DESIGN OF AN OFF-GRID ROOFTOP SOLAR PV SYSTEM FOR YOUNUS KHAN SCHOLARS GARDEN-2, DAFFODIL INTERNATION UNIVERSITY

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of

Bachelor of Science in Electrical and Electronic Engineering

by

Name: Md. Raju Ahmmed

(ID: 171-33-427)

Name: Md. Habibur Rahman

(ID: 171-33-420)

Supervised by

Dr. Md. Alam Hossain Mondal

Associate Professor

Department of EEE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FACULTY OF ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

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Certification

This is to certify that this project and thesis entitled **“DESIGN OF AN OFF-GRID ROOFTOP SOLAR PV SYSTEM FOR YOUNUS KHAN SCHOLARS GARDEN-2, DAFFODIL INTERNATION UNIVERSITY”** is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on June 2021.

Signature of the candidates

____

Name: Md. Raju Ahmmed

ID #: 171-33-427

____

Name: Md. Habibur Rahman

ID #: 171-33-420

Countersigned

____

Name of the supervisor Dr. Md. Alam Hossain Mondal

Associate, Professor,

Department of Electrical and Electronic Engineering

Faculty of Science and Engineering

Daffodil International University.

BOARD OF EXAMINERS

Engr. Mahmud Hossain External Member
Director and Chief Engineer,
Nuclear Power and Energy Division, BAEC.

Md. Ashraful Haque Coordinator

Assistant Professor
Department of EEE, DIU

Farhan Sadik Sium Internal Member

Lecturer, EEE

Department of EEE, DIU

Ms. Fahmida Ahmed Antara Internal Member

Lecturer, EEE

Department of EEE, DIU

Dedicated to

Our Parents

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LIST OF ABBREVIATIONS

NPC	Net Present Cost
IRR	Internal Rate of Return
SRS	solar rooftop system
PV	Photovoltaic Cell
GTI	grid-tie inverter
GHI	Global Horizontal Irradiance
GMT	Greenwich Mean Time
LF	load following
CC	cycle charging

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ABSTRACT

Development of Renewable Energy in Bangladesh is an alternative solution for an increasing of fuel-based energy demand problem. Higher educational institutes may contribute to reducing the energy consumption by implementing green campus policies which include creating a medium-scale solar power installation. This work presents the feasibility analysis of photovoltaic power generation plants development in a Younus khan scholars garden-02 Daffodil International University hostel. In this paper, different off-grid solar rooftop systems were considered in one of the campuses located in rural area. The methodology applied provides a useful and simple approach for sizing and analyzing the hybrid systems using HOMER, an optimization model for renewable energies. This study assesses the potential of a solar system to electrify a Hostel in Daffodil International University. The solar Optimization of Multiple Electric Renewables model is used to assess primary data, develop a load profile and identify the optimal least cost system option for the Hostel. A sensitivity analysis was performed to determine the effect of variations in solar radiation, diesel price on optimal system configurations. The results show that a PV system with a combination of photovoltaic array, converter, battery and diesel generator is the best option from an economic point of view. To meet the Younus khan scholars garden-02 Daffodil International University daily peak demand of 151.60 kW, energy generation cost is estimated at 32.21 BDT ($0.380) per kilowatt hour and net present cost at $1.4M. The optimal system allows for a reduction of 298,450 kg/yr of carbon dioxide emissions per year compared with diesel-only electricity generation. The technical viability of the proposed solar energy system is analyzed using HOMER software. The economic aspects of the plant are analyzed based on standard parameters, the NPC (Net Present Cost) and IRR (Internal Rate of Return) methods. The simulation studies are carried out to identify technical and cost-effective configuration. Feasibility study of the Photovoltaic energy generation was conducted by revealing their potential contributions and applicability's. This study gives emphasis to the techno-economic analysis of renovating the energy supply system of an off grid-connected Daffodil International University hostel building through a Renewable Energy System. Finally, results of the research can be used as reference for the relevant stakeholders and policymakers in developing the off-grid- solar PV systems for power generation in Bangladesh.

CHAPTER-01

INTRODUCTION

1.1 Introduction

Higher education establishments like schools and colleges assume a significant part for society in driving the execution of new innovation. The green grounds program gives critical commitment by elevating practical living to the general public. Driving grounds utilizing environmentally friendly power sources to supplant or supplement the customary assets is important for endeavors in ensuring the climate. One of the models is the utilization of sunlight-based fuel sources to fulfill power need at a ground in Bangladesh. Right now, most colleges apply sun-based energy framework incompletely, for example, for road or nursery lighting. The framework applied Off Grid framework concerning moderately high speculation costs. Miniature lattice/Photovoltaic force establishment framework has been a focal point of a few specialists seriously directed across the world, including achievability examines, PC displaying, control methodology and test work has been seriously directed. Then, the point of this article gives an examination of the probability of miniature lattice model establishment that uses photovoltaic as an environmentally friendly power hotspot for an on-lattice territory at colleges. These displaying of streamlining is led utilizing HOMER® programming. The power use, cost, and sun powered radiation information were needed to perform techno-financial examination dependent on sensitivities utilizing HOMER recreations. To the best of creator's information, there is no extensive investigation on the HOMER based techno-financial examination of such sustainable power frameworks at a campus area.

1.2 Solar energy in Bangladesh

1. Bangladesh is arranged between 20.30 – 26.38 degrees north scope and 88.04 – 92.44 degree east longitude.

2. Every day normal sun-oriented protection rate is 4 to 6.5 KWh per square meter.

3, Maximum measure of During this time, radiation is available March-April (6.5h) and least on December-January (4h).

1.3 Importance of Solar Energy

The primary wellsprings of world energy age are the petroleum derivatives (gas, oil, coal) and atomic power plants. Because of the use of non-renewable energy sources, greenhouse gases (CFC, CH4, O3, yet fundamentally CO2) transmit into the air. From the thermal energy station, carbon is delivered in a little sum (90 grams likeness carbon dioxide per kilowatt hour).[1] But the radioactive waste remaining parts dynamic more than thousand years which is an expected wellspring of natural contamination. Power age is wellspring of the greatest emanation of carbon dioxide. So, creation of this perfect energy is really contributing the most elevated towards worldwide warming. Global warming just as the natural contamination is, in our occasions, the best natural danger to person. On the other hand, there is a disturbing energy emergency worldwide as petroleum derivative stores decline and the maturing power plants are going to shut in not so distant future. From the part of an Earth-wide temperature boost and lack of flammable gas, researchers and specialists are searching for spotless, sustainable power sources. Sun based energy is the perhaps the most ideal alternative. Since the earth gets 3.8 YJ [1YJ = 1024 J] of energy which is multiple times more prominent than the world utilization. [2] Bangladesh is confronting an intense deficiency of energy. Flammable gas is the fundamental wellspring of power age in Bangladesh. Yet, the restricted gas saves cannot satisfy the necessities of both homegrown prerequisites and mechanical and business requests, particularly requests for power age for long. Sun oriented energy could be a significant wellspring of force age in Bangladesh. Bangladesh government intends to make it compulsory to introduce sun oriented board on housetops of each multistoried and hello rise building. As sunlight-based energy is one of the cleanest and easiest types of energy. Sun based energy is promptly accessible anyplace and wherever in the earth. It very well may be utilized it to produce power at the place of utilization Solar controlled structure depends on this idea.

As at last we can say that for utilization of sun-oriented energy:

1. Wellspring of Conventional Energy is Limited.
2. Creation of force from customary Energy causes CO Emission.
3. Simple to introduce and utilize.
4. Commotion free.
5. Less upkeep.
6. Source is limitless.
7. There is no moving part, so its life is long

1.4 Physical Perspective of Renewable Energy in Bangladesh

Bangladesh arranged One of the world's most densely inhabited areas is in north-eastern South Asian countries (1239 individuals/km2 in 2018) with a populace of 163 million out of 2019. Energy, and even more expressly power, is an essential for the mechanical turn of events, higher monetary development and destitution decrease of a country. The future financial improvement of Bangladesh is probably going to bring about a fast development in the interest in energy with going with deficiencies and issues. The nation has been confronting an extreme force emergency for about 10 years Out of different inexhaustible sources hydropower, geothermal, sunlight based, tides, wind, biomass, and biofuel can be viably utilized in Bangladesh. Sun powered energy is the most promptly accessible and free wellspring of energy in our country and customarily sun based nuclear power has been used in various family and mechanical exercises in Bangladesh. A few associations have introduced low limit wind turbines, basically for battery charging in the seaside area of Bangladesh. Not with standing, progress in the breeze energy area of Bangladesh is not noteworthy [3]. Miniature Hydro Power Plants can be introduced in the north-eastern uneven districts and in the current irrigational trench framework with an adequate head. The just hydro power station of the country, the Karnafuly Hydro Power Station with a producing limit of 230 MW by 7 units, is situated in Kaptai across the stream Karnafuly. There are extents of coordinated little flowing force plants in the seaside areas. Biomass is the fourth biggest wellspring of energy worldwide and gives fundamental energy necessities to cooking and warming of provincial families in agricultural nations like Bangladesh. A farming-based nation like Bangladesh has enormous possibilities for using biogas advances. As per IFRD-there is capability of around 4,000,000 biogas plants in our Country.

1.5 Present status of Renewable energy in Bangladesh:

At present our renewable energy capacity day by day increase. In 2021 our renewable energy installed capacity is 730.32 MW. From solar energy 68% renewable energy share and other 31.5% is wind. [4]

Techlology	Off-grid (MW)	On-grid (MW)	Total (MW)
Solar	346.6	149.8	496.39
Wind	2	0.9	2.9
Hydro	0	230	230
Biogas to Electricity	0.63	0	0.63
Biomass to Electricity	0.4	0	0.4
Total	**349.63**	**380.7**	**730.32**

Table-1.1

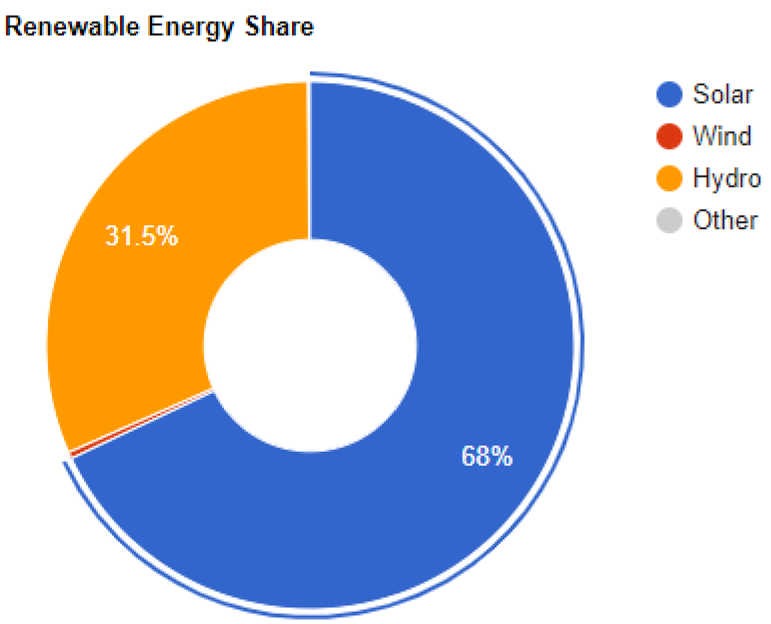


Fig.1.1: Renewable energy share

1.6 Objectives

Main objective:

i. The main objective of the present study is to determine the optimum size of systems able to fulfill the requirements of 1124.71 kWh/day primary load with 151.60 kW peak load of Diu Hostel.

Other objectives:

i. To present much useful data and information about the dissemination of the solar photovoltaic technology
ii. To find out university hostel energy consumption and sizing the (solar rooftop system)SRS components
iii. The aim is to identify a configuration among a set of systems that meets the desired system reliability requirements with the lowest electricity unit cost To Calculate the cost of solar energy per unit based on solar system data.

1.7 Thesis Outline

Chapter two describes the Literature Review section.

Chapter three describes the Methodology of the study.

Chapter four describes the Data Collection.

Chapter five describes the Analysis of load profile of the Thesis.

Chapter Six describe the Result and Discussion.

Chapter seven describe the Conclusion and Reference.

CHAPTER 2
LITERATURE REVIEWS

2.1 Introduction

More we produce energy more we get power. Reasonable, open and secure inventory of energy plays a main impetus for financial improvement of a country. Various late investigations uncover how rustic zap from sun-based force specifically helps in financial improvement of the country differently. In the present situation, sun-based energy is broadly seen as a promising innovation for power age in distant area of the non-industrial nations. This part endeavors to zero in on the survey of chosen writing, key idea of sun powered power as main thrust for financial turn of events, issues and factors affecting financial advancement like family pay, wellbeing, schooling, agrarian creation, admittance to data and other infrastructural administrations [5]

2.2 Photovoltaic cells

Swiss scientists gathered a warm snare, which was a small-scale nursery, in the eighteenth century. He constructed a heated box, enclosing another larger glass box with a glass, for a total of up to five boxes. When they propose to set up the sun brightening, the temperature in the deepest box may be raised to 108 degrees Celsius, which is hot enough to boil water and prepare food. These containers might be considered the world's first solar-powered collection. In the late 1950s, a few organizations and testing facilities began developing a silicon-based sunlight-based cell with the goal of controlling Earth-circling satellites. RCA, Hoffman Electronics, and others are among them. Similarly, the United States Armed Forces Alert Corps (Desideri, Zapparelli, and Garroni, 2013).

