DESIGNING OF A HYBRID ENERGY BASED POWER GENERATION SYSTEM FOR A RESIDENTIAL BUILDING

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of M.Sc in Electronics and Telecommunication Engineering

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APPROVAL

This Project titled **"DESIGNING OF A HYBRID ENERGY BASED POWER GENERATION SYSTEM FOR A RESIDENTIAL BUILDING."**, submitted by *Md. Hafezur Rahman Chowdhury * to the Department of Electronics and Telecommunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of M.Sc. in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on *February, 2019*.

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DECLARATION

I hereby declare that, this project has been done by me under the supervision of **Md. Taslim Arefin, Associate Professor & Head, Department of ICE** Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Renewable energy sources like solar, wind, biomass, hydropower, geothermal and ocean resources are considered as a natural option for generating clean energy. But the electricity generated from solar and wind is less than the electricity generated by fossil fuels, In spite of that, electricity generation by utilizing PV cells and wind turbine increased rapidly in recent years. This thesis is about analysis of Biomass & Solar PV based hybrid power system for a building. Comparison of hybrid energy system consists of biomass and solar energy with single sourced power system like Biomass and Solar is the main focal point of this work. Enough electricity will be produce by the hybrid system to power up an entire building by processing MSW using direct combustion technique and utilizing solar energy by using Solar PV panels, also added designing of the hybrid power system using renewable energy sources, load analysis for an entire residential building, software analysis for this micro-grid optimization working by Homer Pro software. Moreover, waste management are also within the scope of this thesis along with the Schematic diagrams of the system. This thesis also added designing of the hybrid power system using renewable energy sources, load analysis for an entire residential building, software analysis for this micro-grid optimization working by Homer Pro software. The desired hybrid system is designed to provide approximately 70- 80% of energy from the biomass, 20% from solar PV and the remaining will be reliant on main grid line.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The perception of hybrid power plant is new in Bangladesh. On other hand this energy for producing electricity are exploit developed countries for a long time. Biomass energy grant substantial advantages over other renewable energy. Since Bangladesh is an agronomic country, agricultural crop residues, municipal solid waste and animal manure and which the major origin of Biomass energy system and the unlimited power of solar from sun are abundant in here also. So biomass and solar both will serve as the potential renewable energy sources in Bangladesh and there are huge prospect of these energies to reduce energy crisis in the country. Biomass is a biological matter composed of living, or recently living organisms, which can be burned or broken down by anaerobic and aerobic digestion to produce energy. In a simpler ways the word biomass is a kind of material which derived from plants and crops which use sunrays to grow and it includes plant and animal materials. Wood from forests, leftover material from agricultural and forestry processes, and different kinds of organic industrial, human and animal wastes [1] are the example of biomass. The global renewable energy Biomass energy has rapidly become a vital part and account for an ever-growing share of electric capacity worldwide. It acts as a sustainable renewable energy which can be used again and again to meet up the consumer demand [1].

The system is all about renewable energy generation system. In the system biomass, solar, and grid electricity is connected in a synchronized way. The present generated electricity in Bangladesh is not enough to reduce load shedding. There is a huge disparity between the peak demand and the generated electricity. This situation can be lessen by renewable sources.

1.2 Motivation

Bangladesh has acute electricity problem. Our daily life is hampered by Load shedding. The Current Production of electricity is not enough to prevent load shedding. Between

The peak load demand and the actual produced electricity there is a huge difference. This difference can be minimized by establishing renewable energy sources like biomass, Solar based plant. Therefore the idea of this thesis is to dig into the possibilities of biomass and Hybrid energy for individual residential building.

1.3 Aims and objective

- To increase the power generation.
- To possibilities of Hybrid energy generation in Bangladesh.
- To use MSW for green environment.
- To proper use of solar System.
- To enhancement the efficiency of power generation.

1.4 Report Formation

Chapter 1: The primary idea was given about hybrid generation system. This chapter also describes the motivation, aims and objectives of the thesis. The thesis outline is also described in this chapter.

Chapter 2: This chapter described the history of the biomass and solar energy system. Also the earlier research on it.

Chapter 3: This chapter described the concept of hybrid power generation by solar and biomass. And also described Installation of PV Panels, Conversion power, and Electricity Production.

Chapter 4: This chapter direct combustion technique has been discussed with Combustion and Cooling process

Chapter 5: In This chapter proposed generation model has been discussed with grid model.

Chapter 6: In This chapter proposed power plant model has been shown with Existing Design

Chapter 7: In This chapter methodology of this model has been discussed and also load calculation has been shown.

Chapter 8: In This chapter the simulation, result, grid used, time serious plot Power Production & Consumption has been shown.

Chapter 9: In This chapter comparative analysis has been shown.

Chapter 10: Conclusion.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Bangladesh has big problem of electricity. Load shedding is an exquisite problem that frustrate our daily life. The present production of electricity is not enough to prevent load shedding. Between the peak load demand and the actual electricity generation there is a huge difference. This scenario can be minimized by establishing renewable energy sources like biomass, Solar based plant. Therefore the idea of this thesis is to dig into the possibilities of biomass energy for individual residential building.

2.2 concept of hybrid power plant

Hybrid power plant concept is short of new in Bangladesh. Bangladesh is far away from the energy sector but other developed countries are utilizing this for producing electricity for a long time. Over other renewable energy Biomass energy offers substantial advantages, it reduce dependency on fossil fuel and it is abundant, renewable and clean energy. Since Bangladesh is an agrarian country, agricultural crop residues, animal manure and municipal solid waste which are the major sources of biomass energy system. There is a huge prospect of this energy to minimize energy crisis in the country. Biomass will serve as one of the potential renewable energy sources in Bangladesh.

This thesis explains the imitations, advantages, objectives, motives, theories, previous researches and future scopes related to biomass energy system. Finally the results are discussed at the end. Building construction cost, area, vibration of the turbine etc. are because this is the architect and the civil engineer concern. In Our Country Government declared to provide power to all by 2020 at a reasonable and affordable price. Sustainable social and economic development depends on adequate power generation capacity of a country. Except to increase the power generation there is no other way for development. One of the important strategies adopted as part of Fuel Diversification

Program is Improvement of Renewable Energy. Govt. is looking for various Renewable Energy resources for achieve this target. Renewable Energy has a very small contribution to the total generation under the existing power generation of Bangladesh. The Renewable Energy exceeds more than 1% till now. on developing Renewable Energy resources to improve energy security and to establish a sustainable energy regime alongside of conventional energy sources Government is giving priority. Government has already announced "500 MW Solar Power Mission" to increase the use of Renewable Energy to meet the increasing demand of electricity.

Availability of renewable energy sources in Bangladesh are

i. Solar power
ii. Biomass
iii. Wind power
iv. Tidal power
v. Wave energy
vi. Waste to electric energy
vii. Biogas

Biomass sources can be classified in many ways, for example by origin, or by different characteristics and properties. [3] Biomass can be divided into:

2.3 Biodegradable Waste

Bio-waste is describe as biodegradable garden and park waste, food and kitchen waste from households, comparable waste from food processing plants, restaurants, caterers and retail premises. It does not bring in manure, sewage sludge, forestry or agricultural residues, or other biodegradable waste such as paper or processed wood and natural textiles. It's also eliminate those by-products of food production that never become waste.[4] The list of biodegradable wastes as follows:

- Leaves/Falling Leaves.
- Flowers
- Kitchen waste (wet).
- Animal or Human excreta.
- Seedless fruit.
- Handmade bags.
- Dead animals or Human beings.
- Wood.
- Wires without coating.
- Vegetable Scraps.
- Papers.
- Some forms of plastic made from ingredients such as corn starch.
- Paper Towels/Toilet Paper/Paper Plates/Card-Board boxes.
- Weeds/Grass & plant clippings/plant stakes and plant-based pesticides.

2.4 Sewage

Sewage is a source of biomass that is analogous to the other animal wastes. Using anaerobic digestion, pyrolysis or drying and incineration Energy can be extracted from sewage. All these technologies can be found.

2.5 Organic Municipal Solid Waste (MSW)

Food waste, paper etc. are Organic MSW which is matter to collect from commercial or residential properties. Organic waste, whether from commercial or residential properties, makes up a substantial amount of waste that is land-filled. As with other wastes, it can be converted into energy by various ways.[4]

2.6 Non-Biodegradable Waste

In a reasonable amount of time Non-biodegradable waste is a kind of waste which cannot be disintegrated into its base compounds by micro-organisms, air, moisture or soil. Non-biodegradable waste is threatens to overwhelm landfills and create disposal problems. Figure 2.11 shows different types of non-biodegradable waste. [6]

The list of biodegradable wastes as follows:

- Dry kitchen waste
- Flowers.
- Animal or human excretion
- Seedless fruit
- Handmade bags
- Dead animals or human beings wood

List of non-biodegradable wastes include:

- Plastic products like grocery bags, plastic bags, water bottles, etc.
- Nylon products
- Synthetic products
- Silk products
- Clothes
- Rubber tires.
- Dangerous chemicals and toxins
- Metals, metal cans, tins, metal scraps, etc.
- Construction waste, man-made fibers like nylon etc.
- Computer hardware like glass, CDs, DVDS, cellophane, processed woods, cable wires, Styrofoam etc.

2.7 History of Renewable Energy

Biomass technology is an old thought. It was invented in early 1800 centaury. Regarding biomass technology many experiment were done. The following a brief timeline of incident that have shaped the growth of biomass energy from the 1930s to the present is stated [7]. 1930s Kerosene and fuel oil begin to replace wood as primary energy source. In the United States, ethanol is used to fuel cars well into the 1920s and 1930s.

1930s, for example, more than 2,000 service stations in the U.S. Midwest sell “gasohol” (ethanol made from corn).

1940s After World War II, the ethanol fuel industry closes down in the United States, with the arrival of low-priced, abundant petroleum fuels.

1950s Electricity and natural gas displace wood heat in most homes and commercial buildings.

1970s Concerns about crude oil supplies and environmental quality lead to renewed interest in ethanol and other biomass energy sources. Governments begin to fund research into converting biomass into useful energy and fuels.

1980s High energy prices create new interest in biomass energy in Canada. In Atlantic Canada, for example, large institutions and schools modify district heating systems to run on wood wastes. 1985, the state has 850 megawatts of installed biomass power capacity.

1990s As public concerns about environmental issues such as air pollution and climate change grow, governments in Canada and elsewhere take a greater interest in using renewable energy, such as biomass, to decrease greenhouse gases and other emissions.

1992 The Canadian government grants an excise tax exemption for ethanol used in blended fuels.

2000 A research of 133 countries by the International Energy Agency shows that the biomass share of total energy consumption is 10.5%.
For solar cell technology is also an old thought as it was established in early 1839 centaury. In the following a brief timeline of events that have shaped the growth of biomass energy from the 1990 to the present is stated [8][9][9][10][12]

1990 Germany launches $500MM "100,000 Solar Roofs" program. The Cathedral of Magdeburg installs solar panel on the roof, was the first installation in East Germany

1991 President George H. W. Bush directs the U.S. Department of Energy to establish the National Renewable Energy Laboratory (transferring the existing Solar Energy Research Institute) in Sandia, NM

1994 Japan starts "70,000 Solar Roofs" PV subsidy program

1998 California initiates $112MM " Renewables Program" to fund rebates for <30 kW residential and commercial PV systems

2002 CA Public Utilities Commission begins $100MM "Self-Generation Incentive Program" for >30 kW PV projects

2004 Sharp, Kyocera, Shell Solar, BP Solar and RWE SCHOTT Solar Five manufacturers account for 60% of the PV market. GE buys Astro power, the last remaining US independent PV manufacturer

2006 The CA PUC demonstrates leadership by outlining what will become the California Solar Initiative (CSI), a 10-year, $3 billion solar subsidy program.

2007 The CSI program begins and is well received by the market, with higher than expected application volume.

2008 Your company joins the fast-growing list of California business leaders who adopt solar power for their business with Sunlight Electric.

CHAPTER 3

PROCESS DESCRIPTION OF BIOMASS, SOLAR PV TECHNIQUE, AND HYBRID GENERATION

3.1 Introduction

In this chapter the full process description about Biomass, solar PV and Hybrid Power Generation has been described.

3.2 Process Description of Biomass

Figure 3.1 shows that collected municipal solid wastes are convey to the combustion boiler.

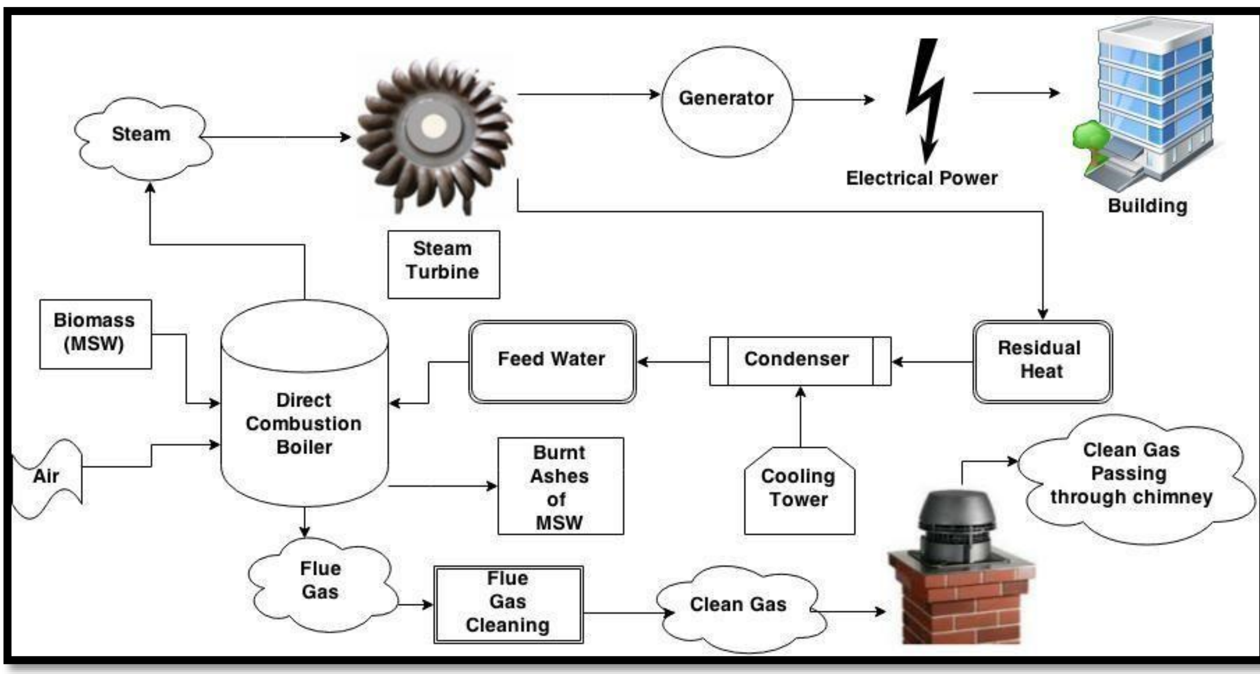


Figure 3.1 Direct Combustion Process.

