803804 T$ 85.95

TUNGGAKAN PERLU DIJELASKAN SERTA MERTA UNTUK MENGELAKKAN PEMOTONGAN BEKALAN 23-01-2009
BIL SEMASA PERLU DIJELASKAN DALAM MASA 30 HARI IAITU SEBELUM:

APPENDIX B
Tenaga Nasional Berhad Electricity Bills 6

TENAGA NASIONAL BERHAD (200866-W)

BIL ELEKTRIK

NO. AKAUN PENGGUNA	KONTRAK	CAGARAN KOD	CAGARAN AMAUN	NO. BIL
0122 00067005 05	9324664	TUNAI	240.00	34283242

PGK SDN BHD
23 JLN 14/27A
SEKSYEN 5 WANGSA MAJU 53300 - KUALA LUMPUR

RU 977

01220006700505

34283242

KETERANGAN	TARIKH	AMAUN	JENIS BACAAN	TARIF
BIL AKHIR	13-02-2009	248.05	N	013
BAYARAN AKHIR	04-02-2009	178.70		

CAGARAN TAMBAHAN	TUNGGAKAN	TARIKH KEMASKINI
0.00	248.05	11-03-2009

NO. JANGKA	MF	DAHULU	SEMASA	KEGUNAAN
89105708	1.00	43043	43306	263 KWH

CAJ	UNIT	KADAR	AMAUN
BLOK KEGUNAAN ELEKTRIK	200	0.218	RM 43.60
	31	0.334	RM 10.35
	32	0.345	RM 11.04

AMAUN ELEKTRIK	: RM 64.99	BIL SEMASA	: RM 66.61
LAIN-LAIN CAJ	: RM 0.00	TUNGGAKAN	: RM 248.05
PELARASAN ANGGRN.	: RM 0.00	CAGARAN TAMB.	: RM 0.00
PELBAGAI	: RM 0.00	JUMLAH	: RM 314.66
PENALTI	: RM 1.62	PENGGENAPAN	: RM -0.01
		JUM. PERLU DIBYR.	: RM 314.65

TRKH BACAAN	DAHULU: 13-02-2009	SEMASA: 17-03-2009	JENIS: N

NO. TELEFON PERTANYAAN/ADUAN : 15454
NO. TELEFON KEDAI TENAGA : 41079355
NO. TIANG:
247 & 248 JLN BDR 13 BDR TMN MELAWATI

MRID: [illegible]

TUNGGAKAN PERLU DIJELASKAN SERTA MERTA UNTUK MENGELAKKAN PEMOTONGAN BEKALAN
BIL SEMASA PERLU DIJELASKAN DALAM MASA 30 HARI, IAITU SEBELUM 16-04-2009