A photovoltaic cell, or sunlight-based cell, is an electrical device that converts the energy of photons incident on it into electrical energy, which is a unique and manufactured marvel. A case module, also known as a sunlight-based board, can relate to a separate cell unit. A sun-powered photovoltaic load up or module is addressed by a group of diverse sun-oriented cells that are connected and structured in the plane. Typically, PV modules have a glass before the board, allowing light to pass through while ensuring the semiconductor plate remains safe within the case Sun based cells are normally related, and masterminded in arrangement or equal module, contingent on the prerequisite of the client. The equal interface unit gets higher current; in any case, the issue, for instance, that shadow impacts can kill more fragile (less brilliant) equal strings (various stages of cells) can cause extraordinary disagreeable impacts and may cause harm on account of their edified complicity and the inversion of dim cell propensities. A progression of stacked units are generally self-governing and not equal, yet beginning from 2014, every module gives a particular force box consistently and interfaces in equal.

2.3 Types of Photovoltaic Technology

There are two primary forms of PV technology, in addition to crystalline silicon (c-Si):

Thin film PV: It is a tiny but rapidly increasing segment of the commercial solar industry. Many thin-film companies are start-ups experimenting with new technology. They are usually less efficient than c-Si modules,

Building integrated photovoltaics: Fill in as an exterior layer of a structure as well as generating power for on-site usage or fare to the matrix. BIPV frameworks can help save money on materials and energy, reduce pollution, and improve the aesthetic appeal of a construction.

2.4 Working Principle of Solar Panels

Sun is a powerhouse of energy and this energy moves around as electromagnetic radiations. These radiations are of a few kinds, for example, light, radio waves, and so on relying on the frequency of the radiations transmitted. A less level of sun's radiations arrive at the world's environment as obvious light. Sun powered cells utilize this obvious light to make electrons. Distinctive frequency of light is utilized by various sun-based cells.

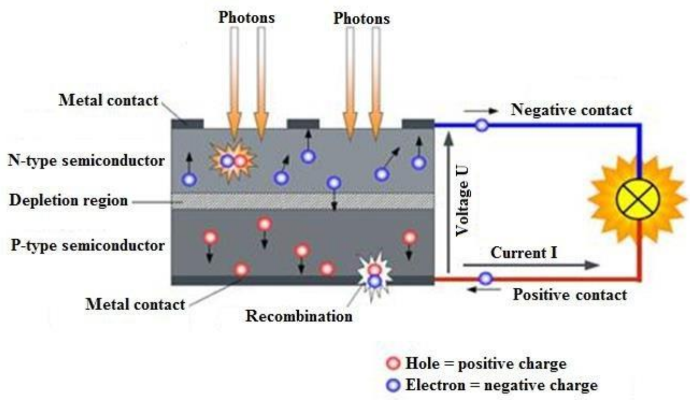


Fig. 2.1: Working principle of solar panels.

Sun-based cells are made up of semiconductor materials like silicon, which are used to generate electricity. The energy is channeled through a stream of tiny particles known as electrons, and the stream is referred to as electric flow. There are two basic types of electric flows: DC (direct flow) and AC (alternating flow). DC (direct flow) has a consistent flow path, but AC (alternating flow) may flip the flow bearing.

A typical sun-based cell comprises two layers of silicon, one of which is n-type at the top and the other of which is p-type at the bottom. When sunlight reaches a sunlight-based cell, silicon consumes the electrons, which then flow through the n and p-layers to generate electric flow, which exits the cell through the metal contact. The power generated is of the AC kind.

2.5 Renewable energy

It is sometimes referred to as "clean energy" since it is derived from natural sources or cycles that are constantly replenished. For example, daylight and wind continue to shine and blow regardless of whether their accessibility is dependent on time or temperature. Here are some examples of renewable energy:

2.5.1 Biomass Energy

Biomass is a renewable and sustainable type of energy that may be used to generate electricity or other forms of power. It is made from organic materials.

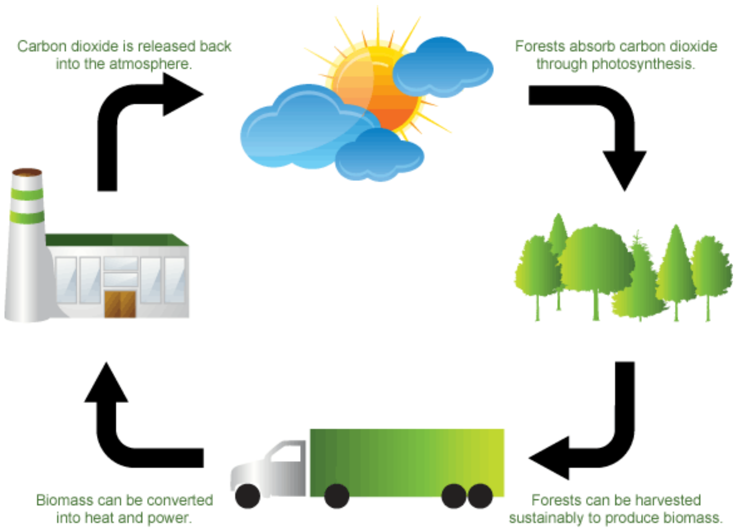


Fig.2.2: cycle of Biomass Energy

2.5.2 Wind power

Another ecologically beneficial energy source is wind power. The active energy of the breeze causes turbines to revolve and a mechanical development to occur. After that, a generator converts the mechanical energy into electricity. Onshore wind turbines, off-shore wind turbines, and even floating wind turbines are all examples of wind renewable energy.

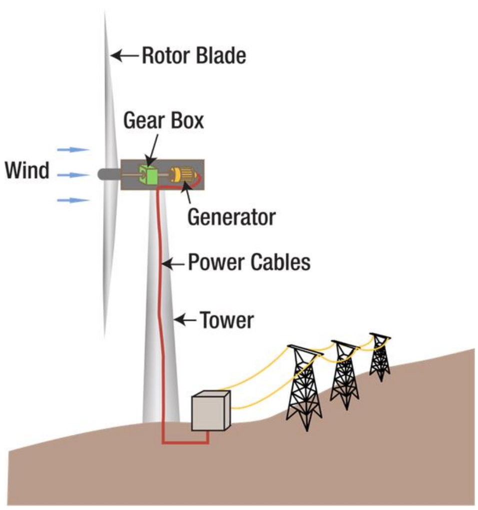


Fig.2.3**:** Wind power system

2.5.3 Hydroelectric power

Hydroelectric energy, also known as hydroelectric power or hydroelectricity, is a type of energy that generates electricity by harnessing the power of moving water, such as water running over a waterfall.

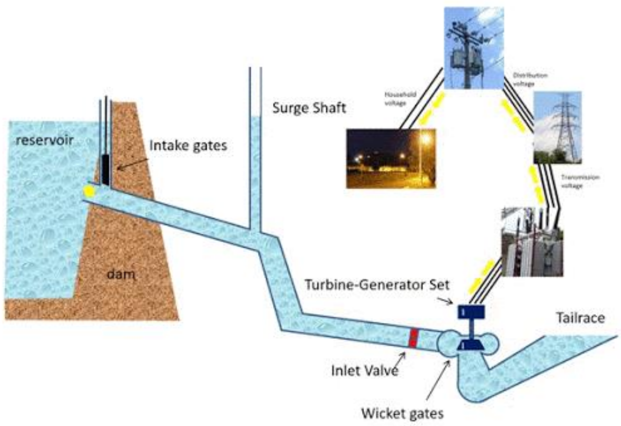


Fig.2.4: Hydroelectric power

2.5.4 Geothermal Energy

Geothermal energy is derived from the Earth's core and is a renewable source of energy. It is derived from the heat created during the planet's creation and subsequent radioactive decay of elements. This thermal energy is stored in the earth's core in the form of rocks and fluids.

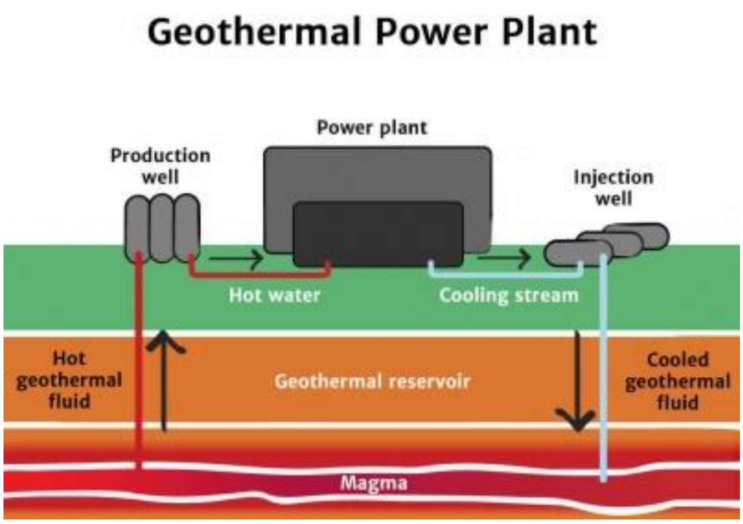


Fig.2.5: Geothermal Energy

2.5.5 Solar energy

Wind energy is the thermos and warmth from the Sun that is harnessed through a variety of ever-evolving innovations such as solar power, photovoltaics, sunlight-based nuclear power, sun-based engineering, liquid salt force plants, and phony photosynthesis.

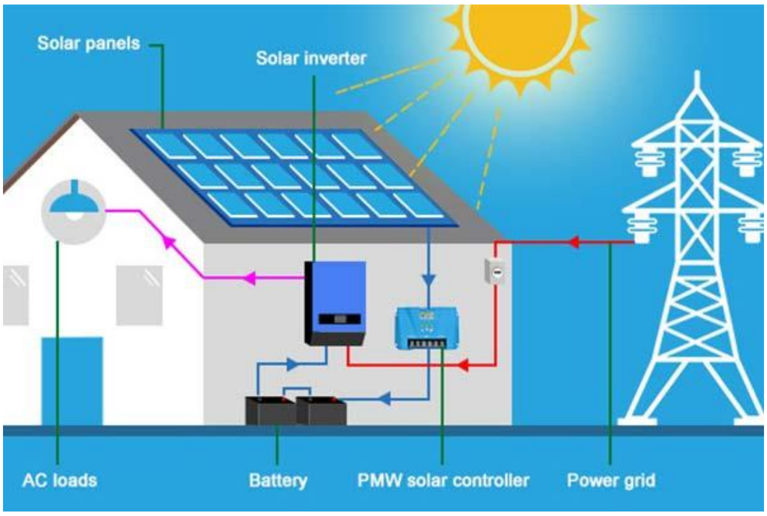


Fig.2.6: Solar Energy System

2.6 Why use solar energy:

Solar energy holds the key to a sustainable energy future. Every day, the sun produces considerably more energy than humans require to power the entire planet.

Renewable:

Photovoltaic arrays generate electricity by converting the sun's constant flow of energy into electricity.

CO_2-free:

When solar panels generate power, no hazardous pollutants are discharged into the atmosphere.

Low operating costs:

The solar method, which converts sunshine to energy, uses no fuel and has no operating expenses.

2.7 The most common types of solar energy

Photovoltaic systems, solar water heating systems, solar power plants, and passive solar heating are four forms of solar energy that are often used. We are now going to go through the following information.:

2.7.1 Photovoltaic systems

Photovoltaic systems, often known as solar cell systems, are one of the most prevalent ways to utilise solar power. They create electricity directly from sunlight.

2.7.2 Solar water heating systems

A second group of sun-based electricity is daylight high-temperature water, which, as the name implies, involves heating water with the sun's warmth. The idea behind this comes straight from nature: shallow water in a lake or water on the shallow end of a beach is usually hotter than deeper water. This is since sunlight may warm the lowest portion of the lake or seashore in shallow areas, thereby warming the water.

2.7.3 Solar power plants

Sun powered power is a third way humans may harness the sun's energy; it's mostly used in engineering applications. Most power plants, as most of us are aware, use non-sustainable fuels simply to boil the water.

2.7.4 Passive solar heating

Another approach to control the sun's power is to use passive solar heating and daylighting techniques.

2.8 The major types of solar panels

Monocrystalline, polycrystalline, and slender solar panels are the three primary types.

Solar panel name	Advantages	Disadvantages
Monocrystalline	○ High efficiency ○ Aesthetics	○ Higher cost
polycrystalline	○ Low cost	○ Lower efficiency and performance
Thin film	○ Portable and flexible ○ Light weight ○ Aesthetics	○ Lowest efficiency and performance

Table2.1: Solar panel advantage and Disadvantages

2.9 Solar Technologies

Photovoltaics (PV), which directly converts light to power; concentrating sun-oriented force (CSP), which uses heat from the sun (nuclear power) to drive utility-scale electric turbines; and sun-based warming and cooling (SHC) implementations, which collect nuclear power to provide high temperature water and air temperature rise or mold protection.