3.3 Process Description of Solar PV

Photovoltaic (PV) cells also called Solar cells, by scientists, transmute sunlight directly into electricity. In 1954 The PV effect was discovered, when scientists at Bell Telephone discovered that silicon (an element found in sand) created an electric charge when exposed to sunlight. Soon calculators and watches, power space satellites were being used to solar cells. Nowadays, individual solar systems power homes and businesses of thousands of people. For large power stations Utility companies are also using solar technology. Solar panels are used to power homes and businesses are typically made from solar cells combined into modules that hold about 40 cells. About 10 to 20 solar panels are typically can be used to power the home. The panels are mounted south facing at a fixed angle. Also they can be mounted on a tracking device which follows the sun, for capture the most sunlight. Many solar panels combined together and create one system is called a solar array. For large electric utility or industrial applications, hundreds of solar arrays are interconnected.

Conventional solar cells are made by silicon, which are usually flat-plate, and generally are the most efficient. Second-generation solar cells are called thin-film solar cells because they are made from amorphous silicon or non-silicon materials such as cadmium telluride. Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Because of their flexibility, thin film solar cells can double as rooftop shingles and tiles, building facades, or the glazing for skylights.

Third-generation solar cells are being made from a variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics. Plastic lenses or mirrors used some new solar cells to concentrate sunlight into a very small piece of high efficiency PV material. However, because the lenses must be pointed at the sun, the use of concentrating collectors is limited to the sunniest parts of the country. [16]

Here's how the solar energy process works in more detail [17]. It is depicted in Figure 3.1

3.3.1 –Installation of PV Panels

Photovoltaic (PV) panels are placed on the roof. The panels will be north facing, or north-east or north-west facing, so that they are able to capture the most energy possible.

3.3.2 – Collection of Sun's Rays

The solar panels on your roof collect the sun's radiance during the day. They are made of silicon and only need the sun's radiance to work, so even on a cloudy day they will still generate power – albeit with lower production than on clear days.

3.3.3 – Conversion to DC Power (Panels)

PV panels assemble the sun's rays and metamorphose them into DC power.

3.3.4 – Conversion to AC Power (Inverter)

An inverter converts that DC power into AC power.

3.3.5 – Power Is Sent Into the Home

The converted AC power is then supply to the home, where it will power your lights, appliances, or anything else that uses electricity.

3.3.6 – Credit for Unused Electricity

If we can produce more power from the solar system we can actually end up using in home, and the excess power is automatically fed back into the grid. A meter is installed by the power company to monitor how much is being imported or exported during the day so they know how much to charge you at the end of the month.

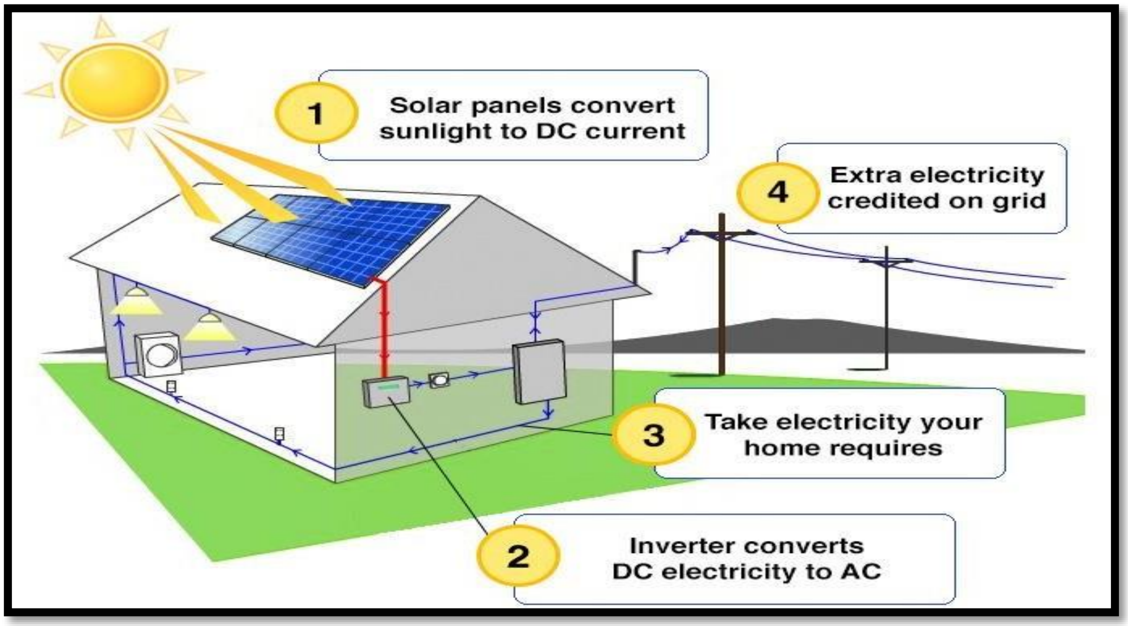


Figure 3.2 Solar System.

3.4 Electricity Production

Solar PVs will be used for solar energy production for the building. In this process solar photovoltaic panel converts the sunrays into electrical power by exciting electrons in silicon cells using the photons of light from sun.[18]Solar panel consumes sunlight and

3.5 Process Description of Solar PV

Produce DC voltage which goes to the solar charge controller. A charge controller is used to maintain the proper charging voltage on the batteries. Since the brighter the sunlight, the more voltage the solar cells produce, the excessive voltage could damage the batteries. As the input voltage from the solar array rises, the charge controller regulates the charge to the batteries preventing any overcharging [19].Lead acid battery is used for store DC voltage that comes from the charge controller. An inverter which is usually known as DC to AC converter is used to convert DC to AC. From Inverter the final electrical power goes to high rise building for powering up the building.

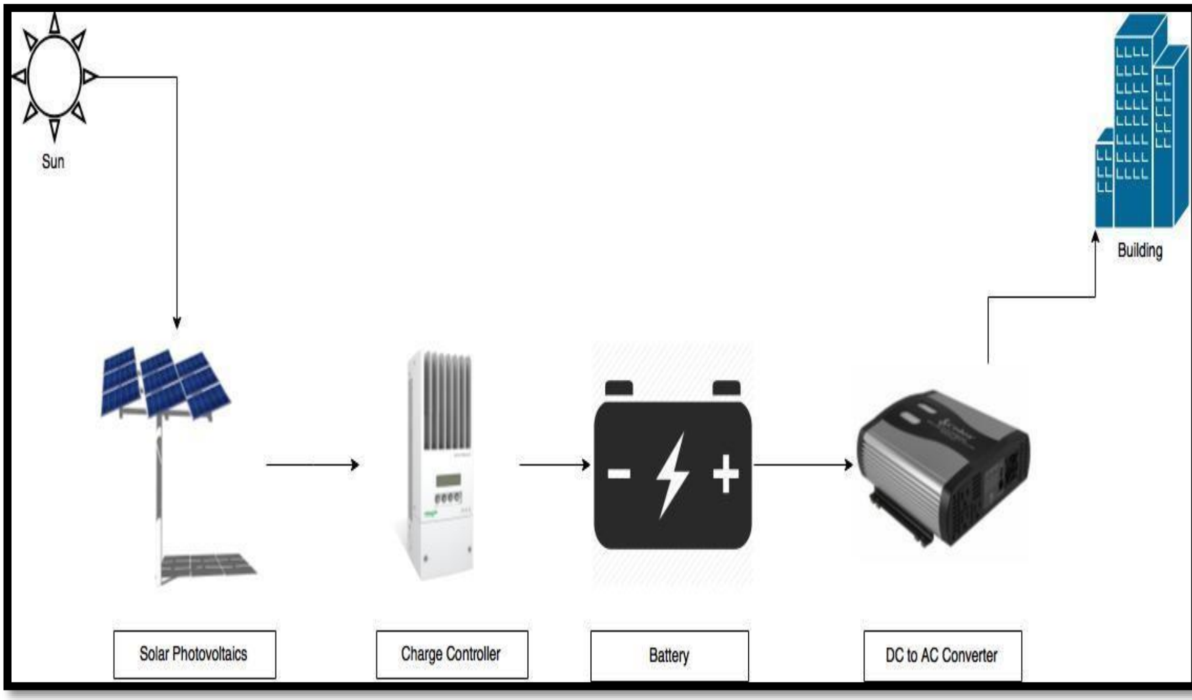


Figure 3.3 Process of Solar PV to Electrical Energy production.

Classification of hybrid system with renewable energy sources (HSRES) According to the availability of conventional energy sources Hybrid systems with conventional sources – mostly the systems, using conventional sources are more powerful and responsible. Hybrid systems without conventional sources – as a general, that kind of systems are relatively low-power and/or tend to be more irresponsible. If the systems are correctly designed and if energy storage is provided, they would be able to generate sustainable energy. These systems are independent of energy sources, which make them especially preferred. Hence, comes the need to develop reliable optimization models. According to the number of the sources – The number of the energy sources is one of the factors that define the complexity of the HSRES as well as its sustainability and efficiency [20].

3.6 Classification of HSRES [21]

According to the conventional energy sources:

- Hybrid systems with conventional sources
- Hybrid systems without conventional sources

According to the type of the produced energy:

- Mechanical
- Electrical
- Thermal
- Mixed

According to the rated power:

- Low power (less than 1 kW)
- Middle power (more than 1 and less than 10 kW)
- High power (more than 10 kW)

According to the energy storage:

- Without storage
- With storage

According to the connection to the distribution grid:

- Grid connected
- Stand alone

Advantages of the System:

- Fuel saving (up to 50%).
- Lower atmospheric contamination.
- Savings in maintenance.
- Silent system.
- Connection to other power supplies (Wind turbines, solar panels, etc.)

CHAPTER 4
DIRECT COMBUSTION TECHNIQUE

4.1 Introduction

Direct combustion hold less chemical reaction than gasification. Combustion is the simple process; but gasification constitutes multi-level process. Various types of venomous gas like CO, SO2 etc. are ejaculate in this method but it can metamorphose it to clean flue gas by using filter. In this method we can get steam outright which will be future requirement for this work. Co-firing method also requisite extra coal, so extra cost will be added [12] [14].

Considering other fact direct combustion technique is selected:

- Combustion method proselytizes solid fuel into gaseous products of combustion through high temperature oxidation reactions.
- Combustion route is noted as a long time technically and commercially.
- Direct Combustion of biomass can be for cogeneration, which produces both heat and electricity [15]

4.2 Combustion and Cooling

MSW passed through the conveyer belt from the waste storage tank to the direct combustion boiler. To extract air to the boiler and burn biomass wastes at a high temperature of 800-1000 degree Celsius a forced draft fan is provided. Into the direct combustion boiler Water is needed to burn the wastes. In that case huge amount of water is provided to store from feed water tank, so that it can immediately provide water in the combustion process . It is showed in Figure 4.1

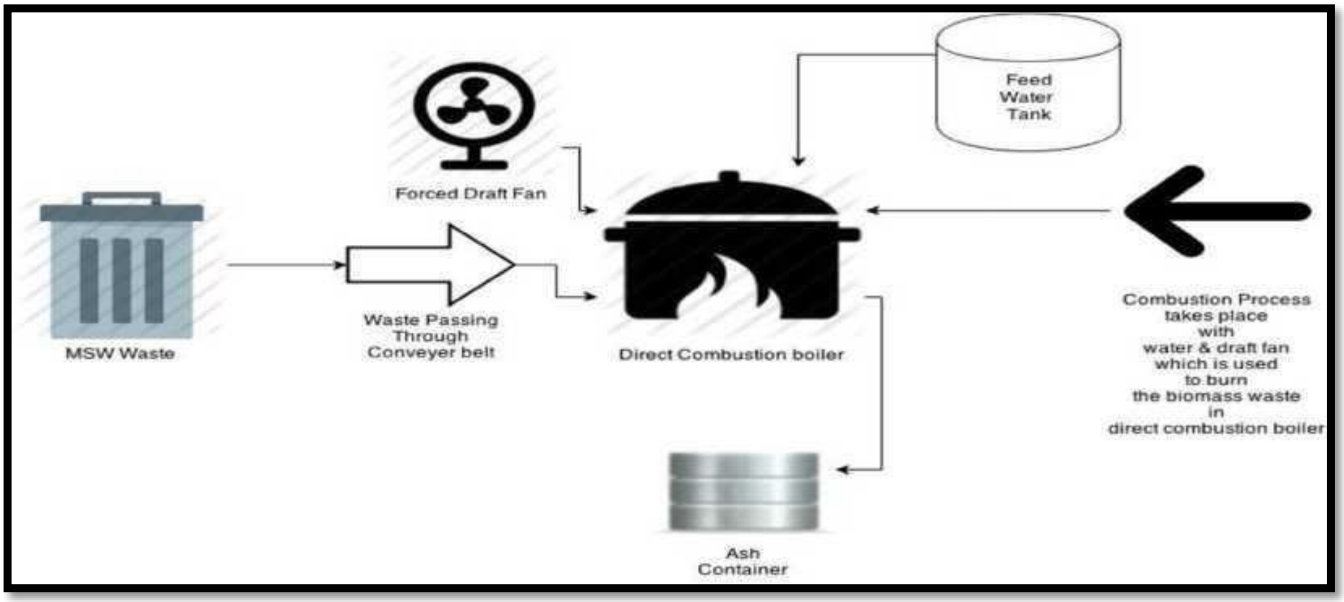


Figure 4.1 Municipal Solid Waste (MSW) Combustion Process.

4.3 Electricity Production

The system will use direct combustion process for biomass waste to energy production. In this process biomass wastes will be store in a storage tank and from this storage tank it will move to direct combustion boiler for combustion. Air is needed for combustion which will be provided by forced draft fan. After completion of combustion we will find steam and flue gas. Steam is required for power generation. It will pass through a steam turbine for mechanically power up the turbine. Then the turbine will mechanically couple to the generator. Generator will produce electrical power from mechanical rotation of turbine. In that case we will use steam turbine genset for electrical power production. Final Electrical power will be provided for powering up the building. Residual heat from the turbine will move to the condenser where it will be cooled by attaching a cooling tower with condenser. Cold water from condenser will be used as feed water that will be provided to the combustion boiler. Flue gas which will be produce as byproduct will be cleaned by using flue gas cleaning system. Clean gas will be moved to the environment through chimney.

CHAPTER 5
PROPOSED GENERATION MODEL

5.1 Introduction

In This chapter proposed Generation model which is generated by HOMER Software has been described.

5.2 Biomass grid model

The whole power plan to primary load connection has been shown in Figure 5.1. Here Direct Combustion Generator (DCG) & Grid has been used for designing the power system of the building. Primary load for building is 1406 kwh/d & peak load is 115kw.
Here Municipal Solid Waste (MSW) has been used as Biomass resource for the generator which had been processed by using direct combustion.