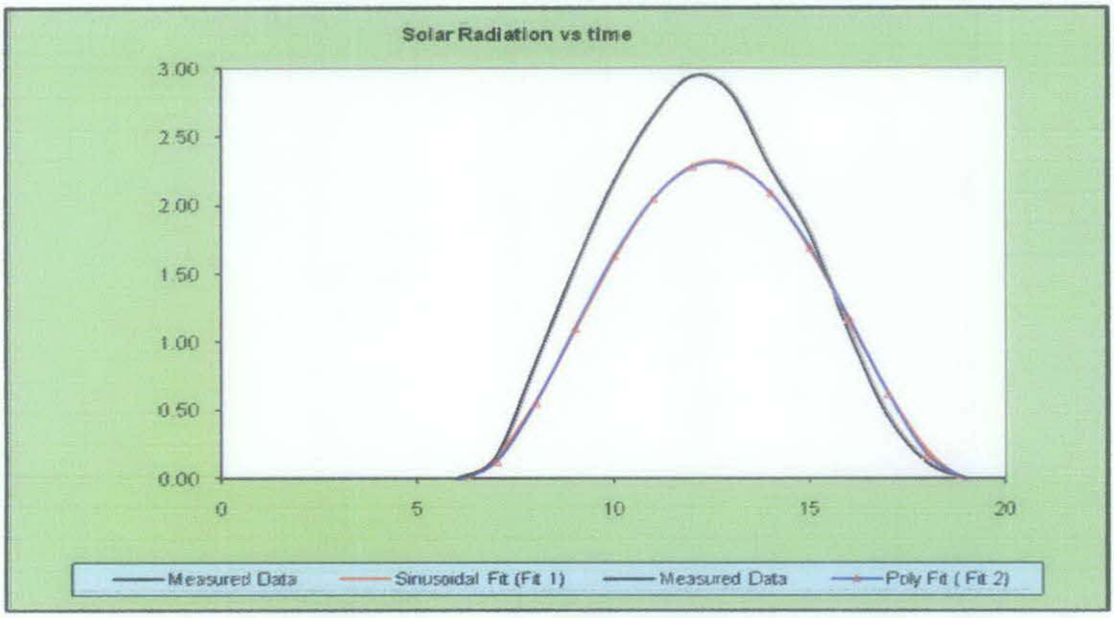
31465

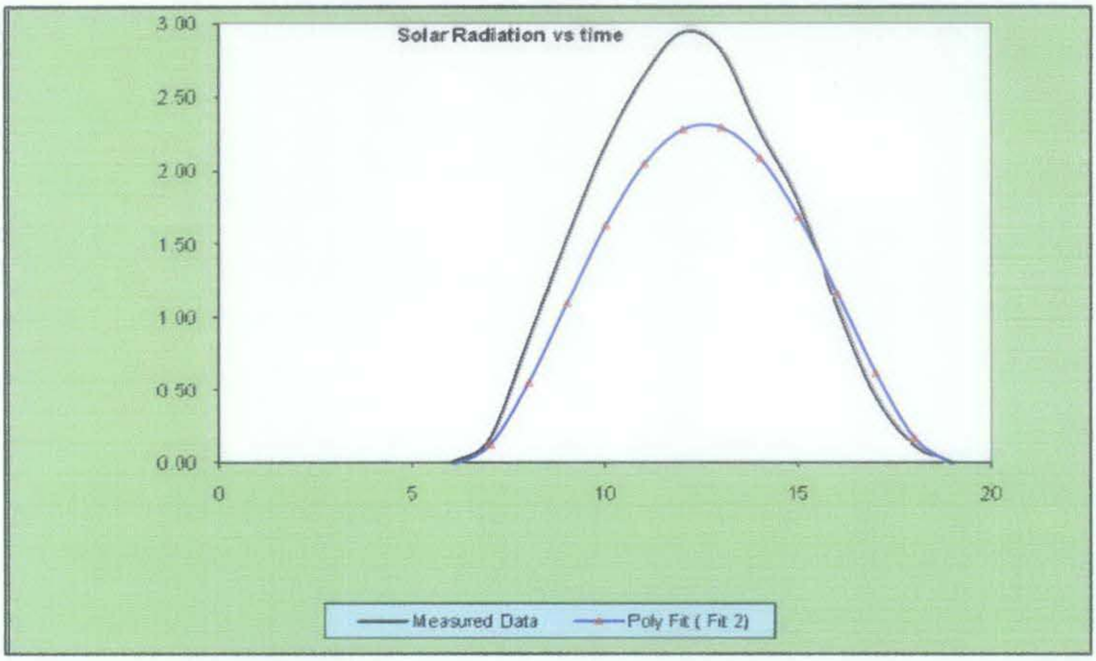
TENAGA NASIONAL BERHAD (200866-W)

NO. AKAUN PENGGUNA	NO. BIL	JUMLAH BAYARAN
0122 00067005 05	34283242	314.65

PGK SDN BHD
23 JLN 14/27A
SEKSYEN 5 WANGSA MAJU 53300 - KUALA LUMPUR

APPENDIX C
Solar Radiation Data for Ipoh, Perak





Solar radiation value:

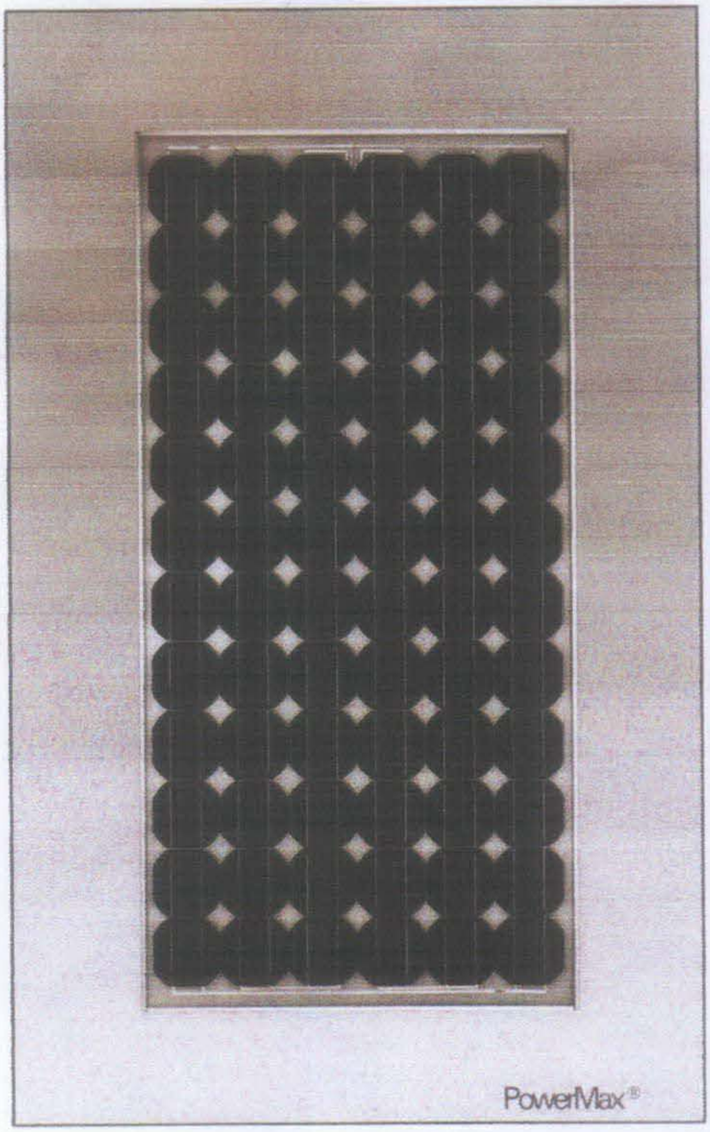
	MJm^{-2}		
Time	Actual	Fit 1	Fit 2
6	0.00	-0.05	-0.02
7	0.16	0.16	0.12
8	0.83	0.56	0.55
9	1.53	1.08	1.10
10	2.16	1.61	1.63
11	2.64	2.04	2.04
12	2.94	2.29	2.28
13	2.83	2.30	2.29
14	2.29	2.08	2.08
15	1.81	1.67	1.69
16	1.09	1.15	1.17
17	0.47	0.62	0.62
18	0.12	0.20	0.17
19	0.00	-0.04	-0.02

	Wm^{-2}		
Time	Actual	Fit 1	Fit 2
6	0.00	-14.37	-6.42
7	43.45	43.78	33.37
8	230.46	156.16	152.41
9	424.31	300.16	304.38
10	599.60	446.86	452.15
11	733.04	566.78	567.71
12	817.66	635.81	632.23
13	785.71	640.09	636.03
14	634.72	578.76	578.59
15	501.49	464.14	468.54
16	302.88	319.26	323.68
17	129.76	173.24	170.95
18	34.62	55.42	46.46
19	0.00	-10.53	-4.53

APPENDIX D
Siemens SP150 Solar Panel Data Sheet

SIEMENS

Solar module SP150 **Preliminary**



When it comes to reliable and environmentally-friendly generation of electrical power from sunlight, solar modules from Siemens provide the perfect solution. Manufactured in compliance with the most stringent quality standards, they are designed to withstand the toughest environmental conditions and are characterized by their long service life.

Siemens solar modules are covered by a 25-year limited warranty on power output – your guarantee of trouble-free solar power generation.

PowerMax® technology
Siemens proprietary PowerMax® technology optimizes the energy production of individual cells and solar modules for all types of environmental conditions. PowerMax process optimization includes a special refining technique for ingots, a clean room semiconductor grade production process and a multistage proprietary TOPS™ (Texture Optimized Pyramidal Surface) process. The TOPS process incorporates the formation of textured pyramids on the surface of the solar cell. These pyramids are then treated with special oxides to passivate the surface. TOPS maximizes photon absorption from direct and diffused light (typical under cloudy conditions). This means that light absorption is especially high, even at low light levels. Siemens PowerMax® solar cells deliver maximum energy throughout the day.

Solar module	
Model:	**SP150**
Rated power:	**150 Watts**
Limited warranty:	**25 Years**

- Module voltage 24 volts
- Single crystalline PowerMax® solar cells, textured for maximum output ratios
- Rugged weather-proof design
- Utility, large project and BIPV applications

Intelligent module design
- All cells are electrically matched to assure the greatest power output possible.
- Ultra-clear tempered glass provides excellent light transmission and protects from wind, hail, and impact.
- Torsion and corrosion-resistant anodized aluminum module frame ensures dependable performance, even through harsh weather conditions and in marine environments.
- Built-in bypass diodes (24V configuration) help system performance during partial shadowing.