2.10 On-grid solar system in Bangladesh –

on-grid solar system in Bangladesh or the grid-tied solar system is connected to the electrical grid, therefore, it can draw energy from both solar panels and the electrical grid. This system is the most common type. It uses a common solar inverter. The excess energy that you generate is exported to the grid for use elsewhere. Likewise, It can draw energy from the grid occasionally when needed. The only drawback is that it can not function during a blackout for safety issues. If the solar panels still generate electricity during breakout, it will be hazardous for people repairing the electricity.

Fig.2.7: On grid solar rooftop system

2.10.1 Advantage of on gird solar System

- The establishment is considerably savvier and requires exceptionally less support.
- The additional power produced can be sold back to the framework. It very well may be an overflow pay for family units.
- Since it can pull energy from the lattice, it functions as a reinforcement. You are to the least extent liable to wind up in haziness.

2.11 Off grid solar system

These systems work freely henceforth requires a battery for safeguarding energy. The boards assimilate energy during sunlight and utilize the produced power around evening time. The batteries and inverters are significantly more costly. They require uncommon gear to create power consistently. This system is generally exorbitant. They give energy in basic hours and generally utilized in far off where the power system is not accessible.

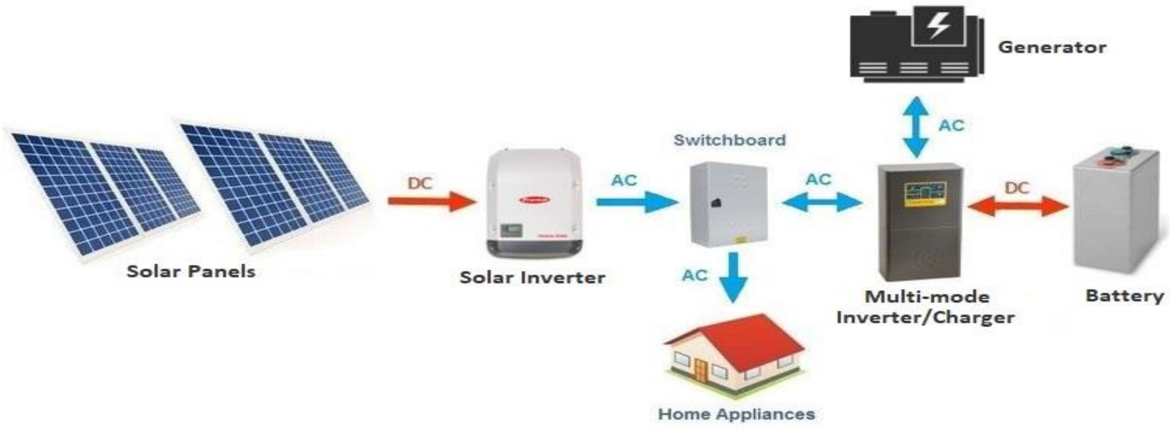


Fig.2.8: off grid solar roof top system

2.11.1 Advantage of off grid solar system

- Blackouts don't influence these systems since they work autonomously.
- Easy Alternative for Rural Areas
- Helps you in saving power costs.

2.12 Hybrid Solar System –

This system is more similar to on-grid sun-based force with unique half-breed inverters. You can utilize power from the matrix when required. The solitary extra element is that during crisis power cuts the reinforcement battery gives you power.

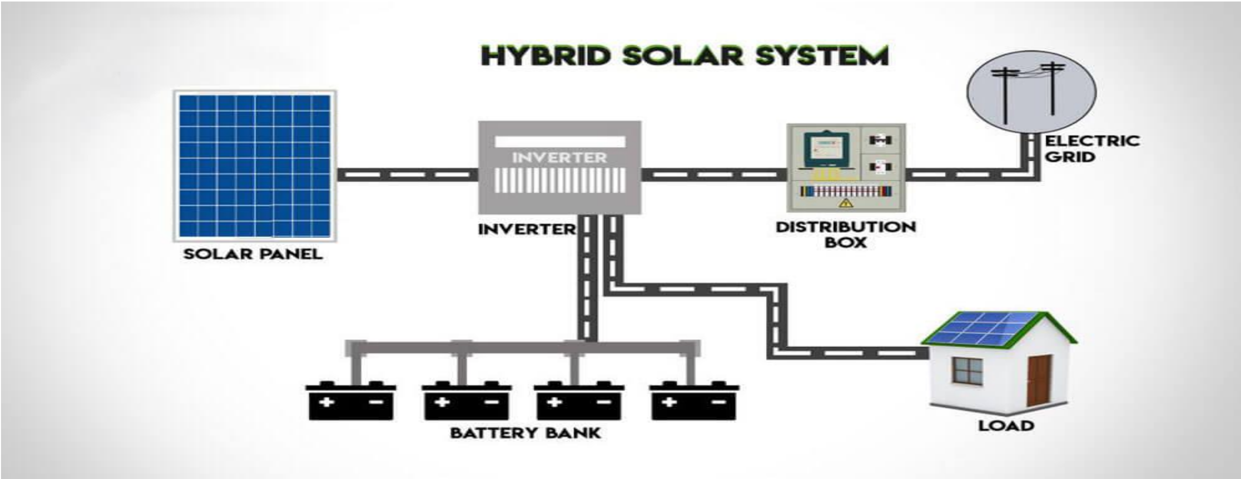


Fig.2.9: Hybrid Solar System

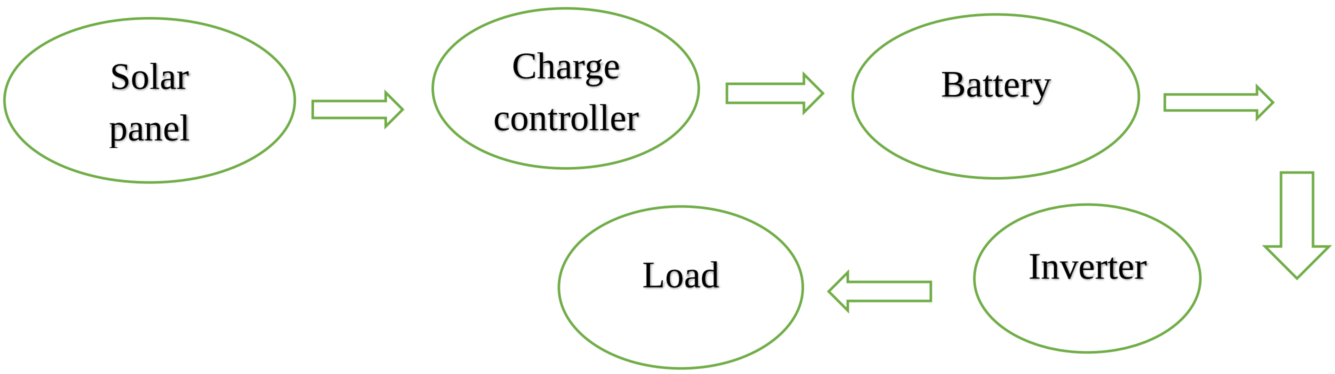
2.12.1 Advantage of Hybrid solar system

- Allows utilization of putting away sun-oriented energy during top night times.
- It is more affordable and there is no necessity for a reinforcement generator.
- Reduces power utilization from the grid.

2.13 Components of a solar Photovoltaics system

An ideal solar PV system consists of solar panel, charge controller, battery, inverter and load.

Here the block diagram of the system:



2.13.1 Charge controller

When a battery is used in a system, a charge controller becomes necessary. A charge controller regulates the fluctuating voltage. Solar cells create greater voltage on a bright sunny day, which can harm batteries. A charge controller aids in maintaining the battery's balance when charging. [6]

2.13.2 Batteries

Batteries are used to store charges. There are many different types of batteries on the market. However, none of them are appropriate for solar PV technology. Nickel/cadmium batteries are the most often used batteries. Other types of high-energy-density batteries are sodium/sulphur zinc/bromine flow batteries. However, nickel/metal hydride batteries have the best cycling performance for medium-term batteries. Iron/chromium red ox and zinc or manganese batteries are the finest long-term options. AGM (Absorbent Glass Mat) batteries are also one of the finest options for solar PV applications. [7]

2.13.3 Inverter

Using suitable transformers, switching, and control circuits, an inverter transforms direct current (DC) to alternating current (AC). The resultant AC can be at any necessary voltage and frequency. Inverters are often used to convert DC electricity from solar panels or batteries into AC power. A high-power electronic oscillator is used in the electrical inverter. It got its name because early mechanical AC to DC converters were designed to function backwards, or "inverted," in order to turn DC to AC.

String inverter:

Fig.2.10: String inverter

Good look

Available in small- and medium-sized PV power station

User-friendly Interface

Power level 1.5KW to 6KW

Power plant inverter:

Fig.2.11: Power plant Inverter

Professional design for large-sized PV power station Transformer type and transformer less type Satisfy different requirement, predigest design of power station.

Grid Tie Inverter:

Fig.2.12: Grid tie inverter

A grid-tie converter, also known as a (GTI), is an electrical inverter that converts direct current into alternating current and feeds it into the utility grid in a renewable energy power system. "Grid-interactive inverter" is the technical term for a grid-tie inverter. Synchronous inverters are another name for them. In most cases, generator inverters cannot be employed in hold systems without access to power source.

2.14 Types of PV model

2.14.1 Solar cell:

Sun-directed radiation was directly converted into electricity by the cells. It is made up of several types of semiconductor materials. It is divided into two types: positive charge and negative charge, as shown in fig.1. This cell invention is used to easily plan solar-powered cells with great change productivity. When the cell consumes photons from daylight, electrons are knocked free from silicon iotas and dragged off by a lattice of metal conveyors, forming an electric direct flow stream. PV cells based on the sun, made up of a variety of synthetics.

Fig.2.13: Solar cell

2.14.2 Photovoltaic model:

PV modules are the foundation building blocks of the PV framework, consisting of sun-oriented cell circuits fixed in a naturally protective cover. Sizes range from 60W to 170W by and large. Typically, multiple PV modules are arranged in a logical and matching manner to satisfy the energy need.

Fig.2.14: Photovoltaic model [Multiple cell]

2.14.3 Photovoltaic panel:

It has at least one PV module that has been grouped together as a pre-wind, field instable unit. PV cell configuration relationships are shown on this board. Individual PV cells are connected to form solar-powered boards.

Fig.2.15: Photovoltaic solar panel

2.14.4 Photovoltaic Array:

It is contained of a few measures of PV cells in arrangement and equal associations. Arrangement associations are liable for expanding the voltage of the module while the equal association is liable for expanding the current in the cluster. It produces greatest 180W in full daylight. Huge the complete surface space of the space of the cluster, more sunlight-based power it will deliver.

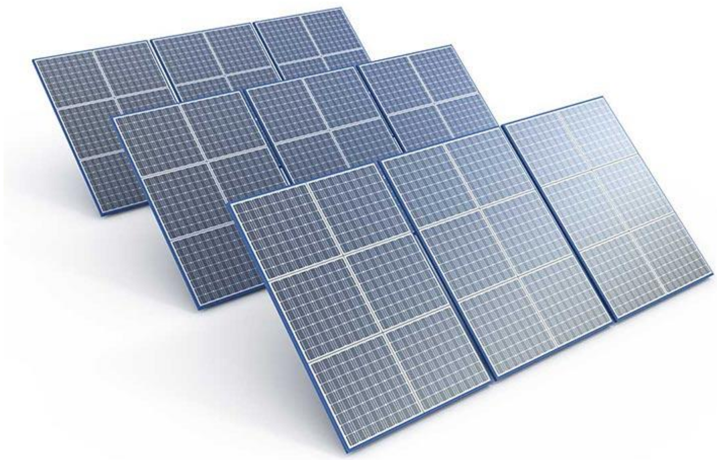


Fig.2.16: Photovoltaic Array

2.15 Top five countries for solar power capacity in 2019

Solar power installations are increasing rapidly around the world as countries step up their renewable energy efforts and attempt to cut carbon emissions from electricity generation.

Along with wind, solar photovoltaic (PV) is the most established of the low-carbon energy technologies, and as it grows in scale, the costs of development are coming down. Total cumulative installed capacity at the end of 2019 amounted to around 627 gigawatts (GW) globally.[8]

1. China – 205 GW

China boasts by far the world's largest installed solar energy fleet, measured at 205 GW in 2019.

In the same year, power generation from solar energy totaled 223.8 terawatt hours (TWh) in the country.

Despite being the world's top emitter, the sheer size of the Chinese economy means it's vast energy needs are able to accommodate both the world's largest coal and renewable fleets.

The largest single solar project in China is the Huanghe Hydropower Hainan Solar Park (2.2 GW) in Qinghai province.

2. United States – 76 GW

The US had the world's second-largest installed solar capacity in 2019, totaling 76 GW and producing 93.1 TWh of electricity.

Over the coming decade, US solar installations are forecast to reach around 419 GW as the country accelerates its clean energy efforts and attempts to fully decarbonize its power system by 2035.

3. Japan – 63.2 GW

Japan ranks third among countries with the largest solar power capacity, with a fleet totaling 63.2 GW in 2019, according to the IEA's data, generating 74.1 TWh of electricity.

Alternative sources of energy like solar and other renewables have become more popular since the Fukushima nuclear disaster in 2011, which prompted the country to significantly scale back its activities in nuclear energy.