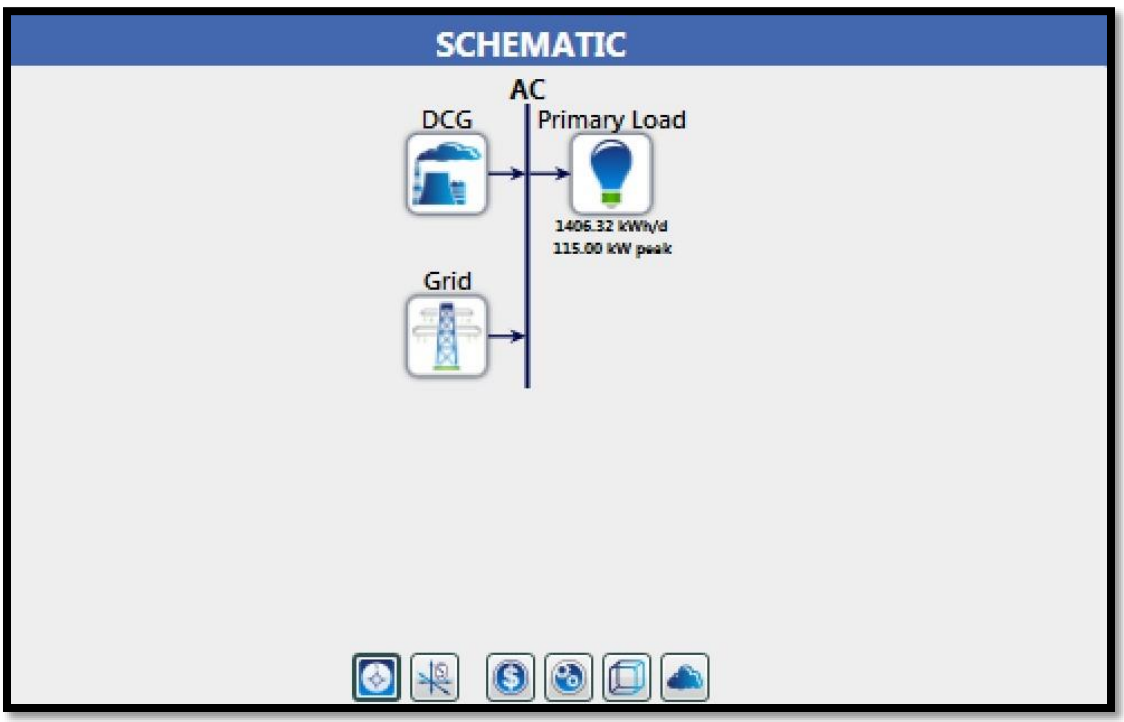


Figure 5.1 HOMER Representation of the System of Biomass.

5.3 Solar Biomass grid model

Figure 5.2 has been shown the schematic model of solar power generation system and grid as backup source which has been generated in homer where primary load is 1406.32 kWh/day and peak is 114.99 kW.

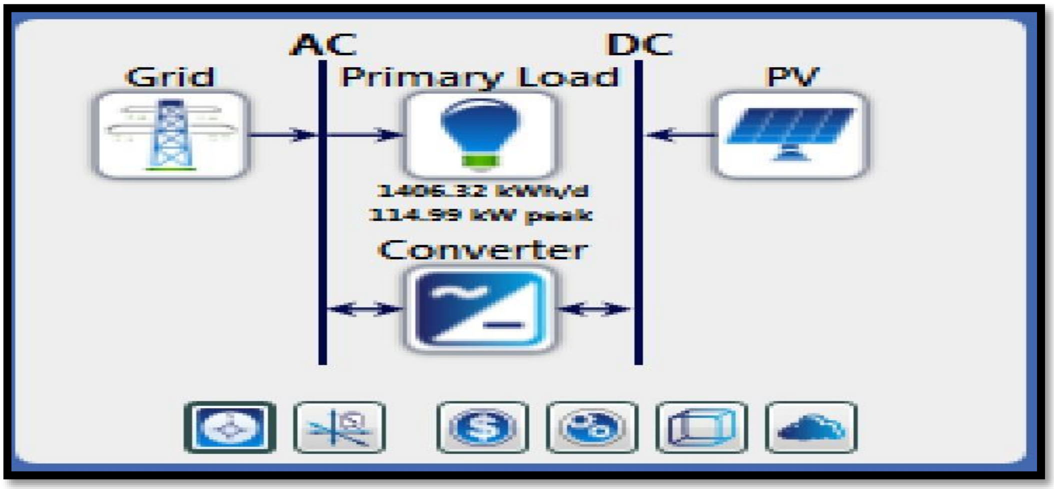


Figure 5.2 System of Biomass HOMER Representation of the System of Solar.

5.4 Hybrid grid model

The schematic diagram simulated in the Homer software has been shown in Figure 7.3 Solar PV is connected with the DC system where a battery is also connected as storage device.

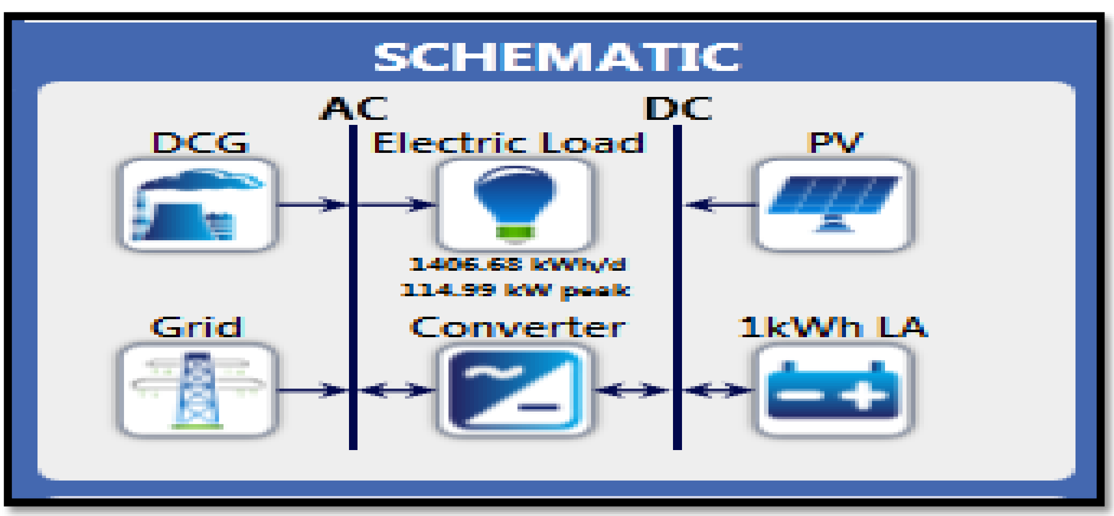


Figure 5.3 HOMER Representation of the System of Hybrid System.

CHAPTER 6
PROPOSED POWER PLANT MODEL

6.1 Introduction

In This chapter proposed Power Plant Model which is designed for the power Generation has been shown. And also the load calculation in summer and winter season has been describe.

6.2 Existing Design of a building

The Existing model of the building section has been shown in Figure 6.1. The solar PV has been located in the rooftop of the building. Ground floor and B 1 is reserved for parking & free space.

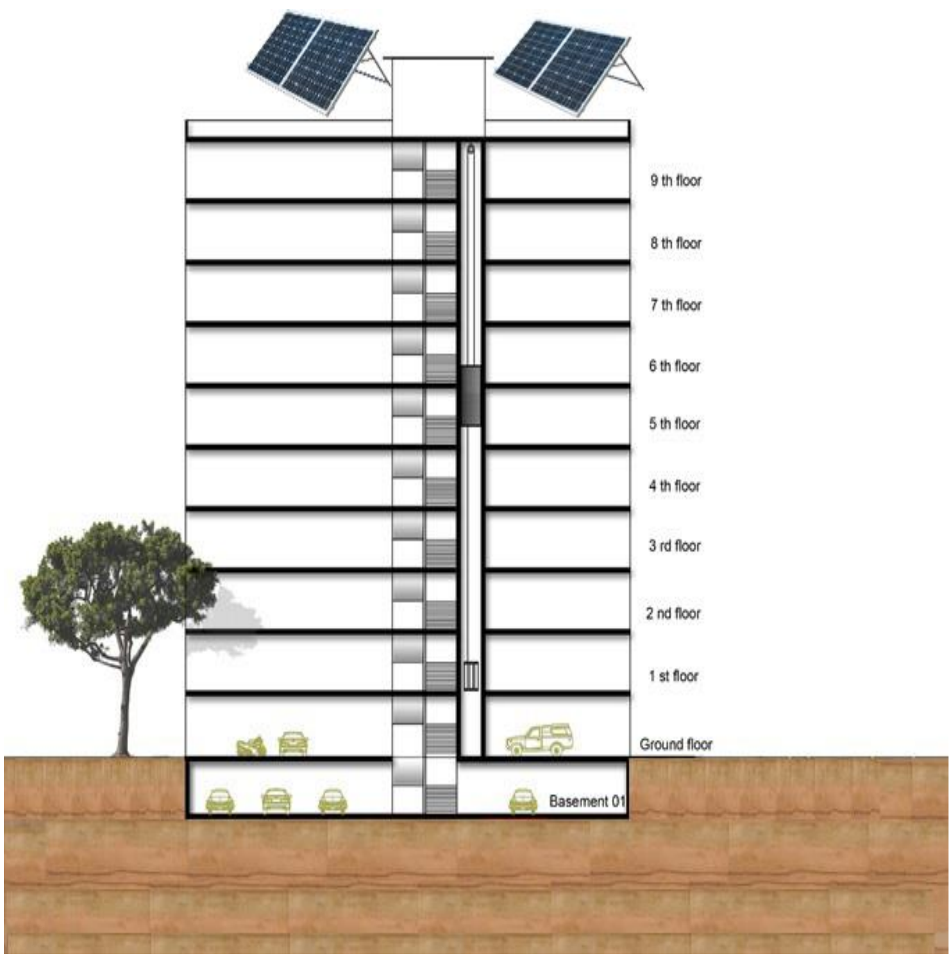


Figure 6.1 Existing Model of the building.

6.3 Proposed Design of a building

The proposed power plant model of the building section has been shown in Figure 6.2.at the underground of the building MSW reserve tank, boiler etc. is placed. At basement 2 Sub-station generator & transformer are placed. Basement 1 & ground floor is reserved for parking & free space. And the solar PV has been located in the rooftop of the building.

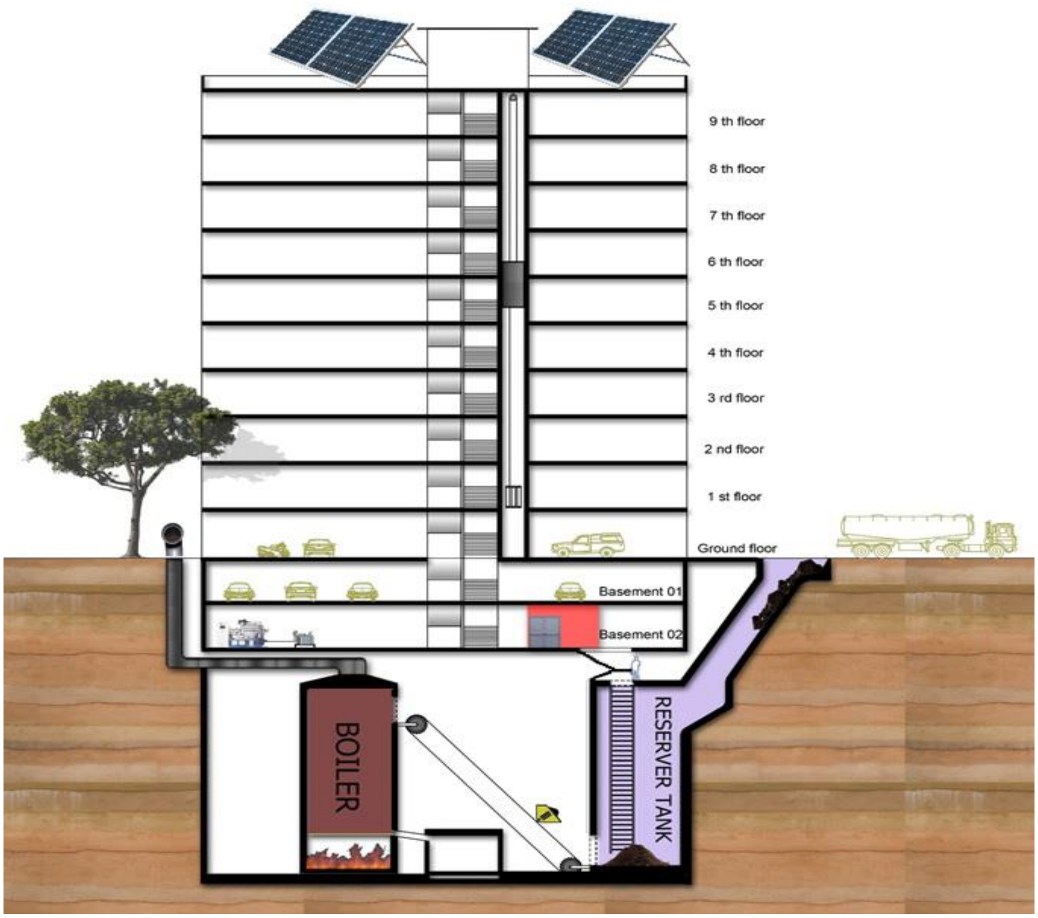


Figure 6.2. Proposed Building Section.

Zoom in section of the proposed building where steps of waste to energy production has been shown in the Figure 6.3. For recognizing the entire model in zoom sections all the sections are marked properly.

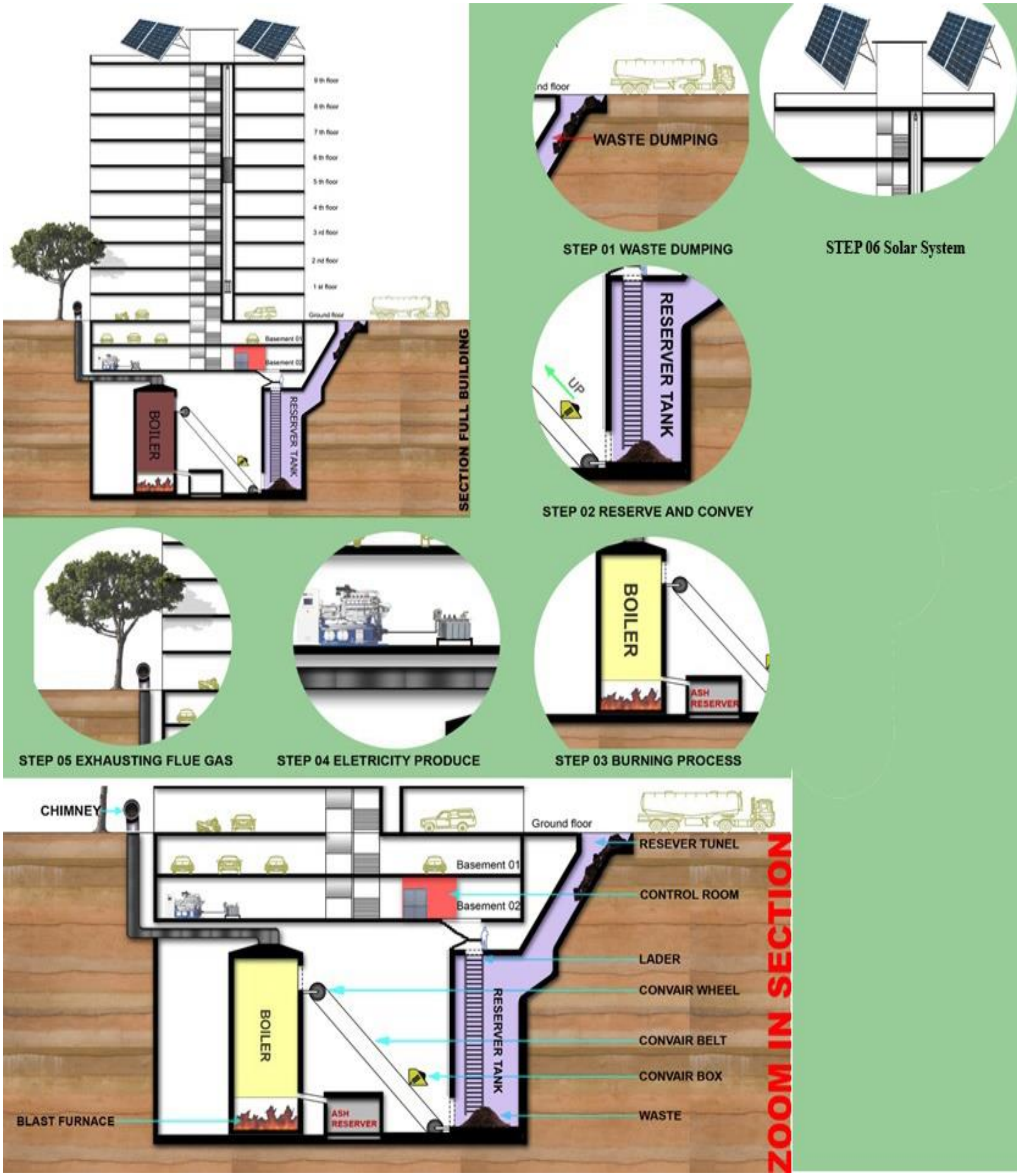


Figure 6.3 Zoom in section of proposed model.