High quality
- Every module is subject to final factory review, inspection, and testing to assure compliance with electrical, mechanical, and visual criteria.
- 72 PowerMax® single-crystalline solar cells deliver excellent performance even in reduced light or poor weather conditions.
- Cell surfaces are treated with the Texture Optimized Pyramidal Surface (TOPS™) process to generate more energy from available light.
- Fault tolerant multi-redundant contacts on the front and back of each cell provide superior reliability.
- Solar cells are laminated between a multi-layered polymer backsheet and layers of ethylene-vinyl acetate (EVA) for environmental protection, moisture resistance and electrical isolation.
- Durable backsheet provides the module underside with protection from scratching, cuts, breakage, and most environmental conditions.
- Laboratory tested for a wide range of operating conditions.
- Ground continuity of less than 1 ohm for all metallic surfaces.
- Manufactured in ISO 9001 certified facilities to exacting Siemens quality standards.

Easy installation
- Standard Sp junction box is designed for trouble-free field wiring and environmental protection.
- Light weight, aluminum frame and pre-drilled mounting holes for easy installation.
- Modules may be wired together in series or parallel to attain required power levels.

Options
- The module is supplied from the factory in a standard 24 volt configuration.
- Modified versions of the solar module are also available, e.g. as frameless laminate. Please contact your Siemens Solar dealer for further information.

Performance warranty
- 25 Year limited warranty on power output.

Further information on solar products, systems, principles, and applications is available in the Siemens Solar product catalog.

Solar module SP150

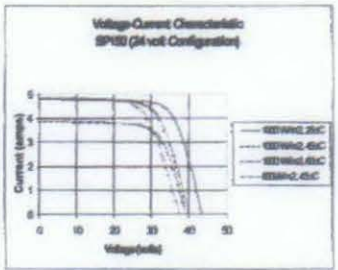
Electrical parameters		(24V)
Maximum power rating P_{max}	$[W_p]$[1]	150
Rated current I_{MPP}	[A]	4.4
Rated voltage V_{MPP}	[V]	34.0
Short circuit current I_{SC}	[A]	4.8
Open circuit voltage V_{OC}	[V]	43.4
Thermal parameters		
NOCT[2]	[°C]	45±2
Temp. coefficient of the short-circuit current		2.06 mA / °C
Temp. coefficient of the open-circuit voltage		-.077 V / °C
Qualification test parameters[4]		
Temperature cycling range	[°C]	-40 to +85
Humidity freeze, Damp heat	%RH]	85
Maximum permitted system voltage	[V]	600 V (1000 V per IEC 1215)
Wind Loading	PSF [N/m²]	50 (2400)
Maximum distortion[3]	[°]	1.2
Hailstorm / hailstones	inches [mm]	1.0 (ø 25)
	MPH [m/s]	52 (v = 23)
Weight	Pounds [kg]	32.6 (14.8)

[1] W_p (Watt peak) = Peak power
Air Mass AM= 1.5
Irradiance E= 1000 W/m²
Cell temperature T_C= 25 °C

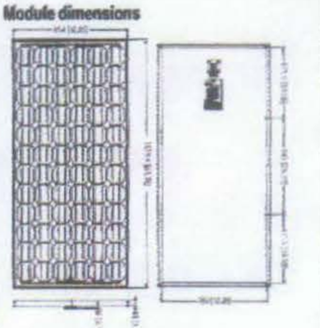
[2] Normal Operating Cell Temperature at:
Irradiance E = 800 W/m²
Ambient temperature T_A = 20 °C
Wind speed v_W= 1 m/s

[3] Diagonal tilting of the module plane

4) Per IEC 61215 test requirements



Module dimensions



Hole diameter 0.26 inch (6.6 mm)
Hole dimensioning referred to hole center

Sp J box

Maximum cable diameter: 4 mm²

Degree of protection: IP54

Your address for photovoltaics from Siemens Solar:

Siemens modules are recyclable.