4. Germany – 49.2 GW

Germany is the leading country in Europe for solar deployments, with a national fleet totaling around 49.2 GW in 2019, generating 47.5 TWh of electricity.

Competitive auctions have boosted the industry in recent years, and the German government recently proposed increasing its 2030 solar installation target to 100 GW as it targets a 65% share of renewables in its energy mix by the end of the decade.

5. India – 38 GW

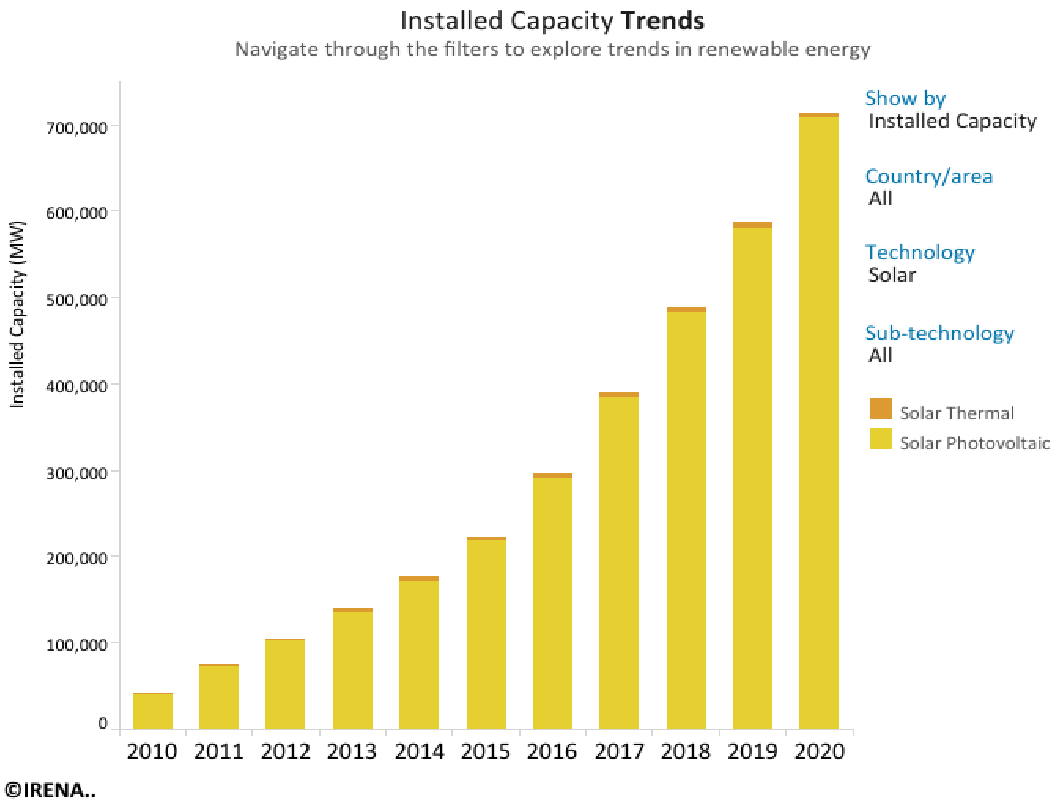
India has the world's fifth-largest installed solar capacity, totaling 38 GW in 2019, and producing 54 TWh of electricity.

Energy demand across India is expected to grow more than any other region over the coming decades and, as the world's third-largest carbon emitter, policies are being developed to shift the country away from fossil fuels like coal in favor of renewables.

Government targets include 450 GW of renewable energy capacity by 2030

2.16 Solar power plant installed capacity trends in the world:

At present solar power plant installed capacity is 707494MW. In 2010 solar power plant installed capacity is 40287 MW. Seeing the graph day by day increase the capacity of solar energy.[9]



Graph.2.1: Solar power plant installed capacity trends.

2.17 Rooftop solar PV system

Each building whether home, industry, foundation or business foundation can produce some sunlight-based force by introducing PV boards on the rooftop top. Some of the time this can be a BIPV.

Some Key Benefits:

•Photovoltaic rooftop top establishments at the last part of the framework can upgrade network soundness and diminish misfortunes

•Savings in land prerequisite and expenses

•Savings being developed of new transmission framework

•Creation of significant worth from under-used/unutilized housetops

•BIPV can upgrade style of structures

•Creation of significant worth from under-used/unutilized roof

2.18 Basics of rooftop Solar PV

solar PV panels convert sunshine into electricity. They do not take advantage of the sun's warmth, and in fact, might suffer a drop in their yield under scorching conditions. The PV boards generate Direct Current electricity (DC). The boards are installed on the housetop using exceptional mounting mechanisms and must be converted to Alternating Current (AC) using an inverter. A battery reinforcement is necessary if sun-based force is required when there isn't enough sunshine for the boards to generate power (for example, in the evening).

2.19 Maintenance of rooftop solar PV systems

The fundamental housetop sun-oriented PV framework has no moving parts and consequently requires almost no support. Extra parts, for example, trackers and batteries, can fundamentally expand the maintenance effort and use.

Solar panel: These normally expect next to zero support past having the residue cleared off them. Sunlight based boards can be relied upon to keep going for a very long time.

Inverter: This can be influenced by framework power quality or different issues basic to control gear, for example, moistness or short circuits brought about by creepy crawlies, and may require some upkeep, for example, substitution of capacitors. The life expectancy of an inverter is 5-10 years.

Mounting structures: These regularly last the lifetime of the plant and do not need upkeep, except if global positioning frameworks are utilized Tracking instruments include moving parts that can wear out or potentially break. The require oil, parts substitution, and adequate room on the housetop for support access.

Different pieces of the framework: Cabling, switchgear, wires, and so on will require minor support to guarantee right activity Batteries – As examined above, batteries require cautious upkeep to work dependably. Ordinary life expectancy is 3-5 years.

2.20 Significant pros and cons of the solar system of Bangladesh

Benefits of solar:

Sustainable – The fundamental reason why more people are switching to alternative green energy is to reduce the burden on other finite resources such as oil, gas, fuel, etc. Sustainability is a rising trend. The sun will be least likely to run out. We have improved technology for taking full advantag**e.**

High return Investment – It is a drawn-out arrangement. Whenever you are finished with establishment cost, it will support you for quite a long time, really many years. Your service bills will be deducted; there will infrequently be any support circumstance. Eventually, it's a mutually beneficial arrangement regardless of whether it appears exceptionally evaluated before all else.

Support from Government - Governments profoundly support the utilization of reusable energy as it no affects natural contamination.

Easy installation– In recent years, technology has been improving drastically. Solar power installation has become relatively more accessible and cheaper. Moreover, they take up no additional space.

Detriments of solar power:

Climate subordinate – A huge reality that cannot be disregarded. The sun, obviously, rises each day, and because of geological reality in certain areas, daylight is not generally accessible. The territories which are inclined to typhoon, thunder, and downpour cause sway the force supply significantly.

Space issue – For private use, the boards are situated at the roof. In any case, for enormous business establishment, a lot of room is required.

2.21 Used of solar Energy.

It is utilized in numerous applications including power, dissipation, warming water, Heating and cooling of structures, preparing of food, water pumping and so on

Fig.2.17: Solar water pump

Fig.2.18: Solar water heating

Fig.2.19: solar cooker

CHAPTER-03

METHODOLOGY

3.1 Introduction:

The Main objective of this chapter Visit the location, Data collecting, find out the daily consumption, Design the project through homer software.

3.2 Flow chart of the working procedure

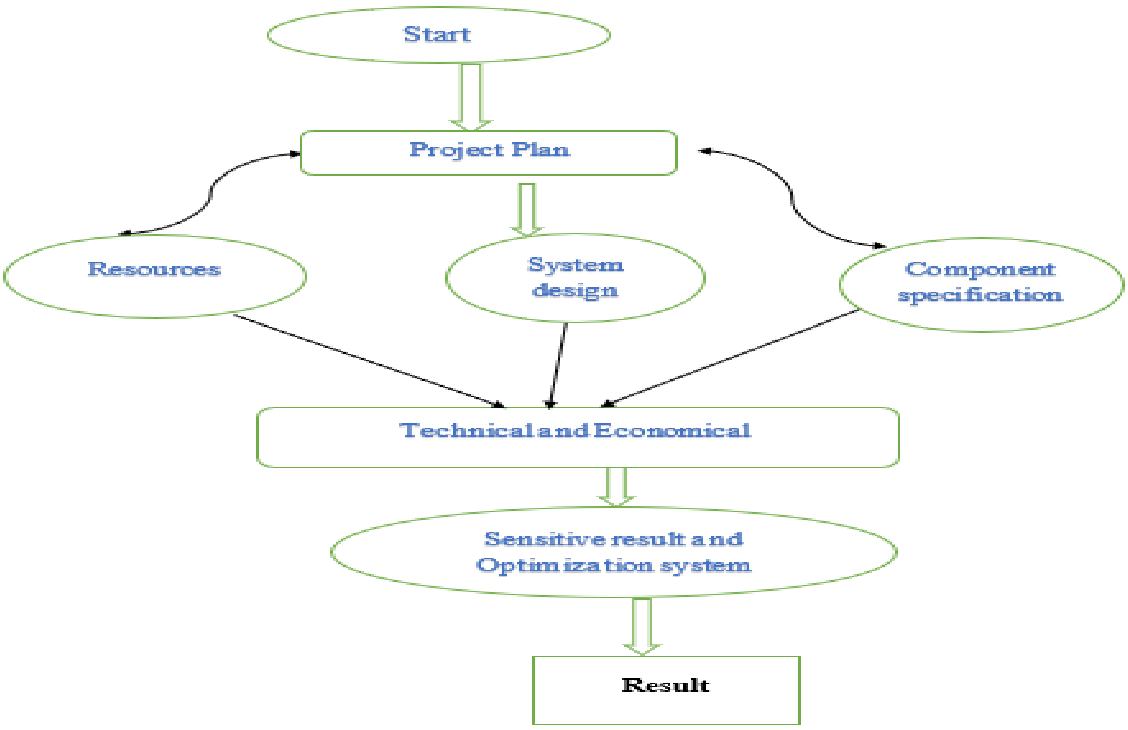


Fig.3.1: Flow chart of the working procedure

3.3 Types of solar system design

Solar system designs come in a variety of shapes and sizes. However, there are three fundamental design considerations:

1. Grid tie
2. Off-grid
3. Stand alone

3.4 Solar PV technologies

New solar energy systems are being launched, and old systems are being upgraded, in response to the rising demand for solar energy. Photovoltaic tissue is divided into four types:

- Single crystalline or even mono crystalline
- Multi- or even poly-crystalline
- Thin movie
- Amorphous silicon

Mono-crystalline vs. single-crystalline: It is widely available and one of the most effective tissue suppliers available. These are the ones that generate the most energy per square foot of component. Every cellular is separated from the single very. To maximize the volume of tissue, the wafers are then further reduced to the shape of rectangle-shaped tissue.

Polycrystalline tissue: These are made from similar silicon components, but instead of being formed into a single very, they're dissolved and placed in a solution.

Amorphous Silicon: Amorphous silicon is actually most recent within the slim movie technologies. With these technologies amorphous silicon watery vapor is transferred upon a few mini meter heavy amorphous movies upon stainless comes. [13] When compared to crystalline silicon, this particular technology utilizes just 1% from the materials. Desk 1 beneath exhibits the actual effectiveness associated with various kinds of solar panels.

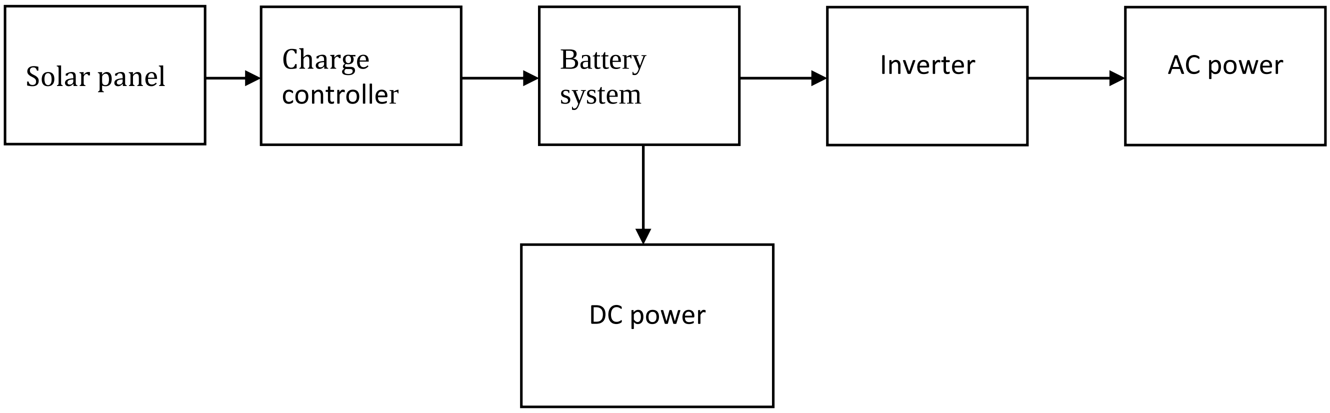
Cell type	**Efficiency, %**
Mono crystalline	12 – 18
Polycrystalline	12 – 18
Thin film	8 – 10
Amorphous Silicon	6 – 8

Table 3.1: Efficiency of different types of solar cells

3.5 Components of a solar PV system

Solar panels, charge controllers, batteries, inverters, and the load are all part of a typical solar PV system. The block diagram of such a system is shown in Figure 3.5.