6.4 Load Calculation

Figure 6.4 and Figure 6.5 has been illustrate the load calculation of the full building in summer and winter season. The entire load calculation or both summer and winter has been used in the simulation [23].

Time	Household Appliances	Household Load, watt	Load, KW	Utility load,KW	Utility connected	Total Load for Building (load*20flat+utility) (KW)
00:00 - 01:00	CFL-1 , laptop- 2,lamp-2,Refrigerator,Freezer,AC (.75 ton)-2	2360	2.36	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	49.975
01:00 - 02:00	CFL-1 , laptop- 2,lamp-2,Refrigerator,Freezer,AC (.75 ton)-2	2360	2.36	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	49.975
02:00 - 03:00	CFL-1 , laptop- 2,lamp-2,Refrigerator,Freezer,AC (.75 ton)-2	2360	2.36	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	49.975
03:00 - 04:00	Refrigerator,Freezer	830	0.83	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	19.375
04:00 - 05:00	Refrigerator,Freezer	830	0.83	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	19.375
05:00 - 06:00	Refrigerator,Freezer,cfl-2, exhaust fan,tube-1	915	0.915	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	21.075
06:00 - 07:00	Refrigerator,Freezer,exhaust fan,cfl-2	915	0.915	3.525	2.775+motor(.75 KW)	21.825
07:00 - 08:00	Refrigerator,Freezer,tube-1	830	0.83	20.55	2.775+lift (18KW)	37.15
08:00 - 09:00	Refrigerator,Freezer,tv,AC (.75 ton)-1	1498	1.498	20.55	20.55	50.51
09:00 - 10:00	Refrigerator,Freezer,tv	1498	1.498	29.55	20.55	59.51
10:00 - 11:00	Refrigerator,Freezer,tv	1498	1.498	29.55	20.55	59.51
11:00 - 12:00	Refrigerator,Freezer,laptop-1,iron,tv	1445	1.445	29.55	20.55	58.45
12:00 - 13:00	Refrigerator,Freezer,laptop-1,washing machine,eshaust fan,tv	1525	1.525	29.55	20.55+motor(.75 KW)	60.05
13:00 - 14:00	Refrigerator,Freezer,laptop-1,tv,AC(1Ton)-1	2475	2.475	30.3	2.775+lift (18KW)	79.8
14:00 - 15:00	Refrigerator,Freezer,laptop-1,tv,AC (.75 ton)-1	1695	1.695	29.55	2.775+lift (18KW)	63.45
15:00 - 16:00	Refrigerator,Freezer,laptop-1,AC (.75 ton)-1	1695	1.695	29.55	2.775+lift (18KW)	63.45
16:00 -17:00	Refrigerator,Freezer,laptop-1,oven	2250	2.25	29.55	2.775+lift (18KW)	74.55
17:00 - 18:00	Refrigerator,Freezer,laptop-1,	2250	2.25	26.325	2.775+lift (18KW)+15 cfl	71.325
18:00 - 19:00	Refrigerator,Freezer,laptop-2,tube-5,cfl-1,tv,oven	4300	4.3	26.325	2.775+lift (18KW)+15 cfl	112.325
19:00 - 20:00	rigerator,Freezer,laptop-2,tube-5,cfl-1,tv,AC(1Ton),AC (.75 tor	4300	4.3	26.325	2.775+lift (18KW)+15 cfl	112.325
20:00 - 21:00	rigerator,Freezer,laptop-2,tube-5,cfl-1,tv,AC(1Ton),AC (.75 tor	4300	4.3	26.325	2.775+lift (18KW)+15 cfl	112.325
21:00 - 22:00	rigerator,Freezer,laptop-2,tube-5,cfl-1,tv,AC(1Ton),AC (.75 tor	4300	4.3	26.325	2.775+lift (18KW)+15 cfl	112.325
22:00 - 23:00	rigerator,Freezer,laptop-2,tube-5,cfl-1,tv,AC(1Ton),AC (.75 tor	4300	4.3	26.325	2.775+lift (18KW)+15 cfl	112.325
23:00 - 00:00	rigerator,Freezer,laptop-2,tube-5,cfl-1,tv,AC(1Ton),AC (.75 tor	4300	4.3	26.325	2.775+lift (18KW)+15 cfl+motor(.75 KW)	112.325

Figure 6.4 load calculation for summer.

Time	Appliances	Load(watt)	Load(KW)	Utility load (KW)	utility connected	Total Load for Building (load*20flat+utility) (KW)
00:00 - 01:00 AM	CFL-1 , laptop- 2,lamp-2,Refrigerator,Freezer	810	0.81	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	18.975
01:00 - 02:00 AM	Refrigerator,Freezer,laptop-1,cfl-1	630	0.63	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	15.375
02:00 - 03:00 AM	Refrigerator,Freezer,	530	0.53	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	13.375
03:00 - 04:00 AM	Refrigerator,Freezer	530	0.53	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	13.375
04:00 - 05:00 AM	Refrigerator,Freezer	530	0.53	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	13.375
05:00 - 06:00 AM	Refrigerator,Freezer,cfl-2, exhaust fan,tube-1	655	0.655	2.775	cfl(15*15W),Tube(40*45 W) Pc (3*250W)	15.875
06:00 - 07:00 AM	Refrigerator,Freezer,exhaust fan,cfl-2	615	0.615	3.525	2.775+motor(.75 KW)	15.825
07:00 - 08:00 AM	Refrigerator,Freezer,tube-1	570	0.57	20.55	2.775+lift (18KW)	31.95
08:00 - 09:00 AM	Refrigerator,Freezer,tv	730	0.73	20.55	20.55	35.15
09:00 - 10:00 AM	Refrigerator,Freezer,tv	730	0.73	20.55	20.55	35.15
10:00 - 11:00 AM	Refrigerator,Freezer,tv	730	0.73	20.55	20.55	35.15
11:00 - 12:00 PM	Refrigerator,Freezer,laptop-1,iron,tv	1810	1.81	20.55	20.55	56.75
12:00 - 1:00 PM	Refrigerator,Freezer,laptop-1,washing machine,eshaust fan,tv	1405	1.405	21.3	20.55+motor(.75 KW)	49.4
1:00 - 2PM	Refrigerator,Freezer,laptop-1,tv	2855	2.855	20.55	2.775+lift (18KW)	77.55
2:00 - 3:00PM	Refrigerator,Freezer,laptop-1,tv	810	0.81	20.55	2.775+lift (18KW)	36.75
3:00 - 4:00PM	Refrigerator,Freezer,laptop-1	610	0.61	20.55	2.775+lift (18KW)	32.75
4:00 -5:00PM	Refrigerator,Freezer,laptop-1	610	0.61	20.55	2.775+lift (18KW)	32.75
5:00 - 6:00PM	Refrigerator,Freezer,laptop-1,tube-5,cfl-1,	1050	1.05	20.775	2.775+lift (18KW)+15 cfl	41.775
6:00 - 7:00PM	Refrigerator,Freezer,laptop-2,tube-5,cfl-1,tv,oven	2130	2.13	20.775	2.775+lift (18KW)+15 cfl	63.375
7:00 - 8:00PM	Refrigerator,Freezer,laptop-2,tube-5,cfl-1,tv,	1130	1.13	20.775	2.775+lift (18KW)+15 cfl	43.375
8:00 - 9:00PM	Refrigerator,Freezer,laptop-3,tube-5,cfl-1,tv,	1210	1.21	20.775	2.775+lift (18KW)+15 cfl	44.975
9:00 - 10:00PM	Refrigerator,Freezer,laptop-3,tube-5,cfl-1,tv,	1210	1.21	20.775	2.775+lift (18KW)+15 cfl	44.975
10:00 - 11:00PM	Refrigerator,Freezer,laptop-2,tube-3,cfl-1,tv-2,	1230	1.23	20.775	2.775+lift (18KW)+15 cfl	45.375
11:00 - 00:00 AM	Refrigerator,Freezer,laptop-2,tube-2	970	0.97	21.525	2.775+lift (18KW)+15 cfl+motor(.75 KW)	40.925

Figure 6.5 load calculation for winter.

Common load of the building also the power station utilities calculation Figure 6.4 and Figure 6.5 has been illustrate the load calculation of the full building in summer and winter season In Figure 6.6.

Load	Rating, W	Quantity	Total, W
CFL Light	15	25 (For common area, ground floor and basements)	375
Tube	40	45(Control room and basements)	1800
Computer	250	3 (for control room)	750
Air Conditioner	3000	3 (for control room)	9000

Figure 6.6 Common load calculation.

CHAPTER 7

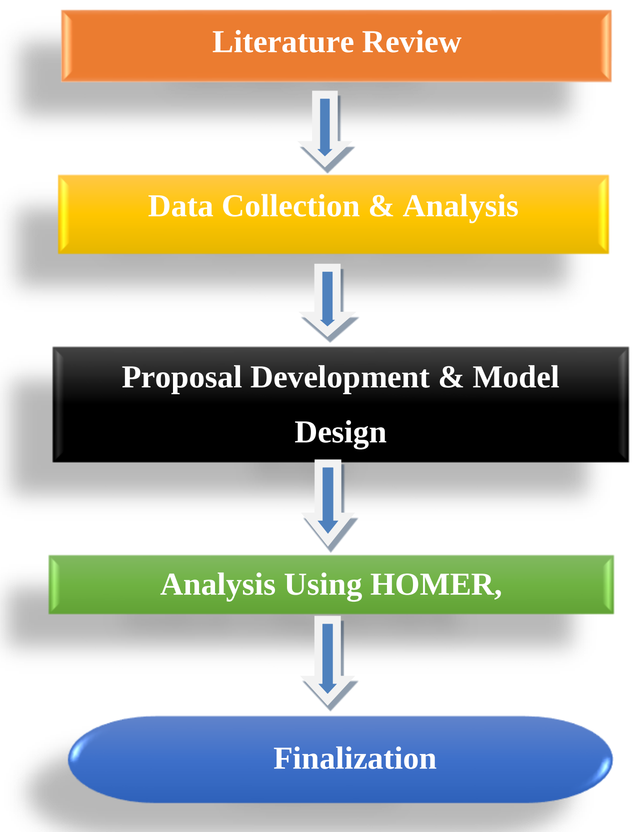
METHODOLGY

7.1 Introduction

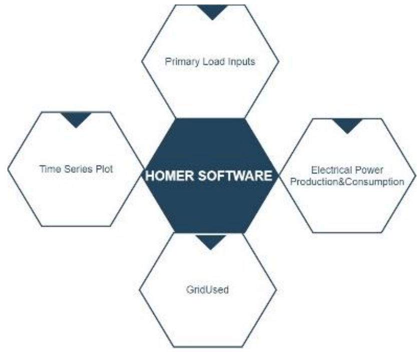
In This chapter the methodology of the simulation has been shown. In the simulation part homer software has been used. We can calculate all the value from homer interface.

7.2 Flow chart of thesis work

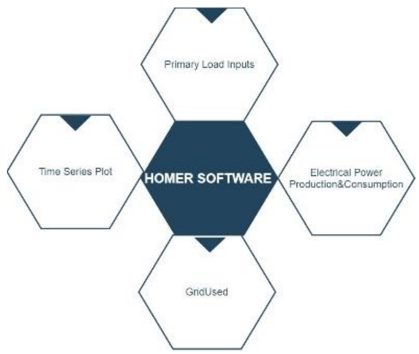
The flow chart of the thesis work has been shown below. In this work literature review was discussed. In literature review discussed about the history of solar power and biomass power generation. After that some data was collected from research or survey work about MSW collection and solar power efficiency in Bangladesh. A new model designed as a proposal of this work which is new in Bangladesh. Homer software was used for the calculation and simulation for this paper.