Siemens Solar GmbH
A joint venture of
Siemens AG and E. ON Energie AG
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D-80915 München
Germany

Siemens Solar Industries
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Camarillo, CA 93011, U.S.A.
Tel: 805-482-6800
Fax: 805-388-6395
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E-mail: ssi.sales@solar.siemens.com

Siemens Showa Solar Pte. Ltd.
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Singapore 349249
Tel: 65-842-3886
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e-mail: ssspv@solar.siemens.com.sg

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APPENDIX E
Photovoltaic Sizing System Coding Using Visual Basic 2008

Form 1

```
Public Class Calculator

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click

        Dim Resultload As Double
        Dim Resultgenerator As Double
        Dim Resultpvparallel As Double
        Dim Resultpvseries As Double
        Dim Resultpvtotal As Double
        Dim Resultpvoutput As Double
        Dim Resultbatterytype As String
        Dim Resultbatteryvoltage As Double
        Dim Resultbatterycapacity As Double
        Dim Resultbatteryparallel As Double
        Dim Resultbatteryseries As Double
        Dim Resultbatterytotal As Double
        Dim batteryvoltage1 As Double
        Dim batteryvoltage2 As Double
        Dim sunshinehour As Double
        Dim moduleefficiency As Double
        Dim totalloadvalue As Double
        Dim location As Double
        Dim generatorvalue As Double


        Dim Form2 As New Form2

        If combobat.SelectedIndex = 0 Then
            Resultbatteryvoltage = 6
        ElseIf combobat.SelectedIndex = 1 Then
            Resultbatteryvoltage = 12
        ElseIf combobat.SelectedIndex = 2 Then
            Resultbatteryvoltage = 24
        End If

        If combobat.SelectedIndex = 0 Then
            batteryvoltage1 = 360
        ElseIf combobat.SelectedIndex = 1 Then
            batteryvoltage1 = 225
        ElseIf combobat.SelectedIndex = 2 Then
            batteryvoltage1 = 120
        End If



        If combobat.SelectedIndex = 0 Then
            batteryvoltage2 = 6
        ElseIf combobat.SelectedIndex = 1 Then
            batteryvoltage2 = 12
        ElseIf combobat.SelectedIndex = 2 Then
            batteryvoltage2 = 24
        End If
        'Resultbatteryseries = 12 / batteryvoltage2

        'Resultbatterytotal = Resultbatteryparallel * Resultbatteryseries
```

```
If combosunshine.SelectedIndex = 0 Then
            sunshinehour = 5
        ElseIf combosunshine.SelectedIndex = 1 Then
            sunshinehour = 6
        ElseIf combosunshine.SelectedIndex = 2 Then
            sunshinehour = 7
        ElseIf combosunshine.SelectedIndex = 3 Then
            sunshinehour = 8
        ElseIf combosunshine.SelectedIndex = 4 Then
            sunshinehour = 9
        ElseIf combosunshine.SelectedIndex = 5 Then
            sunshinehour = 10
        End If


        totalloadvalue = 1.2 * (Val(txtloadenter.Text))
        generatorvalue = totalloadvalue - (((Val(txtgenenetor.Text)) / 100) *
totalloadvalue)
        Resultpvparallel = ((generatorvalue / 84) / sunshinehour) / 4.4
        Resultpvseries = 1

        Resultpvtotal = Resultpvparallel * Resultpvseries


        If comboeffciency.SelectedIndex = 0 Then
            moduleefficiency = 0.05
        ElseIf comboeffciency.SelectedIndex = 1 Then
            moduleefficiency = 0.1
        ElseIf comboeffciency.SelectedIndex = 2 Then
            moduleefficiency = 0.15
        ElseIf comboeffciency.SelectedIndex = 3 Then
            moduleefficiency = 0.2
        End If

        If combolocation.SelectedIndex = 0 Then
            location = 800
        ElseIf combolocation.SelectedIndex = 1 Then
            location = 810
        ElseIf combolocation.SelectedIndex = 2 Then
            location = 820
        ElseIf combolocation.SelectedIndex = 3 Then
            location = 830
        ElseIf combolocation.SelectedIndex = 4 Then
            location = 840

        End If
        Resultpvoutput = 1.31 * moduleefficiency * location


        If combobat.SelectedIndex = 0 Then
            Resultbatterytype = "Trojan LP16"
        ElseIf combobat.SelectedIndex = 1 Then
            Resultbatterytype = "Trojan SCS 225"
        ElseIf combobat.SelectedIndex = 2 Then
            Resultbatterytype = "Trojan LP12"
        End If

        If combobat.SelectedIndex = 0 Then
            Resultbatterycapacity = 360
        ElseIf combobat.SelectedIndex = 1 Then
            Resultbatterycapacity = 225
        ElseIf combobat.SelectedIndex = 2 Then
            Resultbatterycapacity = 120
        End If
```

```
        Resultbatteryseries = 12 / batteryvoltage2

        Resultbatteryparallel = (((generatorvalue / 84) * (Val(txtrainy.Text))) / 0.5)
/ Resultbatterycapacity

        Resultbatterytotal = Resultbatteryparallel * Resultbatteryseries

        Resultload = (Val(txtloadenter.Text))
        Resultgenerator = (Val(txtgenenetor.Text))

        Form2.Show()

        Form2.txtload.Text = Resultload
        Form2.txtgen.Text = Resultgenerator
        Form2.txtpvparallel.Text = Resultpvparallel
        Form2.txtpvseries.Text = Resultpvseries
        Form2.txtpvtotal.Text = Resultpvtotal
        Form2.txtpvop.Text = Resultpvoutput
        Form2.txtbattype.Text = Resultbatterytype
        Form2.txtbatvoltage.Text = Resultbatteryvoltage
        Form2.txtbatcapa.Text = Resultbatterycapacity
        Form2.txtbatparallel.Text = Resultbatteryparallel
        Form2.txtbatseries.Text = Resultbatteryseries
        Form2.txtbattotal.Text = Resultbatterytotal



    End Sub

    Private Sub Label5_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Label5.Click

    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        Me.Close()
    End Sub

    Private Sub Calculator_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        txtloadenter.Text = ""
        combolocation.SelectedIndex = -1
        combosunshine.SelectedIndex = -1
        txtrainy.Text = ""
        txtgenenetor.Text = ""
        combobat.SelectedIndex = -1
        comboeffciency.SelectedIndex = -1

    End Sub
End Class
```