Fig; 3.5Block Diagram of a typical solar PV System



3.6 Site Assessment:

This study was led in one of Daffodil worldwide University grounds. The grounds region is situated at (23°52.6'N, 90°19.3'E), with an elevation of 10 meters above ocean level and the normal of complete precipitation each month is 179 mm. Right now, the whole power interest of the grounds is provided by the utility framework through a circulation transformer. A basic off-grid model proposed in this examination is changed in accordance with the accessible nearby fuel sources. Off-grid is assembled utilizing photovoltaic as sustainable power plant. In this design, the introduced PV power is utilized ideally.

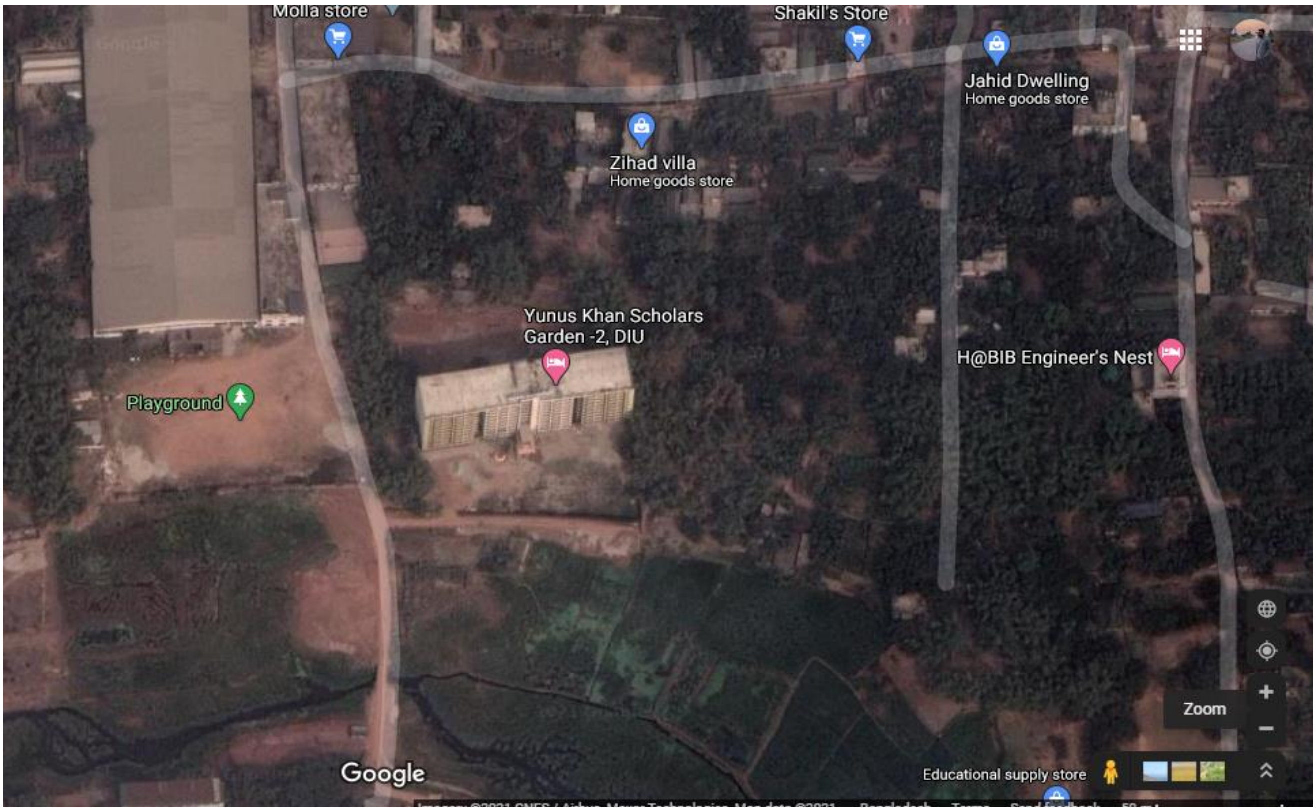


Fig.3.2: Satellite view of Yunus Khan Scholar's Garden building-02[DIU]

Fig.3.3: Building Site Front View

This structure can be found at Daffodil International University. The structure is positioned at a decent angle. and a flat roof for solar to the southeast, a tall building There are no problems with extreme shading.

Fig.3.4: West side Rooftop view

Fig.3.5: East side rooftop view

Yunus Khan Scholar's Garden building-02 Total Rooftop area =954m^2

CHEPTER-04

DATA COLLECTION

4.1 Introduction

This article gives an overview of the concept of 'Load Profiling.' It describes what a Load Profile is, how the Profile Administrator (PRA) creates them, and how they are applied to the Balancing and Settlement Code (BSC). Load profiling is a notion that has been around for a while. Since the foundation of the Electricity Commission, data has been gathered and analyzed for many years. Load Research by the Council The use of 'Load Profiles' for electricity settlement, on the other hand, is very recent, and was a result of the Power Pool's '1998 Program,' which was implemented to open up the electricity supply market to competition. To be able to avoid the exorbitant expenses of implementing Half-Hourly metering in every supply market consumer, it was agreed that customers with a maximum demand of less than 100 kW would be segregated load profiles and readings from clients' current electrical meters would be used to decide the dispute. The 'Profiling Taskforce' began an analysis effort in 1994 to determine the quantity and kind of profiles to be utilized in Settlement. It was agreed that there would be eight fundamental categories. sorts of profiles (Profile Classes) that would be changed to model the myriad of possibilities There are a variety of metering setups available in the power supply industry.

4.2 Load Assessment of the study area

The assessment of load is done carefully, firstly the base load as shown in table:1 was selected which should be converted on PV system then assessment of load was done by calculating the working hours of institute, according to the working hours the seasonally assessment of load was carried out. Younus khan scholars garden building 2 total load 179.366 KW

Total Load Calculation				
Sr. No	Name of Appliances	Quantity	Watt	Total Watt (Q.N)
1	Tube Light	960	22	21120
2	Celling Fan	864	65	56160
3	LED Light	888	12	10656
4	Laptop Charger	864	65	56160
5	Mobile Charge	864	25	21600
6	Air Exhaust	32	25	800
7	Lift	2	600	1200
8	Water Filter	16	25	400
9	Water Pump 10 hp	1	7460	7460
10	Water Pump 5 hp	1	3730	3730
11	CCVT	16	5	80
Total	11	4508	12034	179366

Table 4.1: Total load calculation

4.3 Determination of the daily consumption

In order to determine the daily consumption of the dwelling a table including all the appliances with an hourly time step was constructed. The table was then given to the occupants of the building so marks could be made when an appliance was used and in which time step it was used. They were asked to fill one out for a summer scenario and a winter scenario. This gave a good understanding of how often the appliances are used during the two different periods of the year. The recorded electrical consumption of each appliance was then inserted into these cells in order to quantify the amount of electricity used during each hourly time step, see Table 2 and table 3

Summer	Tube light (22 W)	Ceiling fan (65W)	Laptop Charger (65W)	Mobile Charger (25W)	Air Exhaust (25W)	Water Filter (25W)	Water Pump 10 hp (7460W)	Water Pump 5 hp (3730W)	Elevator (1200W)	LED Light (Room 12W)	LED Light (Washroom 12W)	LED Light (Corridor& Stair 12W)	CCTV (5 Watt)	Hourly Consumption
5:00 AM		56160					7460				2304	2976	80	68980
6:00 AM		56160				400	7460				2304		80	66004
7:00 AM		56160					7460				2304		80	66004
8:00 AM		56160						3730			2304		80	62274
9:00 AM		56160						3730	1200		2304		80	63474
10:00 AM		56160				400		3730	1200		2304		80	63474
11:00 AM		56160						3730	1200		2304		80	63474
12:00 PM						400			1200		2304		80	3584
1:00 PM									1200		2304		80	3584
2:00 PM			56160						1200		2304		80	59744
3:00 PM			56160						1200		2304		80	59744
4:00 PM			56160			400			1200		2304		80	59744
5:00 PM					800				1200		2304		80	4384
6:00 PM	21120	56160							1200	5376	2304	2976	80	89216
7:00 PM	21120	56160				400			1200	5376	2304	2976	80	89216
8:00 PM	21120	56160							1200	5376	2304	2976	80	89216
9:00 PM	21120	56160								5376	2304	2976	80	88016
10:00 PM	21120	56160				400				5376	2304	2976	80	88016
11:00 PM	21120	56160								5376	2304	2976	80	88016
12:00 PM		56160		21600							2304	2976	80	83120
1:00 AM		56160		21600							2304	2976	80	83120
2:00 AM		56160		21600							2304	2976	80	83120
3:00 AM		56160									2304	2976	80	61520
4:00 AM		56160									2304	2976	80	61520
Total	**126720**	**1010880**	**168480**	**64800**	**800**	**2400**	**22380**	**14920**	**14400**	**32256**	**55296**	**35712**	**1920**	**1548564**

Table 4.2: Summer hourly power consumption

Winter	Tube light (22 W)	Laptop Charger (65W)	Mobile Charger (25W)	Air Exhaust (25W)	Water Pump 10 hp (7460W)	Water Pump 5 hp (3730W)	Elevator (12200W)	LED Light (Room 12W)	LED Light (Washroom 12W)	LED Light (Corridor& Stair 12W)	CCTV (5 Watt)	Hourly Consumption
5:00 AM					7460				768	2976	80	11284
6:00 AM					7460				768		80	8308
7:00 AM					7460				768		80	8308
8:00 AM						3730			768		80	4578
9:00 AM						3730	1200		768		80	5778
10:00 AM						3730	1200		768		80	5778
11:00 AM				21600			1200		768		80	23648
12:00 PM				21600			1200		768		80	23648
1:00 PM				21600			1200		768		80	23648
2:00 PM		56160					1200		768		80	58208
3:00 PM		56160					1200		768		80	58208
4:00 PM		56160					1200		768		80	58208
5:00 PM				800			1200		768		80	2848
6:00 PM	21120						1200	5376	768	2976	80	31520
7:00 PM	21120						1200	5376	768	2976	80	31520
8:00 PM	21120						1200	5376	768	2976	80	31520
9:00 PM	21120						1200	5376	768	2976	80	31520
10:00PM	21120							5376	768	2976	80	30320
11:00 PM	21120							5376	768	2976	80	30320
12:00PM									768	2976	80	3824
1:00 AM									768	2976	80	3824
2:00 AM									768	2976	80	3824
3:00 AM									768	2976	80	3824
4:00 AM									768	2976	80	3824
Total	**126720**	**168480**	**0**	**65600**	**22380**	**11190**	**15600**	**32256**	**18432**	**35712**	**1920**	**498290**

Table 4.3: Winter Total Hourly Power Consumption

At the end of each time step the sum of consumption is shown in the column to the right. By adding the hourly consumptions together, the total daily consumption was reached. This daily consumption is based on the highest electrical consuming day of the week. The solar PV system is then designed on this high daily consumption so it can meet this load in case all the appliances are actually used on the same day.

During the winter and summer break and on weekends institute is close and with that in winter the consumption of electricity is less than summer.

CHEPTER-05

LOAD ANALYSIS

5.1 Introduction

To reduce CO2 emissions and provide advanced power management capabilities, smart and micro grids integrate renewable energy sources (RES), storage, and advanced metering infrastructure (AMI). As a result, optimization techniques are used to optimize power generation, distribution, and use. One of these grids' key goals is to match demand with supply and schedules. Energy demand, as well as electricity cost and availability, are factors in power generating. Overestimation and underestimating are both detrimental to energy generating and conversion systems, hence load demand estimation cannot be done indiscriminately. To effectively estimate consumption using historical and real-time data, load forecasting and profiling algorithms are utilized. The goal of this study is to look at the current state of load profiling research and evaluate its effectiveness. First, we will go through the various aspects. The energy usage of influence is then summarized by common load types and clusters. Finally, we go through some of the most prevalent load profiling methods and their drawbacks. To save space, we have removed a detailed performance comparison of load profiling techniques, load factors, and clustering techniques.

5.2 Types of Loads

The classification of loads determines energy consumption levels and the ability to move appliances to different times. It's also useful for figuring out what related loads are and how they behave. Loads are divided into three categories based on their energy consumption: Brown items, white goods, and small appliances are all available. Brown items are relatively light electric items, such as workplace and entertainment equipment. Heavy electric equipment and significant appliances, such as HVAC systems, fall into the second category. Because of its stochastic nature, this group is difficult to mathematically model. Small appliances, such as blenders and cell phones, are light electric equipment that are not regularly used chargers.

Loads can also be classified according to their Demand-Response (DR) opportune-ties and constraints. Some loads can be shifted from the current time period to a later one. Other loads cannot be shifted either because of their machine cycle or the user comfort levels, such as fridges and lighting. The following categories are identified: storage, shiftable, non-shiftable and thermal loads. Clustering loads is used to generate models and extract characteristics for DR applications.