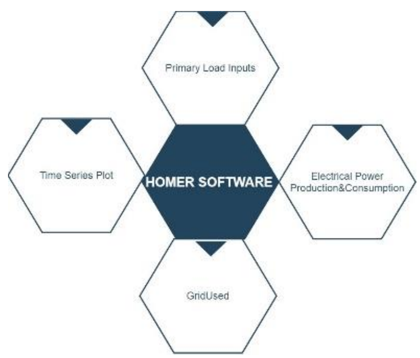
7.3 Designing Biomass Power System



7.4 Designing Solar Power System



7.5 Designing Hybrid Power System

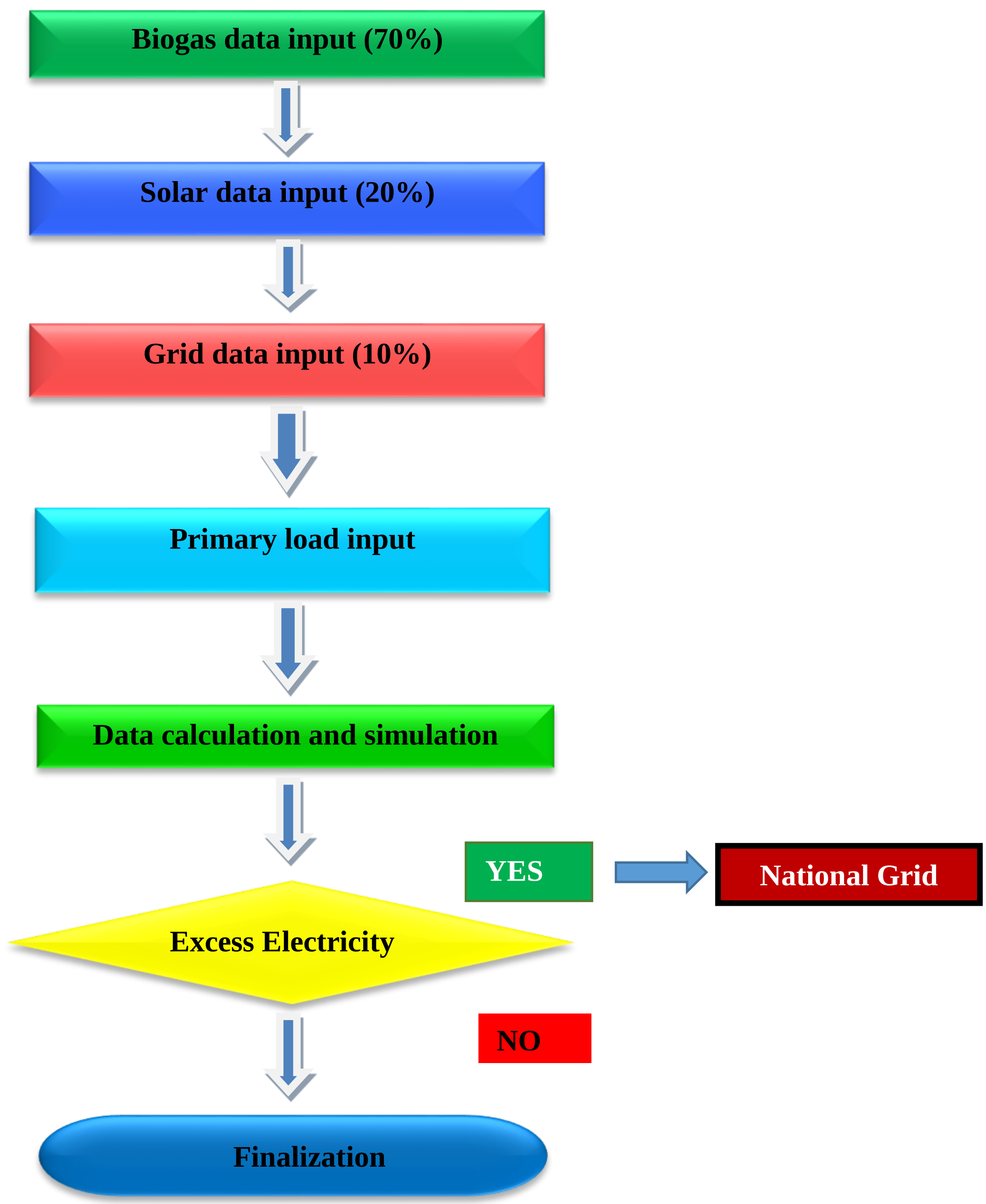


7.6 Load calculation

The System is designed for a residential building. Common load has been considered as fixed load. Some of the load will run every day 24/7 like (fridge and Refrigerator) Total load is = 1399kwh/day, average load is 58.3kw. Common load is 11.925kw/day

7.7 Flow chart of Simulation

The flow chart of the simulation has been shown below. In simulation biogas, solar and grid data was input. Then the primary load of winter and summer was input in the software interface. If excess electricity generate then it will be again supply in national grid.



CHAPTER 8
SIMULATION AND RESULT

8.1 Introduction

In This chapter the simulation and result which is done by homer software has been shown. Also the comparison of Existing results with this model has been shown.

8.2 Biomass Power System

8.2.1 Primary Load Inputs

Figure 8.1 and Figure 8.3 has been shown the Existing model of primary load inputs for two months November- January and another is February to October.

Figure 8.2 and Figure 8.4 has been shown the Proposed Model of primary load inputs for two months November- January & another is February to October.
Hourly variation of loads is low in November to January because winter session remained in that time. Other hand hourly variation of loads is more than November-January in February to October. Since warm weather is staying most of the time in a year in Bangladesh so in that time demand of electricity is higher than winter session. Here Primary Load type is AC.
Baseline data is monthly basis & day type is weekdays. Load has been put in the data table as demand wise for every single hour of a day. Random variability factor consists of day to day which is 0.1% & time step to time step which is 0.6%. Scaled Annual Average is 1399kwh/d. Figure 8.1 and Figure 8.2 Also shows some graphical pictures which are showing Daily Profile, DMap& Seasonal Profile.

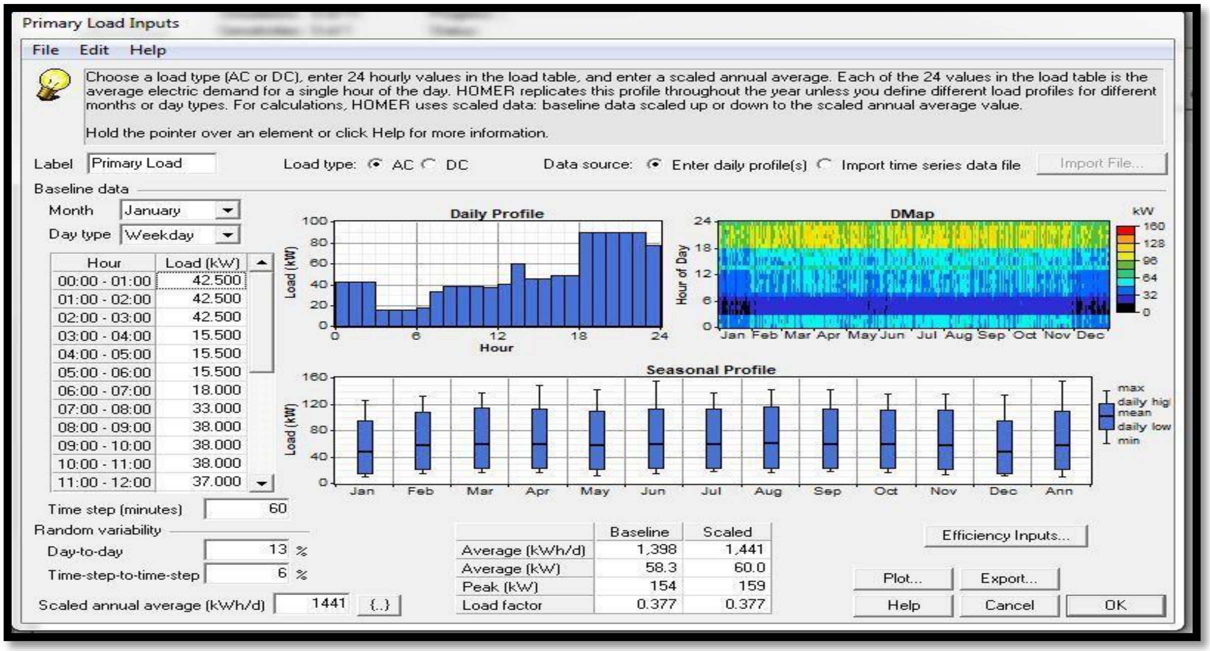


Figure 8.1 Existing Model Primary load inputs (November-January).

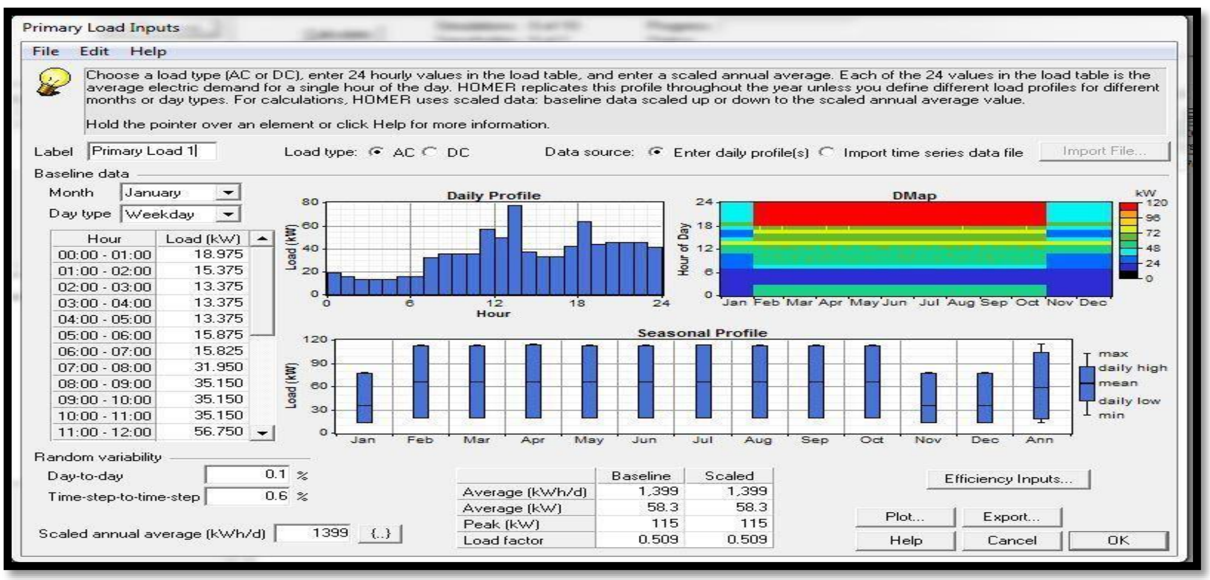


Figure 8.2 Proposed Model Primary load inputs (November-January).

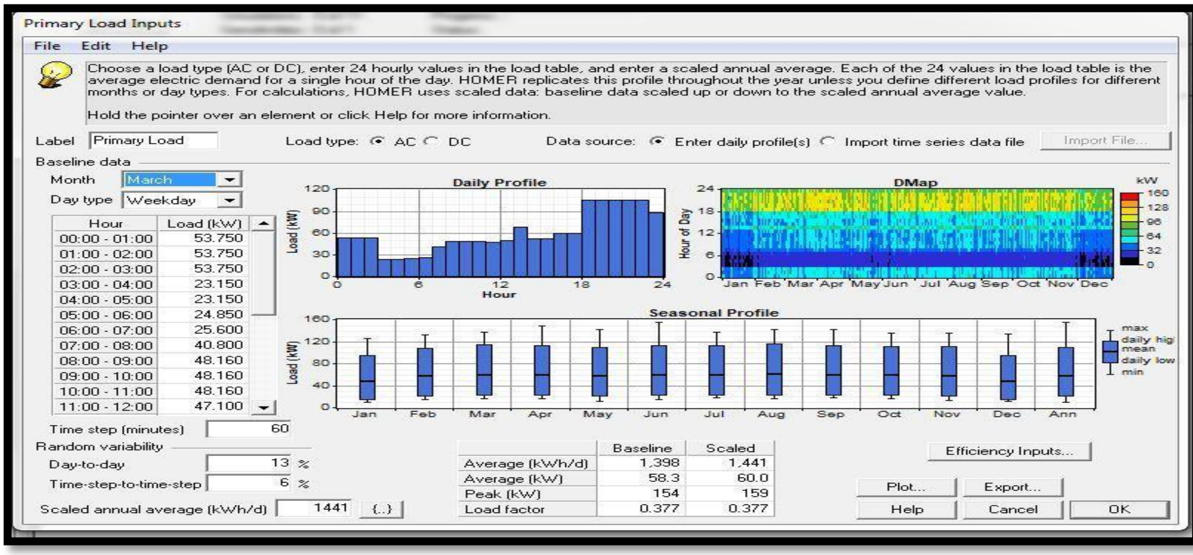


Figure 8.3 Existing Model Primary load inputs (February-October).

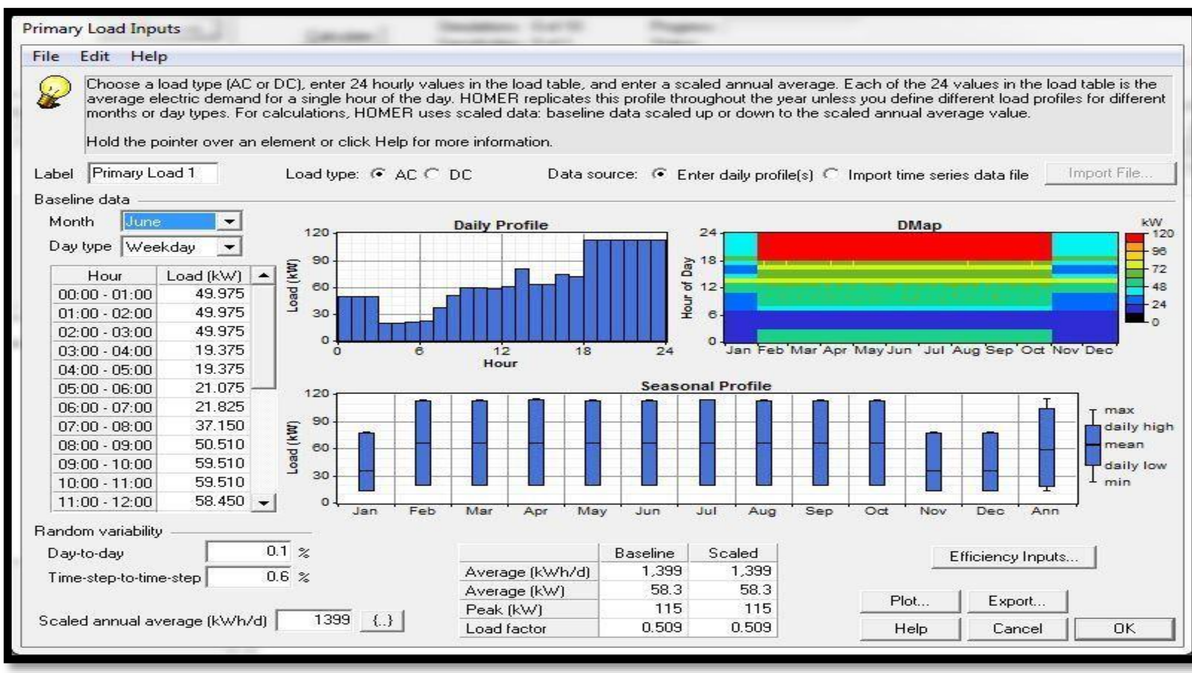


Figure 8.4 Proposed Model Primary load inputs (February-October).

8.2.2 Electrical Power Production & Consumption

Production & consumption of the electrical power per year has been shown in Figure 8.6. Total 513,606kWh/yr power is produce for 100kw direct combustion generator & 18kw grid power system. Where direct combustion generator produces 493,987 kWh/yr & grid power purchases is 20,193 kWh/yr. Electrical power consumption of AC primary load is 513,307 kWh/yr which shows 100% consumption of power production. Other quantity such as excess electricity is 0 kWh/yr, unmet electric load is 0 kWh/yr and capacity shortage is 7.2% which is 36,927 kWh/yr. other renewable fraction and max renewable penetration is 0%. The monthly average electric power production of generator & grid is shows in Data plot.

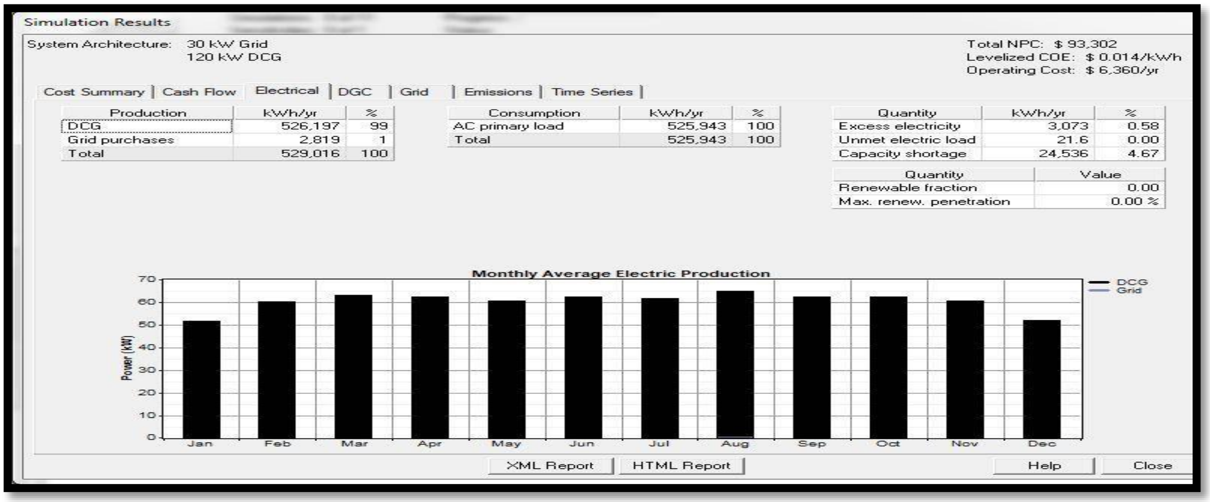


Figure 8.5 Existing Model Electrical Power Production & Consumption.