Form 2

```
Public Class Form2

    Private Sub PictureBox1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs)

    End Sub

    Private Sub GroupBox2_Enter(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles GroupBox2.Enter

    End Sub

    Private Sub TextBox10_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatparallel.TextChanged

    End Sub

    Private Sub TextBox6_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtpvtotal.TextChanged

    End Sub

    Private Sub Label12_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs)

    End Sub

    Private Sub TextBox8_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatvoltage.TextChanged

    End Sub

    Private Sub TextBox9_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatcapa.TextChanged

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub
End Class
```

Form 3

```
Public Class Form3

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click
        'Dim Form1 As New Form
        'Form1.Show()
    End Sub
End Class
```

```
        Resultbatteryseries = 12 / batteryvoltage2

        Resultbatteryparallel = (((generatorvalue / 84) * (Val(txtrainy.Text))) / 0.5)
/ Resultbatterycapacity

        Resultbatterytotal = Resultbatteryparallel * Resultbatteryseries

        Resultload = (Val(txtloadenter.Text))
        Resultgenerator = (Val(txtgenenetor.Text))

        Form2.Show()

        Form2.txtload.Text = Resultload
        Form2.txtgen.Text = Resultgenerator
        Form2.txtpvparallel.Text = Resultpvparallel
        Form2.txtpvseries.Text = Resultpvseries
        Form2.txtpvtotal.Text = Resultpvtotal
        Form2.txtpvop.Text = Resultpvoutput
        Form2.txtbattype.Text = Resultbatterytype
        Form2.txtbatvoltage.Text = Resultbatteryvoltage
        Form2.txtbatcapa.Text = Resultbatterycapacity
        Form2.txtbatparallel.Text = Resultbatteryparallel
        Form2.txtbatseries.Text = Resultbatteryseries
        Form2.txtbattotal.Text = Resultbatterytotal


    End Sub

    Private Sub Label5_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Label5.Click

    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        Me.Close()
    End Sub

    Private Sub Calculator_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        txtloadenter.Text = ""
        combolocation.SelectedIndex = -1
        combosunshine.SelectedIndex = -1
        txtrainy.Text = ""
        txtgenenetor.Text = ""
        combobat.SelectedIndex = -1
        comboeffciency.SelectedIndex = -1

    End Sub
End Class
```

Form 2

```
Public Class Form2

    Private Sub PictureBox1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs)

    End Sub

    Private Sub GroupBox2_Enter(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles GroupBox2.Enter

    End Sub

    Private Sub TextBox10_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatparallel.TextChanged

    End Sub

    Private Sub TextBox6_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtpvtotal.TextChanged

    End Sub

    Private Sub Label12_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs)

    End Sub

    Private Sub TextBox8_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatvoltage.TextChanged

    End Sub

    Private Sub TextBox9_TextChanged(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles txtbatcapa.TextChanged

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub
End Class
```

Form 3

```
Public Class Form3

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        Me.Close()
    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click
        'Dim Form1 As New Form
        'Form1.Show()
    End Sub
End Class
```