5.3 HOMER Pro Software

The HOMER Pro, a miniature framework programming by HOMER Energy, is the worldwide norm for improving microgrid plan in all areas, from town force and island utilities to network associated grounds and army installations. Initially created at the National Renewable Energy Laboratory, USA, and upgraded and disseminated by HOMER Energy. HOMER (Hybrid Optimization Model for Multiple Energy Resources) homes three integral assets in one programming item, so that designing and financial aspects work one next to the other. At its center, HOMER is a recreation model. It will endeavor to reproduce a feasible framework for all potential blends of the hardware under thought. HOMER recreates the activity of a crossover miniature matrix for a time of year, in time ventures from one moment to 60 minutes.

5.4 Modeling of the Solar PV Power Generation

The components are selected from HOMER Pro software for designing the off-grid solar system. Figure:3.5 shows the off-grid or without grid designed system which consist of Generator, PV array, converter, and batteries for backup system.

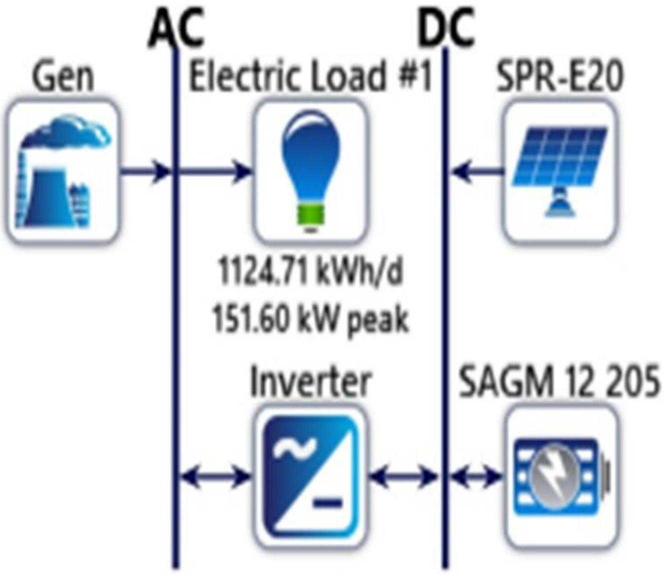


Fig.5.1: Homer schematic diagram of Off grid solar rooftop System

5.5 Design Requirement:

- **Generator**
- **Electrical Load**
- **Inverter**
- **SAGM 12 205 Battery**
- **SPR-E20 Solar PV**
- **AC Busbar**
- **DC Busbar**

5.6 Solar Radiation Profile:

Solar radiation information and Cleanness Index information are recovered online from HOMER Energy Website, which is informational collection: NASA SSE World. Information scope and longitude of the examination area (23°52.6'N, 90°19.3'E) and the time region of area (GMT +06) are entered to the HOMER programming. Scaled yearly normal of sunlight based worldwide even irradiance (GHI) information got is shown 4.8 kwh//day.

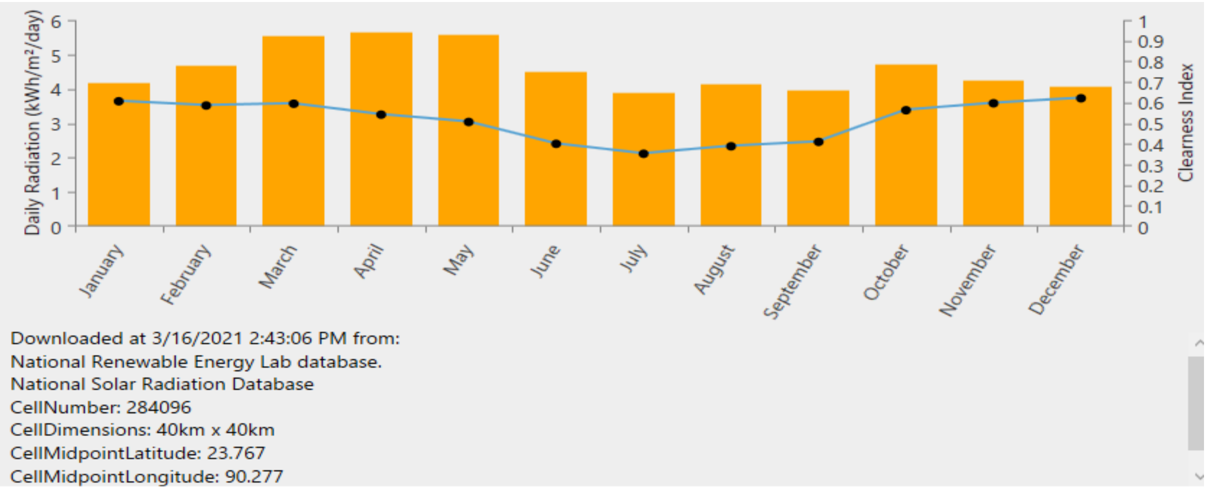


Fig.5.2: Solar Radiation Profile for Younus Khan Scholars Garden-2, (DIU)

5.7 Load Profile:

The characteristics of electric load depend on the activities performed and equipment used. The electrical usage was measured every hour for 24 hours. Furthermore, the electricity bill was also considered to represent the electricity usage. Afterward, those data are compared to be an input variable for HOMER. The load profile of the assumed load is shown in the Fig- 3.11 and is based on the Hostel building of the campus. A load of around 1KW remains throughout the day in the 24-hour profile while a maximum load of 60KW appears at the evening. Monthly and seasonal load profiles can be seen in fig.3.12. And fig.3.13 It shows the difference loads every time, especially when winter season.

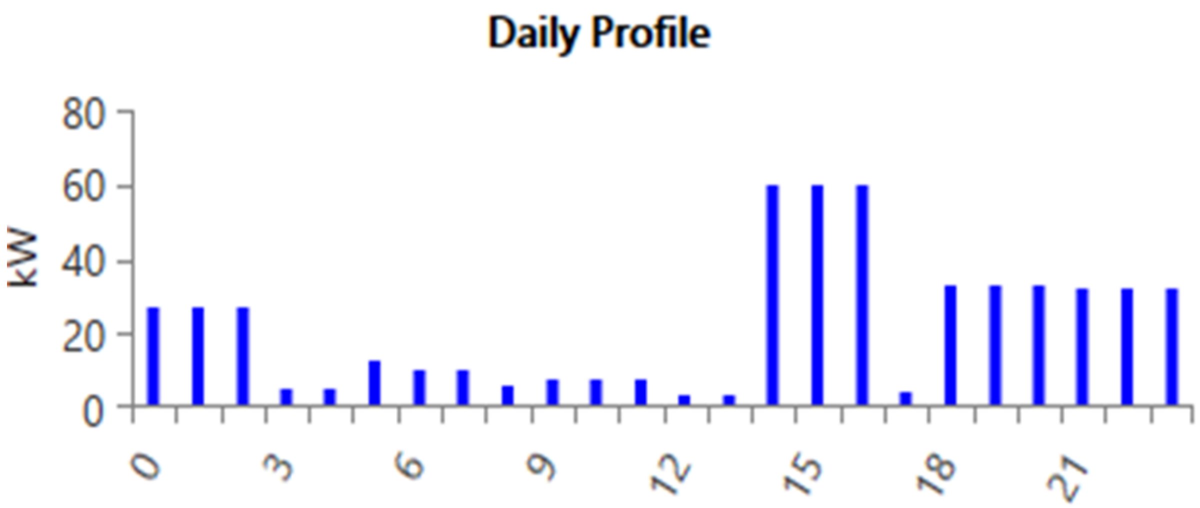


Fig.5.3: Daily Load Profile

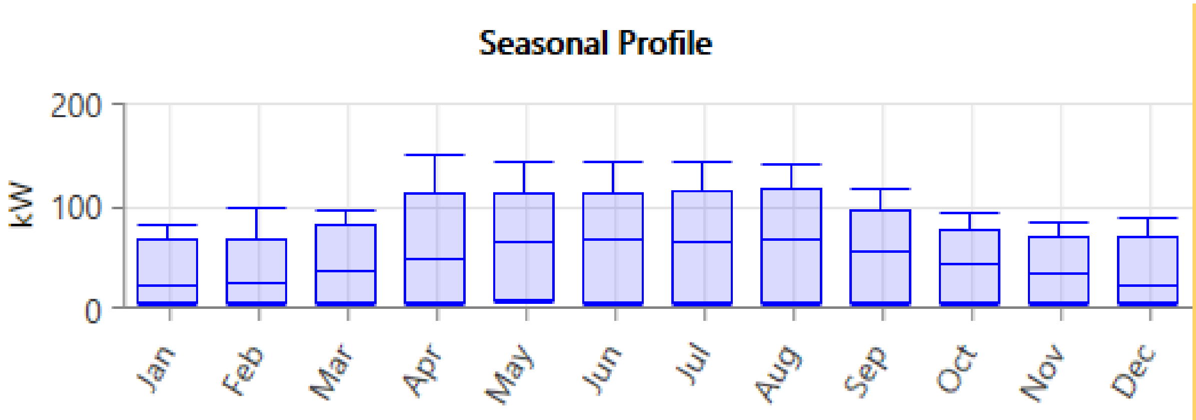


Fig.5.4: Monthly Load Profile

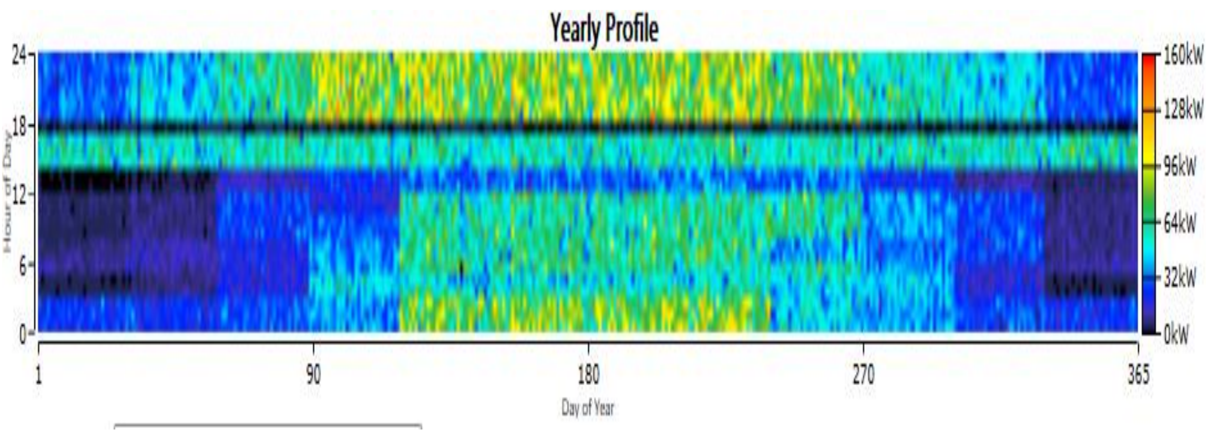


fig.5.5: Yearly load profile

Monthly Load Profile

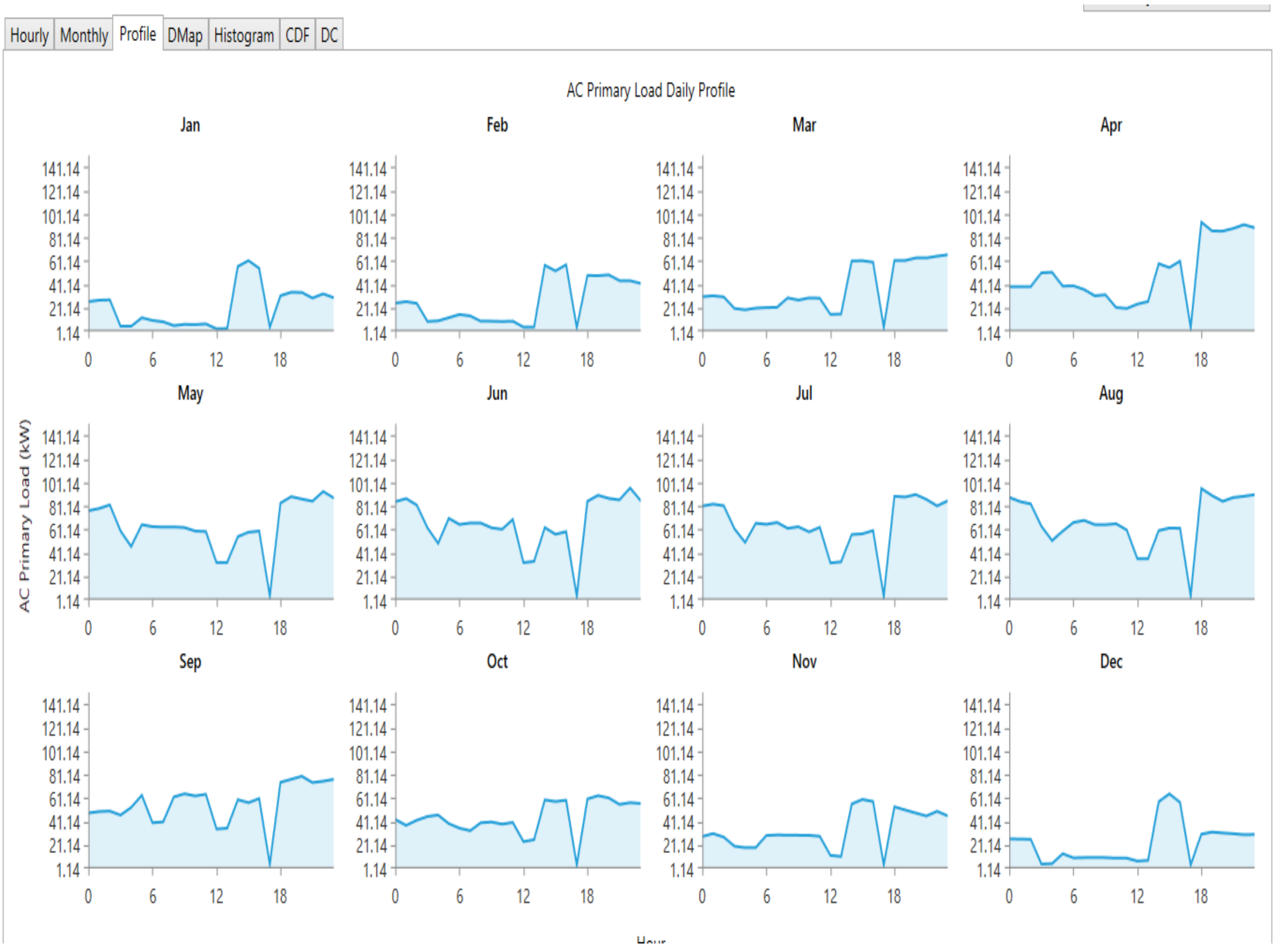


Fig 5.6: Monthly load profile of Younus khan Scholar's Garden-2

5.7.1 Generator:

Module parameter	Value
Type	Auto size genset
Minimum Electrical Output	42.5 kw
Maximum Electrical Output	152 kw
Fuel Consumption	114,016 L
Specific Fuel Consumption	0.330 L/KWH
Mean Electrical Efficiency	30.8%
Operational Life	2.53 yr
Capacity Factor	23.2%
Electrical Production	345,670 kwh/yr