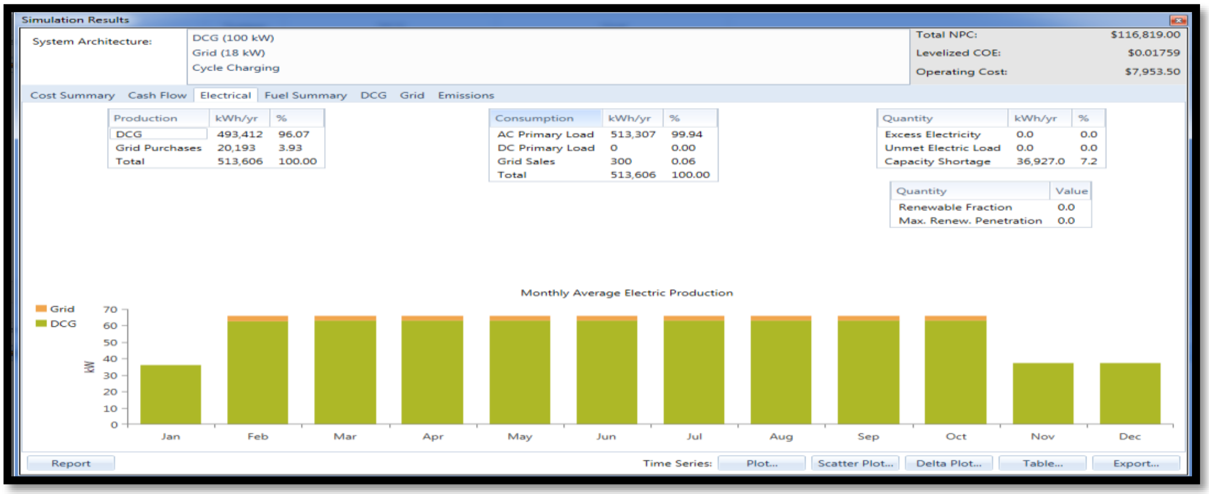


Figure 8.6 Proposed Model Electrical Power Production & Consumption.

8.2.3 Grid Used

The monthly grid purchases, energy sold, net energy purchases, peak demand, energy charge & demand charge for a whole year has been shown in Figure 8.8. Here, annual electricity purchased is 20,193 kWh, energy sold is almost negligible which is 300 kWh, net energy purchases is 19,894 kWh, 15 kW is annual peak demand, and annual energy charge is $1,989.40 & demand charge is $.

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)
January	0	100	-100	0	$0	$0
February	2,050	0	2,050	14	$0	$0
March	2,306	0	2,306	14	$0	$0
April	2,230	0	2,230	15	$0	$0
May	2,282	0	2,282	15	$0	$0
June	2,224	0	2,224	15	$0	$0
July	2,285	0	2,285	15	$0	$0
August	2,320	0	2,320	15	$0	$0
September	2,222	0	2,222	14	$0	$0
October	2,274	0	2,274	14	$0	$0
November	0	99	-99	0	$0	$0
December	0	101	-101	0	$0	$0
Annual	20,193	300	19,894	15	$1,989.40	$0

Figure 8.7 Existing Model Grid use data for whole year.

Simulation Results

System Architecture: 30 kW Grid
120 kW DCG

Total NPC: $ 93,302
Levelized COE: $ 0.014/kWh
Operating Cost: $ 6,360/yr

Cost Summary | Cash Flow | Electrical | DGC | Grid | Emissions | Time Series

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Purchases (kWh)	Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)
Jan	10	0	10	10	1	0
Feb	136	0	136	16	14	0
Mar	342	0	342	21	34	0
Apr	292	0	292	30	29	0
May	210	0	210	26	21	0
Jun	374	0	374	30	37	0
Jul	204	0	204	22	20	0
Aug	532	0	532	26	53	0
Sep	283	0	283	26	28	0
Oct	165	0	165	20	16	0
Nov	213	0	213	19	21	0
Dec	58	0	58	18	6	0
Annual	2,819	0	2,819	30	282	0

XML Report | HTML Report | Help | Close

Figure 8.8 Proposed Model Grid use data for whole year.

8.2.4 Time Series Plot

The hourly variation of all the quantities regarding Grid purchases for the month of January, Direct Combustion Generator (DCG) power & AC primary load, has been shown in Figure 8.10.

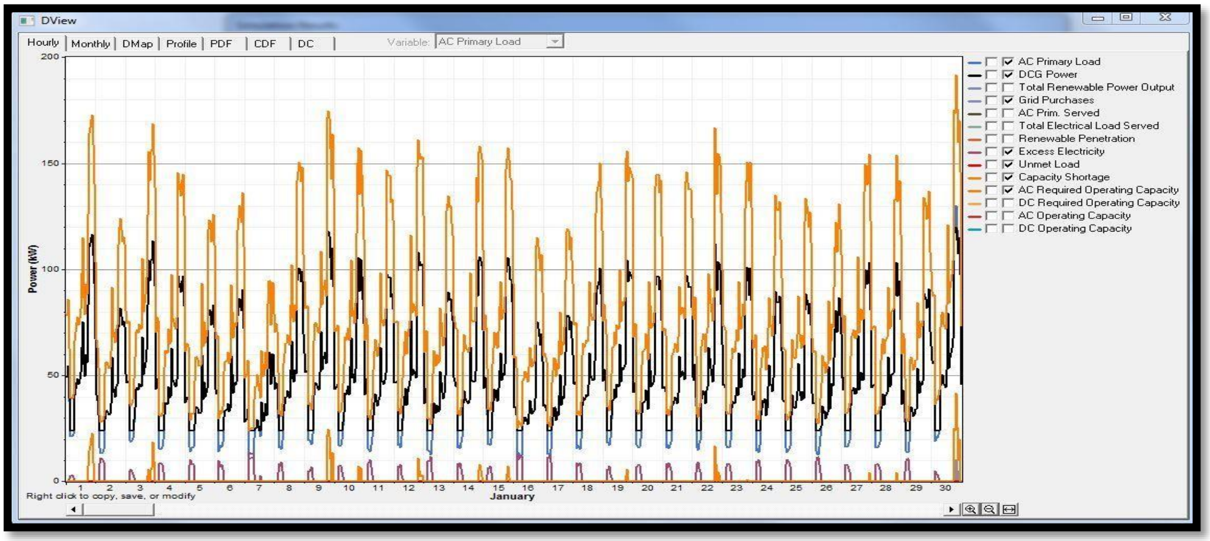


Figure 8.9 Existing Model Time series plot of power production and consumption.

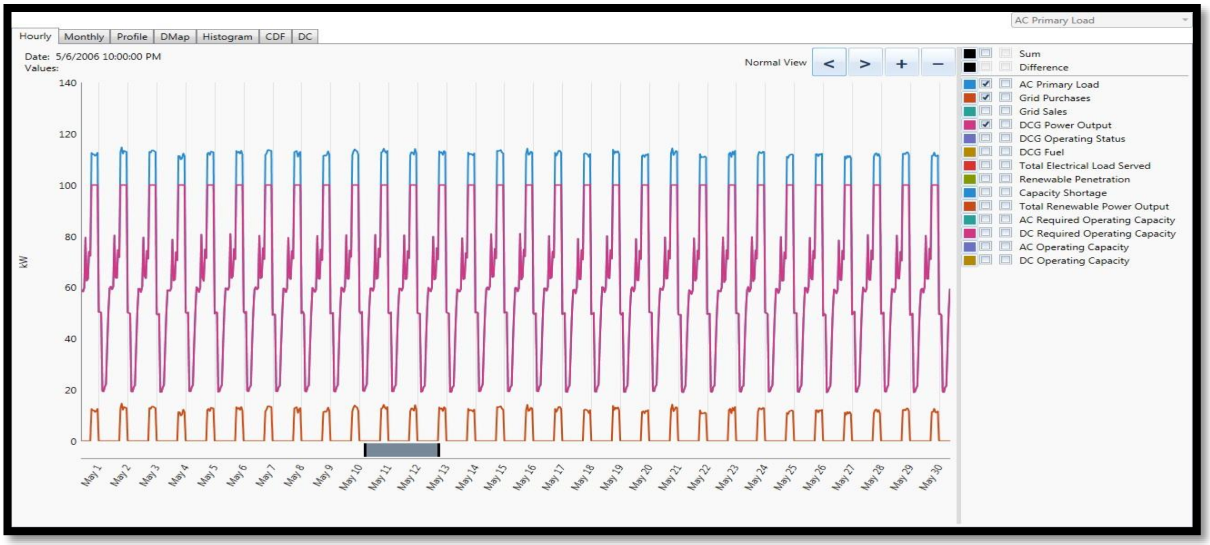


Figure 8.10 Proposed Model Time series plot of power production and consumption

Figure 8.11 has been shown the AC primary load monthly profile in respect of 24 hour time period.

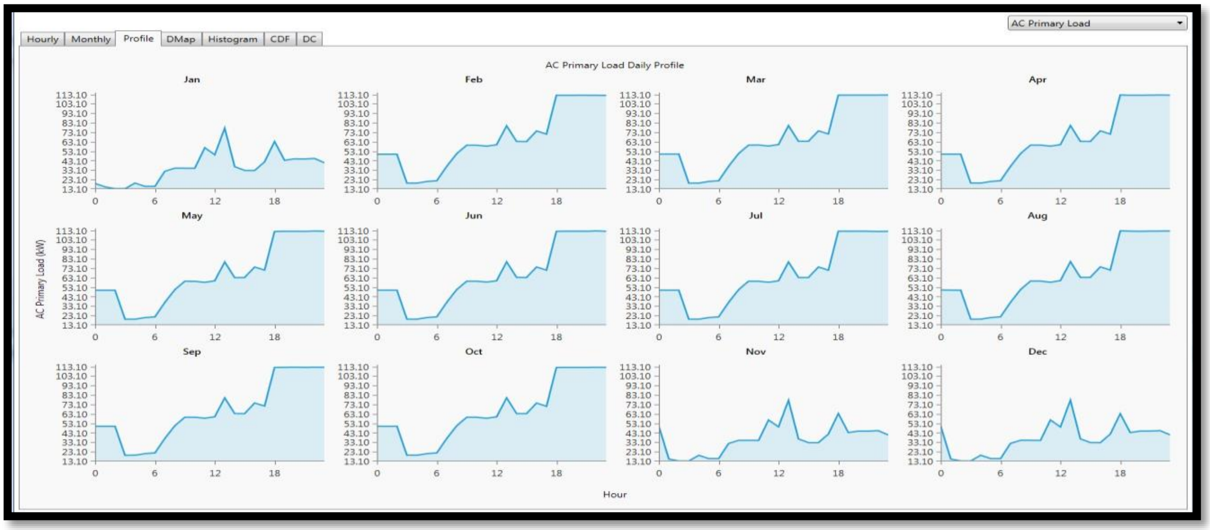


Figure 8.11 Hourly variation of all quantities for 12 months.

8.3 Solar Power System

8.3.1 Electrical Power Consumption & Production

The electrical power consumption & production per year has been shown in Figure 8.12. For 12kW grid & 180KW solar PV along with 150KW System converter based power system total power produces is 673,112kWh/yr. where Solar PV produces 348,117 kWh/yr& grid power purchases is 324,995 kWh/yr. Electrical power consumption of AC primary load is 513,306 kWh/yr which shows 100% consumption of power production. Other quantity such as excess electricity is 138,882 kWh/yr, unmet electric load is 0 kWh/yr and capacity shortage is 0 KWh/yr. other quantities named renewable fraction 36.7% and max renewable penetration is 550.4%. The monthly average electric power production of generator & grid shows in Data plot.

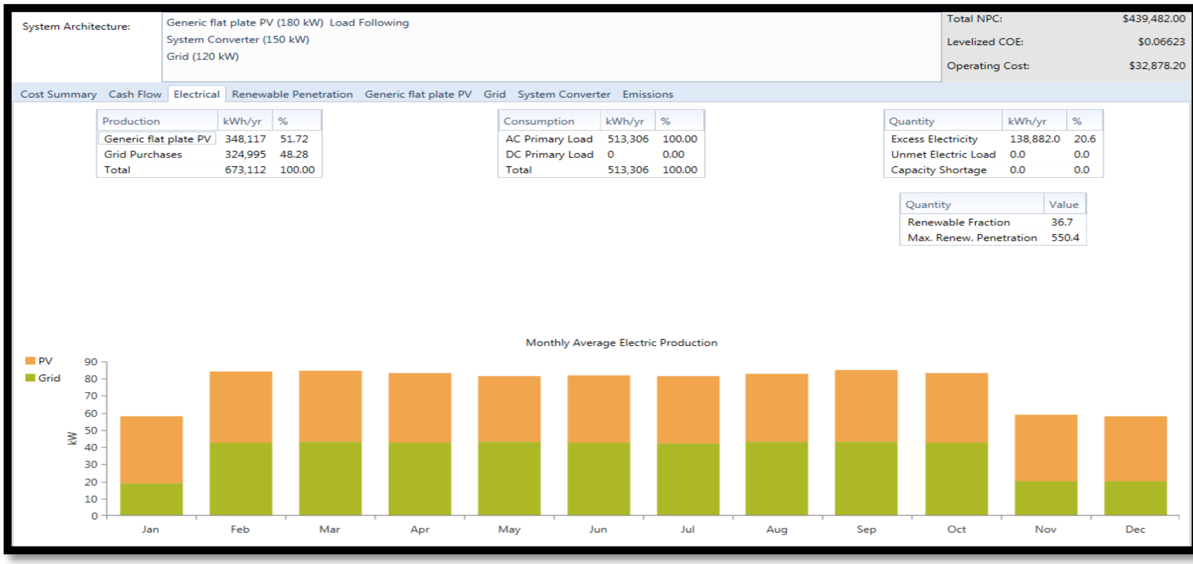


Figure 8.12 Electrical Power Production & Consumption.

8.3.2 Grid Used

Monthly grid electricity purchases, energy sold, net energy purchases, peak demand, energy charge & demand charge for a whole year has been shown in Figure 8.13. Here, annual energy purchased is 324,995 kWh, energy sold is 0 kWh, net energy purchases is 324,995 kWh, annual peak demand is 115 kW, annual energy charge is $32,499 & demand charge is $0.

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)
January	14,212	0	14,212	71	$0	$0
February	28,610	0	28,610	114	$0	$0
March	32,040	0	32,040	114	$0	$0
April	30,674	0	30,674	115	$0	$0
May	32,099	0	32,099	115	$0	$0
June	30,790	0	30,790	115	$0	$0
July	31,613	0	31,613	115	$0	$0
August	32,145	0	32,145	115	$0	$0
September	31,242	0	31,242	114	$0	$0
October	31,921	0	31,921	114	$0	$0
November	14,609	0	14,609	65	$0	$0
December	15,040	0	15,040	72	$0	$0
Annual	324,995	0	324,995	115	$32,499.00	$0

Figure 8.13 Grid use data for whole year.

8.3.3 Time Series Plot

Figure 8.14 has been shown the hourly variation of all the data regarding AC primary load, Solar PV power output and grid electricity purchases for the month of May.

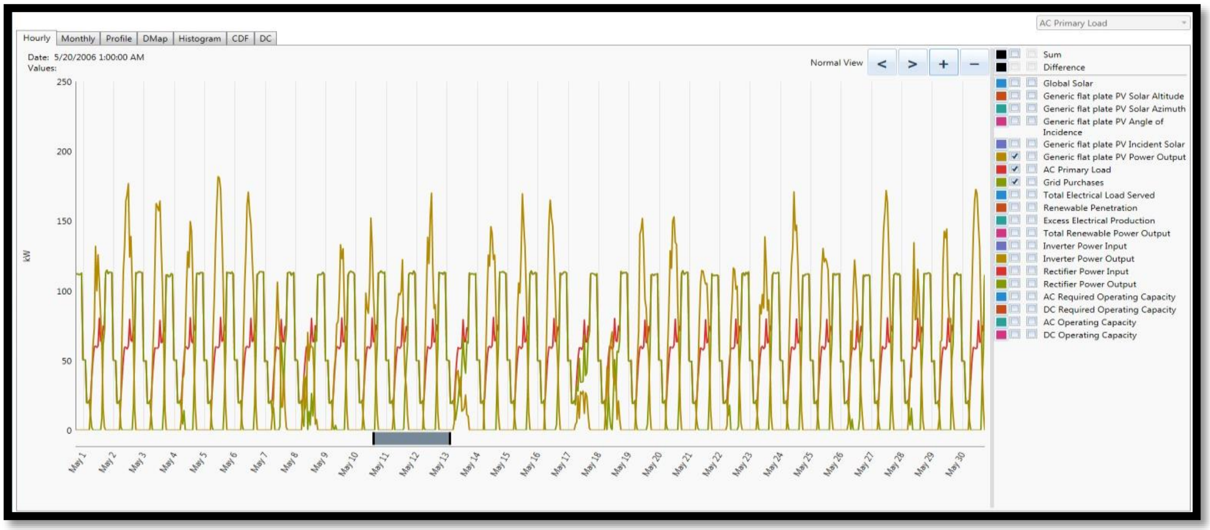


Figure 8.14 Time series plot of power production and consumption.

Figure 8.15 has been shown the AC primary load monthly profile in respect of 24 hour time period.

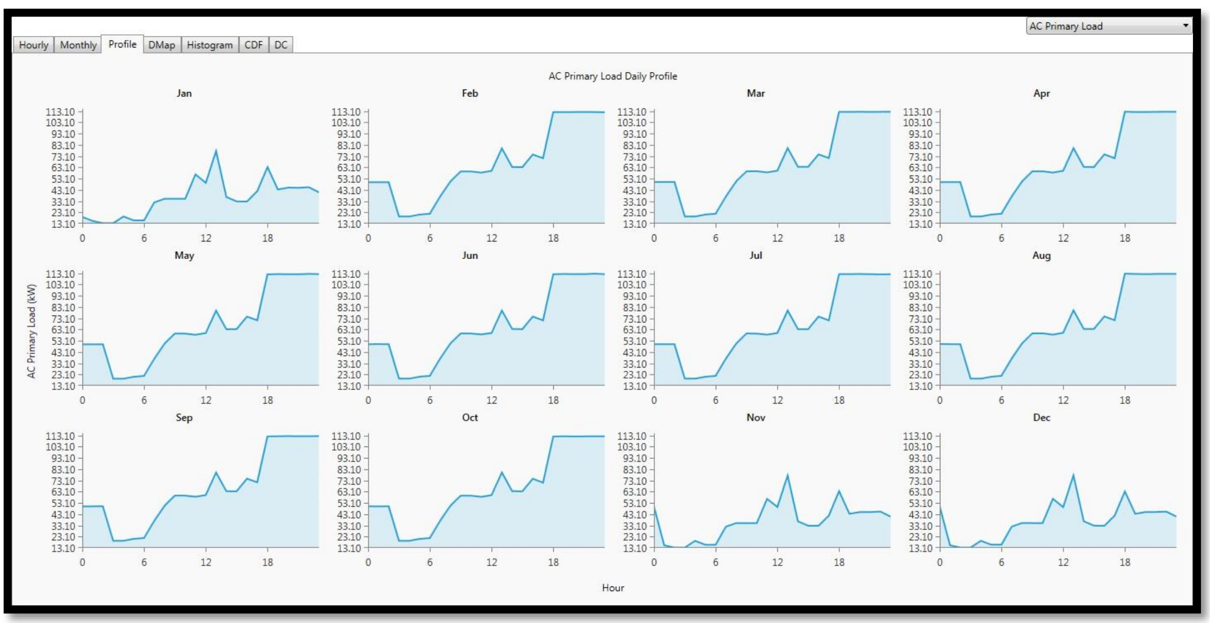


Figure 8.15 Hourly variation of all quantities for 12 months.

8.4 Hybrid Power System

8.4.1 Electrical Power Consumption & Production

Figure 8.16 has been shown the electrical power consumption & production per year. For 20kW grid & 100kW direct combustion generator (DCG) and 70KW solar PV power system. Total power generation is 526,519 kWh/yr. where direct combustion generator(DCG) produces 377,516 kWh/yr& grid power purchases is 35,000 kWh/yr. Electrical power consumption of AC primary load is 513,438 kWh/yr which shows 100% consumption of power production. Other quantity such as excess electricity is 1,867.3 kWh/yr, unmet electric load is 0 kWh/yr and capacity shortage is 0.0 % which is 0.0 kWh/yr. other quantity named renewable fraction and max renewable penetration is 19.7 and 179.4. Monthly average electric power production of grid & generator shows in Data plot.

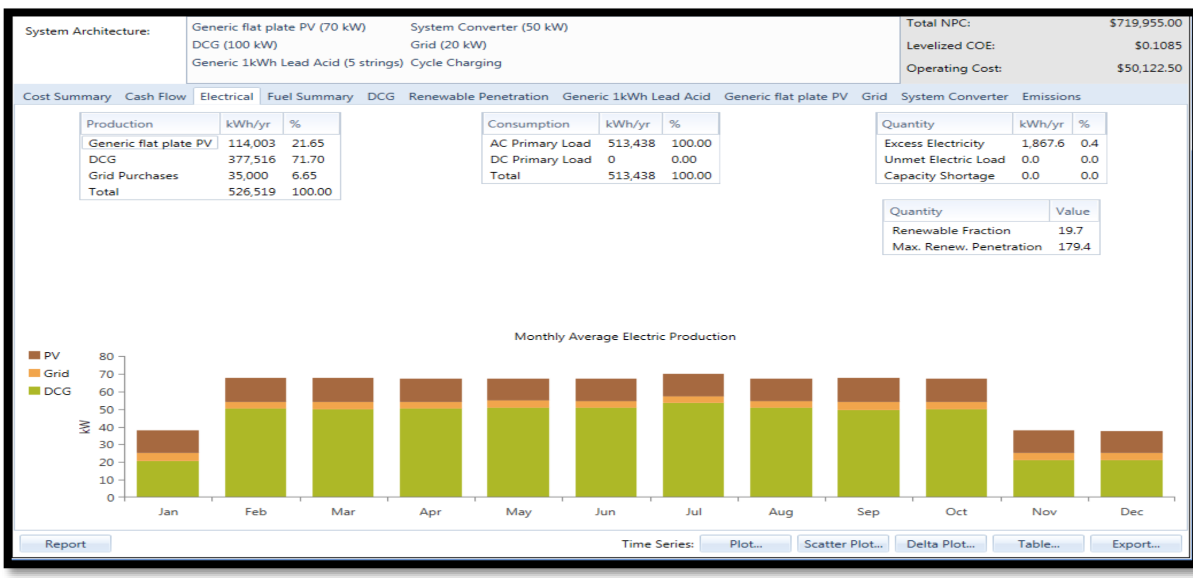


Figure 8.16 Electrical Power Production & Consumption.

8.4.2 Grid Used

Figure 8.17 has been shown the monthly grid electricity purchases, energy sold, net energy purchases, peak demand, energy charge & demand charge for a whole year. Here, annual energy purchased is 35,000 kWh, energy sold is 0 kWh, net energy purchases is 35,000kWh, annual peak demand is 17 kW, annual energy charge is $3,500 & demand charge is $0.

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)
January	3,184	0	3,184	16	$0	$0
February	2,527	0	2,527	16	$0	$0
March	2,926	0	2,926	16	$0	$0
April	2,850	0	2,850	17	$0	$0
May	2,830	0	2,830	17	$0	$0
June	2,752	0	2,752	16	$0	$0
July	2,802	0	2,802	16	$0	$0
August	2,771	0	2,771	16	$0	$0
September	3,213	0	3,213	17	$0	$0
October	3,054	0	3,054	17	$0	$0
November	2,905	0	2,905	17	$0	$0
December	3,187	0	3,187	16	$0	$0
Annual	35,000	0	35,000	17	$3,500.00	$0

Figure 8.17 Grid use data for whole year.

8.4.3 Time Series Plot

Figure 8.18 has been shown the hourly variation of all the data regarding AC primary load, Direct Combustion Generator (DCG) power output, Solar PV power output and grid electrical purchases for the month of May.

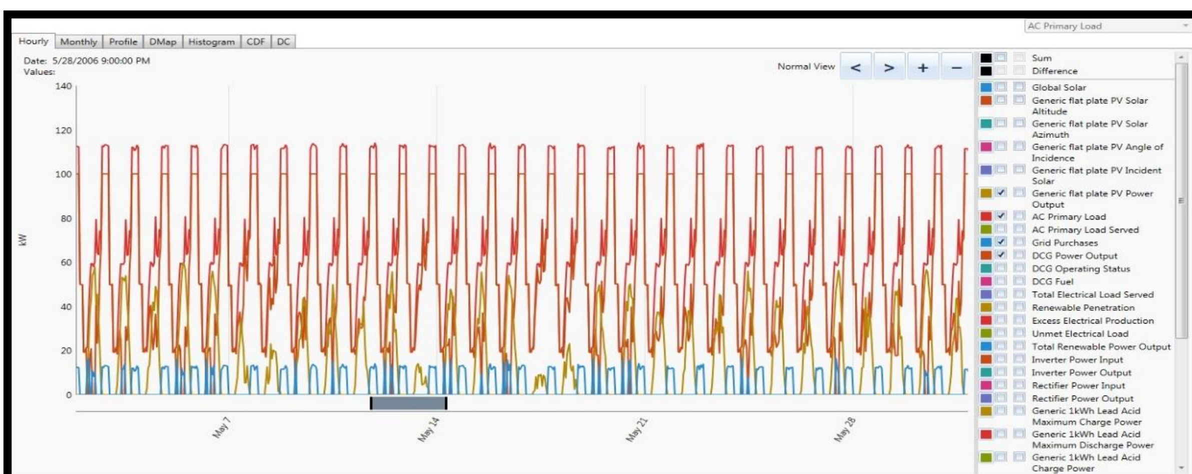


Figure 8.18 Time series plot of power production and consumption.

Figure 8.19 has been shown the AC primary load monthly profile in respect of 24 hour time period.

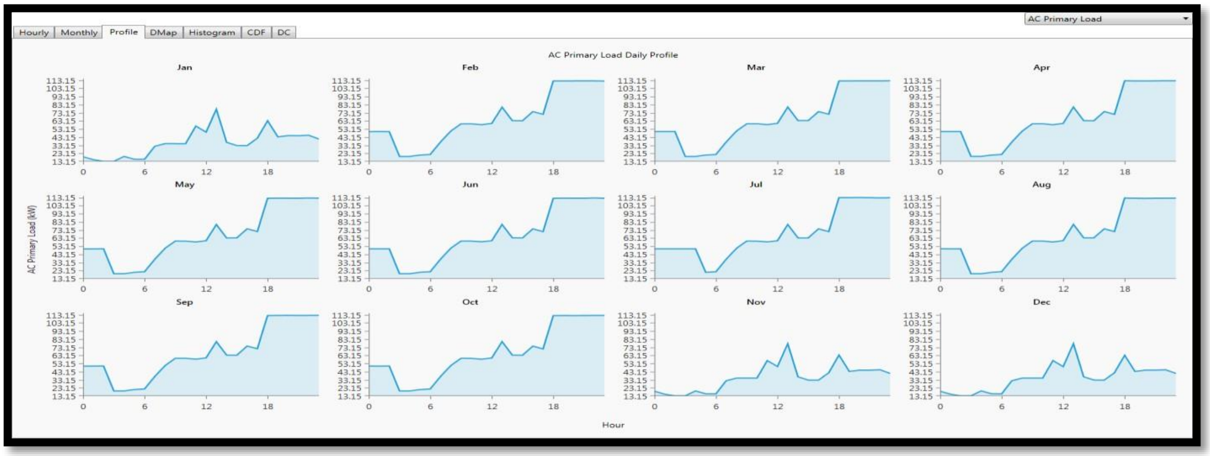


Figure 8.19 Hourly variation of all quantities for 12 months.

8.4.4 Hybrid System Architecture

Figure 8.20 Hybrid System Architecture.

Figure 8.21 this graph has been shown the percentage of different source generation with their respective cost of production. It's so clear that the PV/Photovoltaic will cost almost half of biomass production cost whereas grid production cost is not the concern anymore rather the negligible purchase cost of 6.65% of production. Moreover it also proves that Biomass and PV generation are enough to meet the maximum demand of the building in any typical situation.

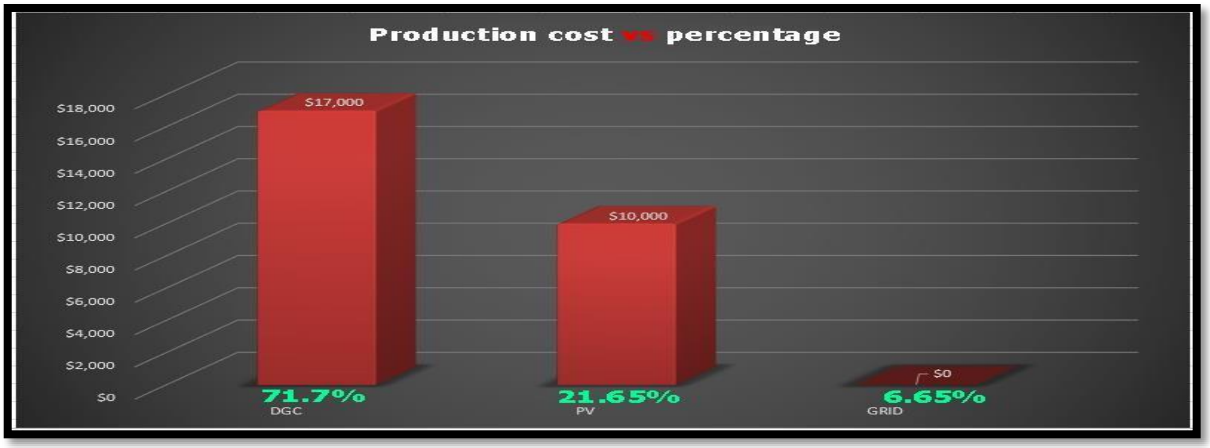


Figure 8.21 bar diagram of production cost vs percentage.