Table 5.7.1: Generator model parameter

Auto size Genset Output (kW)

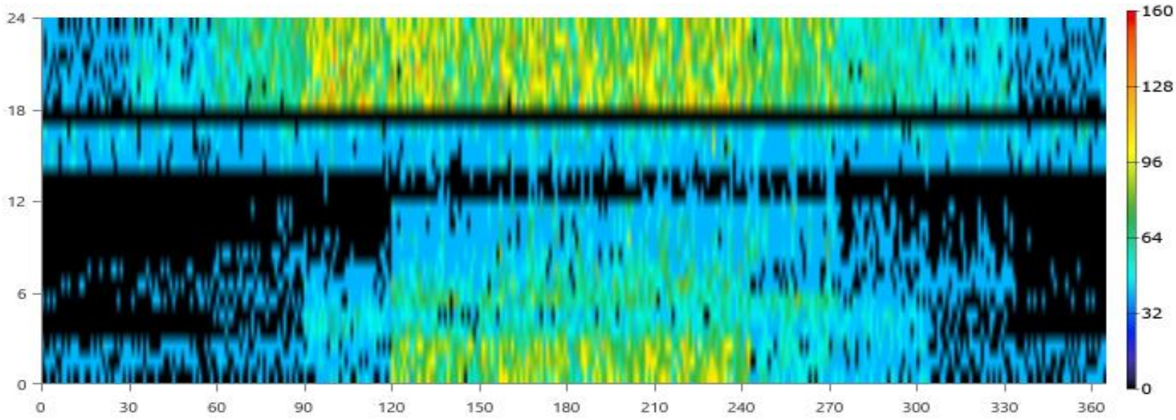


Fig.5.6: Generator output

5.7.2 Solar pv module:

The PV modules used is generic. The PV array size is estimated from the load demand. The considered PV system rating is 95 kW, but the sizes considered for the simulation are 90kW and 100kW. The initial cost, replacement cost, operation and maintenance cost are adjusted to cover the balance of system cost and others. The solar module parameters are shown in table 5:

Module parameter	Value
Type	**SunPower X21-335-BLK**
Rated capacities considered	90 KW and 100 KW
Panel type	Flat plate
Output current	DC
Lifetime considered	25years
PV derating factor	88%
Tracking system	No Tracking
Azimuth	0 deg
Ground reflectance	20%
Capital Cost per kW	342.97USD
Replacement cost	342.97USD
Operation and maintenance cost	10/year

Table 5.7.2: solar module parameters

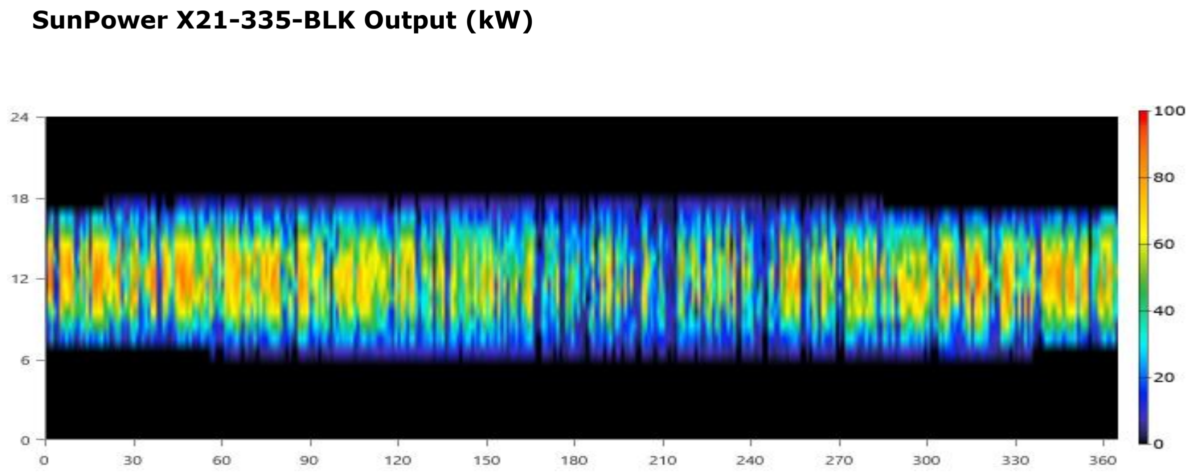


Fig 5.7: Annual Energy Penetration of SPV array at the site

5.7.3 Batteries:

Batteries are an integral part of hybrid renewable energy systems. The battery backup adds stability to the network by storing energy during peak generation and releasing the energy for peak consumption when there is insufficient generation from renewable sources. The battery considered for the project is a Trojan SAGM 12 205 capacity battery with supplier integration into HOMER-Pro. The particulars and cost are given in the software. The battery model parameters are shown in Table 6

Module parameter	**Value**
Type	Kinetic battery model
Quantities considered	30,35,40,45
String size	1
Expected lifetime	5 years
Nominal voltage	12 V
Nominal capacity in KWh	2.63 KWh
Nominal capacity in Ah	219 Ah
Roundtrip efficiency	90%
Maximum charging current	41 A
Maximum discharge current	300 A
Annual throughput	20,572 kWh /yr
Initial state of charge	100%
Minimum state of charge	20%
Capital Cost per unit	459.95 USD
Replacement cost	459.95 USD
Operation and maintenance cost	4 USD

Table 5.7.3: The battery model parameters

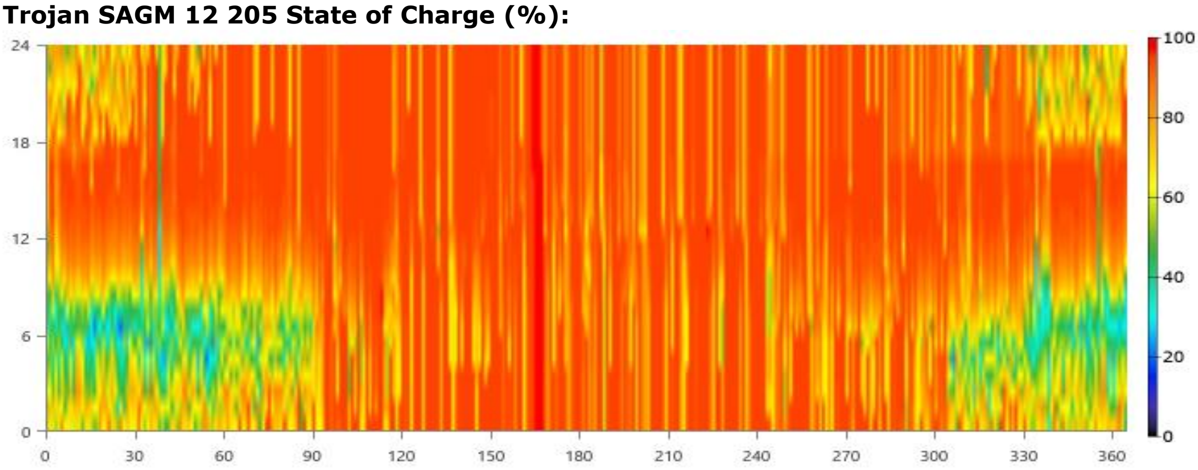


Fig 5.8: Battery state of charge

5.7.4 Converter:

The bidirectional converter is utilized to interface between the DC transport associated with the PV framework and the AC transport fueled from the hydro framework. A conventional enormous free converter was chosen from the HOMER information base to permit battery measuring without estimating the converter for various ESS and charging arrangements, for example, load following (LF) and cycle charging (CC). The inverter and rectifier efficiencies of the converter were taken as 95% each. Table 7 shows the converter model parameters.

Module parameter	**Value**
Type	Generic large free converter
Lifetime	10 years
Inverter can parallel with AC generator?	Yes
Rectifier relative capacity	96%
Rectifier/Inverter efficiency	96%
Capital Cost per unit	38,670 USD
Replacement cost	38,670 USD

Table 5.7.4: Converter model parameters

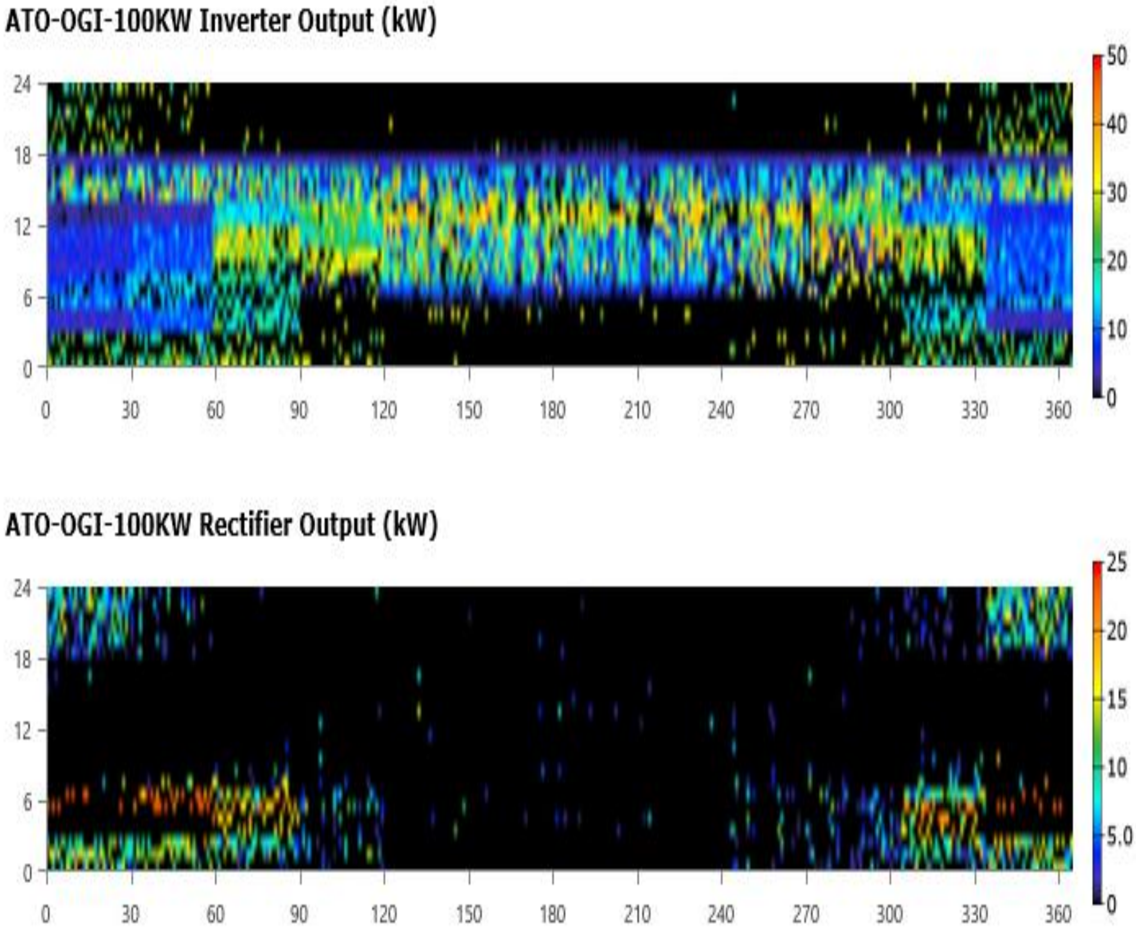


Fig.5.9: The energy output profile of bi-directional converter during period of one year

CHAPTER-06

RESULT AND DISCUSSION

6.1 Introduction:

Global warming is motivating practically all nations in the world to develop alternative sources of solar, wind, geological, and wind power, such as nuclear and renewable energy, which are not carbon reasons, due to greenhouse gas emissions and a shortage of global power. Emitted Nuclear power is available to wealthy countries, but emerging countries like Bangladesh are not that fortunate. As a result, renewable energy sources such as solar and hydro power are now the only options available in Bangladesh. Bangladesh is a semi-tropical country in northeastern South Asia that receives enough of sunshine all year.