Usually it's more convenient to expect the overall Electricity consumption and production will reach as high as possible with optimize annual cost. Luckily the graph shows the best outcome in this case. So, according to the graph almost half of energy can be saved in the PV batteries after meeting the annual load demands. In such a way there will be an opportunity to ensure the safety measures in unwanted shutdown of any generation source.

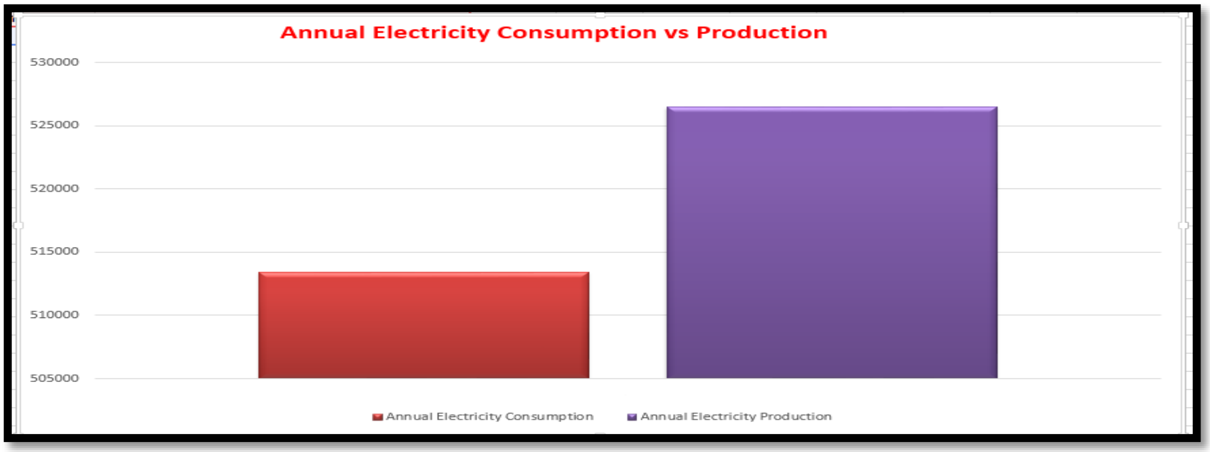


Figure 8.22 bar diagram of annual electricity consumption vs. production.

CHAPTER 9
COMPARATIVE ANALYSIS

The main comparison of biomass, solar and hybrid system has been shown [24] [25] [26] [27]

Biomass Power System	**Solar PV Power System**	**Hybrid Power System**
Advantages: 1) Abundant and Renewable Resource: Biomass resources are available all over the world. Besides, Biomass energy is generated from organic material, plant or animal waste, which is burned to provide energy, e.g. heat & electricity. Since they come from living sources, these products potentially never run out which makes biomass a renewable energy source. 2) Emission Free: As decent flue gas cleaning system has been developed now a day for biomass based power plant so no harmful emission can be produced from this power generation system.	**Advantages:** 1) Low Installation and Maintenance Cost: Installation and maintenance cost of solar system is lower than other conventional power systems. 2) Low Emission: Solar Power systems has low emission rate than other fossil fuel based power systems. 3) Renewable Source: As there is endless and cost- free availability of solar energy so Itis a completely renewable resource based energy generating system. 4) Maintenance Requirement: For Solar based power system, little maintenance work	**Advantages:** 1) Multiple Power Source: As hybrid power system is a combination of one or more power generation system so if one system is off due to maintenance or fault then other system constantly provide power for primary loads. 2) Reliability: Now a day's hybrid system is more reliable source of power for commercial and residential users. As a result, dependency on one- sided energy source is getting reduced by the users. 3) Greater Efficiency: Combination of multiple power generation sources actively efficient in terms of electricity production for commercial, industrial and residential users. For Example: Hybrid system such as Solar- Biomass power generation system jointly produces more than 80%

a result, it helps to develop a sustainable power generation system for this modern world. 3) Reduce landfills: It can take waste that is harmful to the environment and turn it into something useful is another benefit of this energy. 4) Reduce Dependency on Fossil Fuels: As an advantageous source of energy it helps to reduce the dependency on fossil fuel based energy sources. As a result, commercial and residential users are depending less on non-renewable energy sources for the betterment of future world.	Is required. So, it becomes one of the burden free power generating system among other conventional power systems. 5) Noise Free: Solar system makes absolutely no noise at all. They do not make a single peep while extracting useful energy from the sun.	Of total power where grid is only used for backup power source. 4) Various Applications: hybrid power system is not only a necessary source of energy to meet up load demands of primary loads but also an important source of power for various kind of hybrid system like hybrid vehicles, electric concept cars and off-grid power systems.

Disadvantages:	Disadvantages:	Disadvantages:
1) Consume more Fuels: Continuous supply of biomass is required to generate biomass energy. So, Fuel Consumption rate is high for biomass based power plant. 2) Inefficiency: Biomass fuels based power system are Inefficient as Compared to Fossil Fuels based power systems. 3) Land Requirement: Biomass combustion based power plant requires more land for combustion process. 4) Transportation and Management difficulties: Biomass transporting to generating plant and proper management of Biomass wastes and resources are difficult for The biomass power system. 5) Expensive: Biomass based power plants are economically expensive to install and maintenance.	1) Availability of Sunlight: As solar energy is available only during daytime so solar power cannot be created during night time. 2) Land Requirement: Require huge area to install solar system. For Example: installing a solar power generation system for a residential building, a huge rooftop area is required for precise installation. 3) Low Efficiency: Efficiency rate is comparatively lower than other power generation system. Most solar panels have a 40% efficiency rate which means 60% of the sunlight gets wasted and is not harnessed because all the light from the sun is absorbed by the solar PV. 4) Primary Cost: The primary cost of purchasing and installing solar panels for a solar system is bit high. 5) Expensive Energy Storages: Solar Energy storages are quite expensive and bulky.	1) Huge Area Requirement: For installing hybrid energy system such like combination of solar and biomass energy system a huge land and rooftop area is required to setup the power generation system precisely. 2) Higher Installation Cost: A large amount of capital is required for installing a hybrid energy system. 3) Manpower Requirement: Lots of people are required to operate the entire power system in a very proper way. 4) Backup Requirement: In case the whole power system undergoes maintenance work or fault occurs then an alternative power generating source is required to run the system without any interruption

Figure 9.1 has been shown the bar diagram of the production of proposed hybrid generation model.

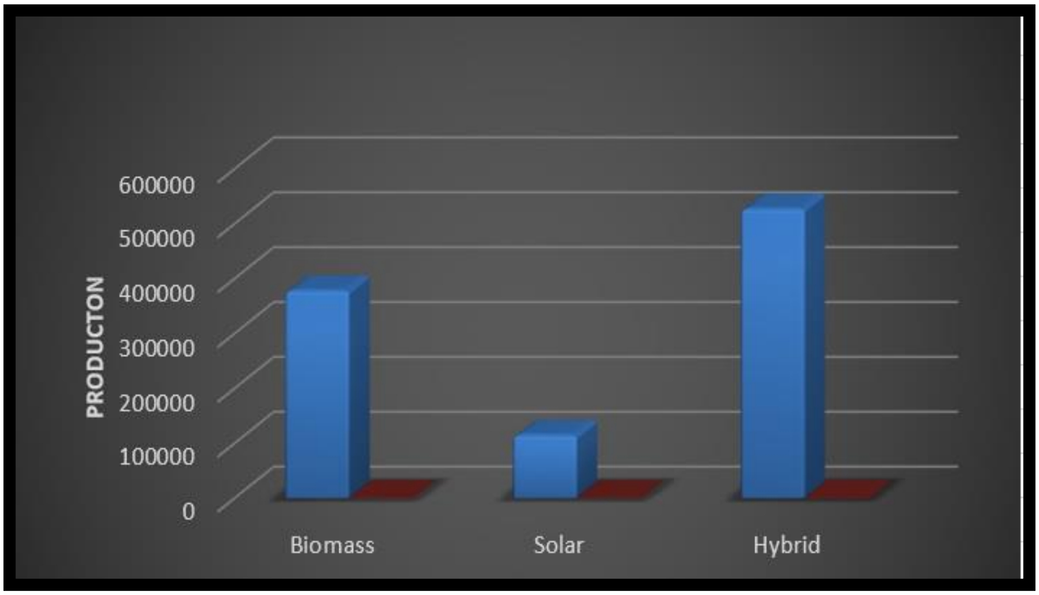


Figure 9.1 bar diagram of production of proposed hybrid generation model

Figure 9.2 has been shown the diagram of power production of hybrid generation in previous year

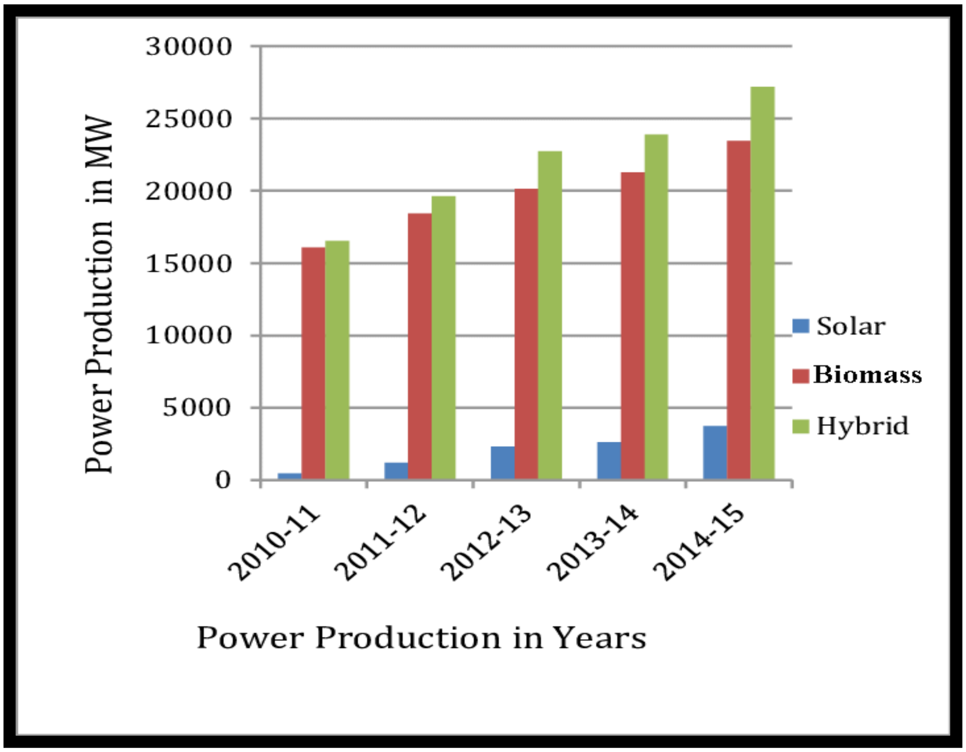


Figure 9.2 Diagram of Power Production of hybrid generation in previous years.

Figure 9.3 has been shown the monthly power production by using solar, biomass and hybrid system.

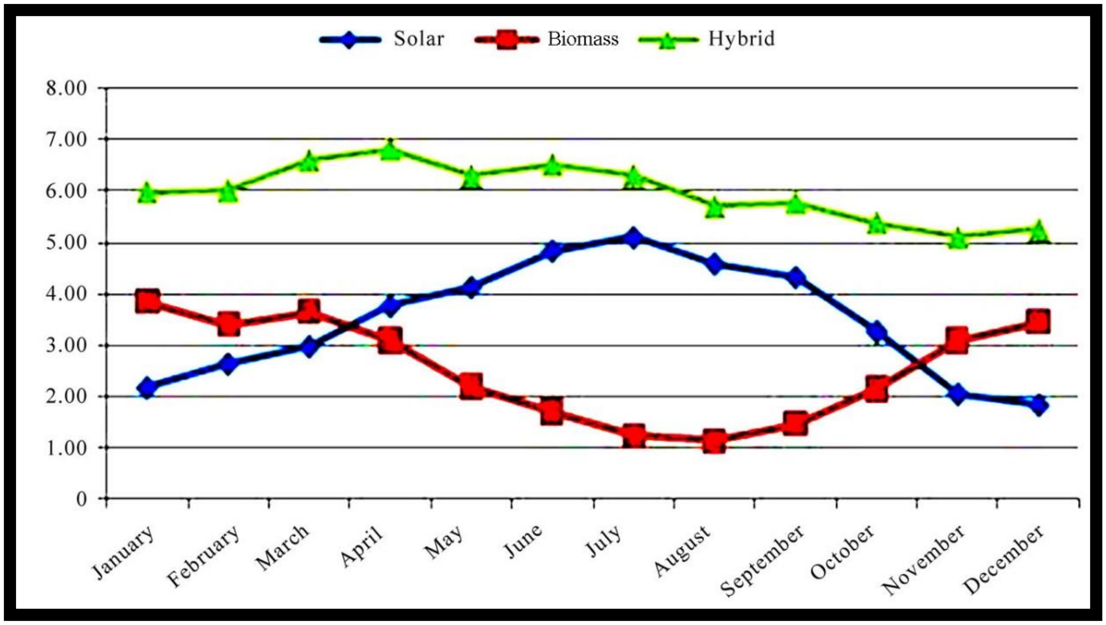


Figure 9.3 Diagram of monthly Power Production.

CHAPTER 10
CONCLUSION

Bangladesh has a tropical monsoon climate with heavy summer rain and high summer temperatures. Winters are dry and cool. Main seasons prevail in Bangladesh are summer (March-May), Rainy Season (June-September) and winter (December-February). South and Southwest winds dominate from mid-April to mid-October and bring enormous amounts of moisture from the Indian Ocean and the Bay of Bengal. 95% of the total rainfall, which averages about 1733 millimeters, occurs during that period. The temperatures range from an average of about 68 F (18C) in January to about 86 F (30C) in April.

Typical biomass based power generation system produces electricity about 90% and above by using only biomass resources (e.g. municipal solid waste). On the other hand, hybrid generation system discussed in this paper is producing 70% from biomass, 20% from solar and rest of the power is from conventional grid system (e.g. is case of backup). So, there is less dependency on a single source (e.g. biomass or solar PV). Therefore, the generation diversity results in increased security of supply. Bangladesh is a developing country and load shedding is a severe phenomenon. Rapid increase of population makes the demand of electricity high in every consecutive year. By establishing this kind of hybrid energy generation system may become most optimized solution to cut off conventional fossil fuel based power plant productions in our urban residential buildings. However, it also reveals the possibility to keep our environment green with zero emission. Though the system has designed for the high-rise buildings, it will ensure the use of annual power consumption in more economic and secure manner for the total electric load. In addition, near future there might be a scope that the system can be used for grid sell purposes to make money from extra generation. In contrast, the proposed hybrid system is now proved to be a unique pathway to solve the shortcomings of electricity problems not only for High rise buildings but also it can cost-effectively Installed in rural electrification.

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