6.2 Installed components:

The following are Four major components of the system running. The components installed in the system can be seen in the table.1. Component Name Size Unit Generator Auto size Genset 170 KW PV SunPower X21-335-BLK 95 KW Storage Trojan SAGM 12 205 45 strings System Converter ATO-OGI-100KW 49.9 KW Dispatch strategy HOMER Load Following.

Component	Name	Size	Unit
Generator	Autosize Genset	170	kW
PV	SunPower X21-335-BLK	95.0	kW
Storage	Trojan SAGM 12 205	45	strings
System converter	ATO-OGI-100KW	49.9	kW
Dispatch strategy	HOMER Load Following		

Table 6.1: System Architecture

6.3 Cost Analysis:

If users replace their existing system with rooftop solar system, then within 18 years they can recover their initial cost; that means the payback period is 18 years. Here in the rooftop PV system no subsidy has been considered for that reason the payback period is much higher. If we consider 40% government subsidy as per process, then the payback period will be much lower than the present value. Therefore, by adopting this proposed system users can save their money and improve their economic conditions. In a SRS (Solar Rooftop System) generally a large portion of cost around 80% of total cost has been added because of the battery and its short lifespan. The cost summary of the proposed project is shown in Fig 4.1

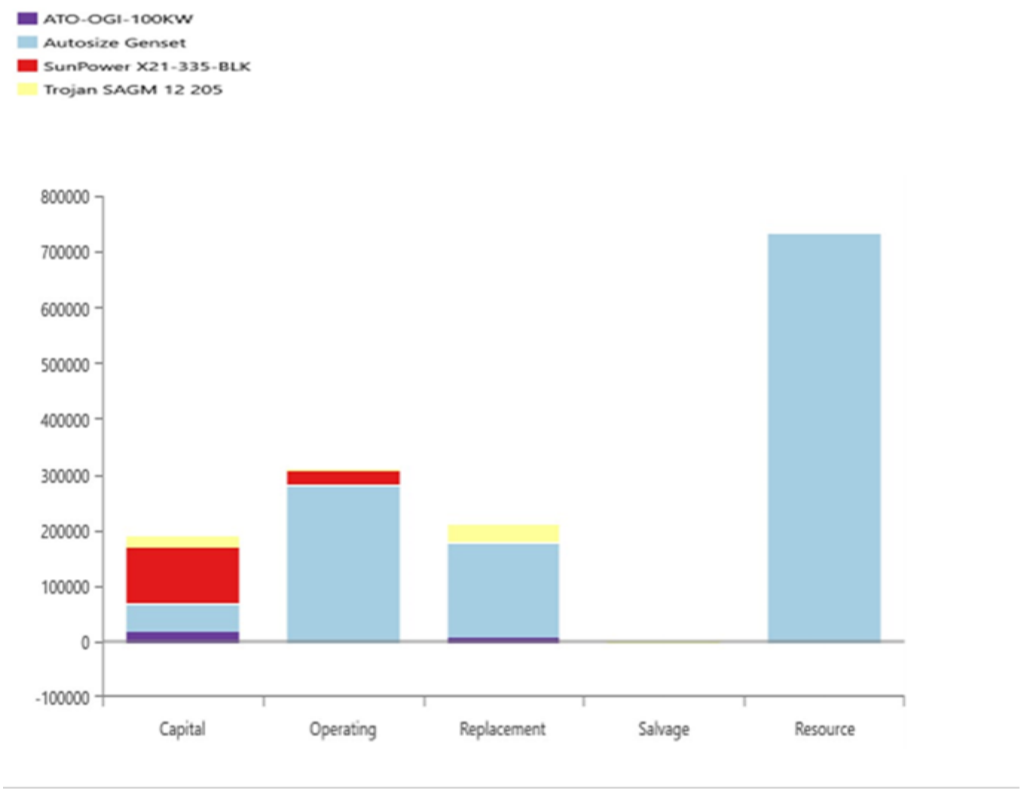


Fig.6.1: Cost flow summary of SRS over lifespan.

From the cost summary displayed in Fig.4.1, it can be seen that the bulk of expenses is due to the specific Generator Auto size Genset. The long lifespan of PV cells and inverter contribute to the system's feasibility for use. Fig.4.2 presents the yearly cash flow of each component of SRS for the lifespan.

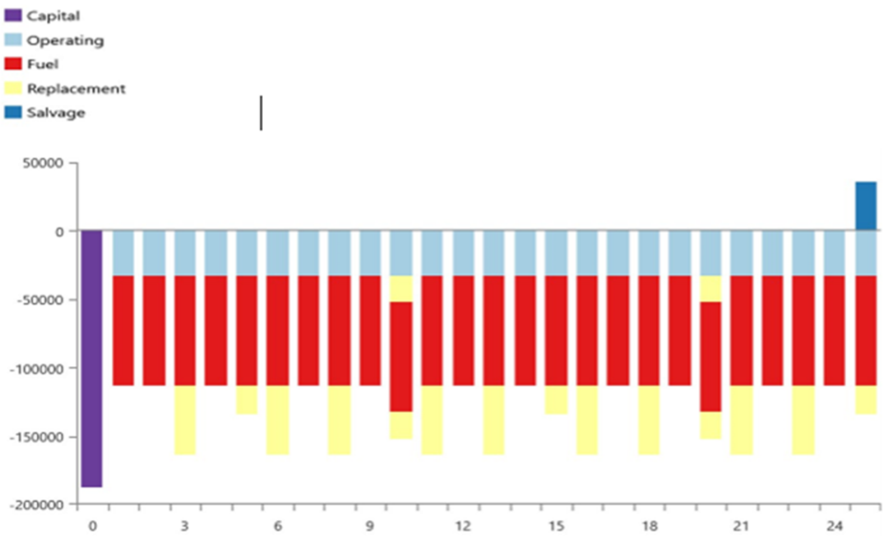


Fig.6.2: Cash flow of SRS over lifespan

The cash flow diagram provides us a clear idea of the typical expenses of different components of SRS. For our system, a user will initially need to spend a fairly amount of money and then spend smaller amounts periodically. It is important to note that every five years users will need to replenish the battery because of its limited lifespan. The inverter and cost will add once 15 year is passed also battery cost will be add after 5 year and at the end of the life span of the system salvage value will return or the system will be replaced completely. The nominal cost of the system is also mentioned for every year, which includes periodic servicing of the inverters and cleaning the panels.

6.4 Net present cost and Annulized cost:

Name	Capital	Operating	Replacement	Salvage	Resource	Total
ATO-OGI-100KW	$18,827	$897.37	$10,290	-$908.48	$0.00	$29,106
Autosize Genset	$51,000	$278,850	$168,426	-$549.60	$735,337	$1.23M
SunPower X21-335-BLK	$97,260	$26,134	$0.00	$0.00	$0.00	$123,394
Trojan SAGM 12 205	$20,698	$1,659	$31,418	-$1,981	$0.00	$51,794
System	$187,785	$307,540	$210,133	-$3,439	$735,337	$1.44M

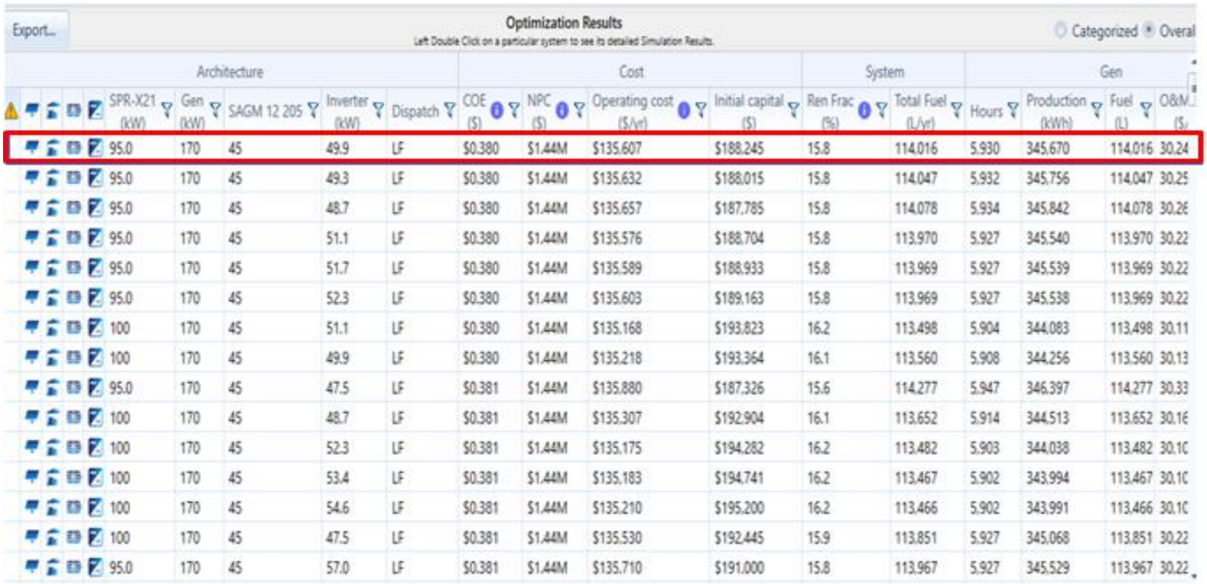
Table 6.2: Net Present cost

Name	Capital	Operating	Replacement	Salvage	Resource	Total
ATO-OGI-100KW	$2,043	$97.38	$1,117	-$98.58	$0.00	$3,158
Autosize Genset	$5,534	$30,258	$18,276	-$59.64	$79,792	$133,801
SunPower X21-335-BLK	$10,554	$2,836	$0.00	$0.00	$0.00	$13,390
Trojan SAGM 12 205	$2,246	$180.00	$3,409	-$214.93	$0.00	$5,620
System	$20,377	$33,371	$22,802	-$373.15	$79,792	$155,969

Table 6.3: Annualized cost

6.5 Economic Analysis:

Batteries are utilized for back power in off-grid systems that are not connected to the grid. The cost analysis of this off-grid system is shown in Figure 8, how in the architecture of components section for PV (kW), the capacity optimization of limit was given approximately 90 and 100 kW according to the peak demand, from which the HOMER selected 95 kW from the boundaries, and the battery was chosen with such a nominal capacity of 45 kWh and the adapter was chosen with a nominal capacity of 49.9 kW. The cost of the overall network for 25 years is calculated in the cost section; thus COE (cost of energy) is $0.380, NPC (Net Present Cost) is $1.44M, and the system's starting cost is $1.44M. $188,245 and nominal discount rate taken is 12%


Export...
Optimization Results
Left Double Click on a particular system to see its detailed Simulation Results.
Categorized Overall

Architecture					Cost				System		Gen				
SPR-X21 (kW)	Gen (kW)	SAGM 12 205	Inverter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial capital ($)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M ($
95.0	170	45	49.9	LF	$0.380	$1.44M	$135,607	$188,245	15.8	114,016	5,930	345,670	114,016	30,24
95.0	170	45	49.3	LF	$0.380	$1.44M	$135,632	$188,015	15.8	114,047	5,932	345,756	114,047	30,25
95.0	170	45	48.7	LF	$0.380	$1.44M	$135,657	$187,785	15.8	114,078	5,934	345,842	114,078	30,26
95.0	170	45	51.1	LF	$0.380	$1.44M	$135,576	$188,704	15.8	113,970	5,927	345,540	113,970	30,22
95.0	170	45	51.7	LF	$0.380	$1.44M	$135,589	$188,933	15.8	113,969	5,927	345,539	113,969	30,22
95.0	170	45	52.3	LF	$0.380	$1.44M	$135,603	$189,163	15.8	113,969	5,927	345,538	113,969	30,22
100	170	45	51.1	LF	$0.380	$1.44M	$135,168	$193,823	16.2	113,498	5,904	344,083	113,498	30,11
100	170	45	49.9	LF	$0.380	$1.44M	$135,218	$193,364	16.1	113,560	5,908	344,256	113,560	30,13
95.0	170	45	47.5	LF	$0.381	$1.44M	$135,880	$187,326	15.6	114,277	5,947	346,397	114,277	30,33
100	170	45	48.7	LF	$0.381	$1.44M	$135,307	$192,904	16.1	113,652	5,914	344,513	113,652	30,16
100	170	45	52.3	LF	$0.381	$1.44M	$135,175	$194,282	16.2	113,482	5,903	344,038	113,482	30,10
100	170	45	53.4	LF	$0.381	$1.44M	$135,183	$194,741	16.2	113,467	5,902	343,994	113,467	30,10
100	170	45	54.6	LF	$0.381	$1.44M	$135,210	$195,200	16.2	113,466	5,902	343,991	113,466	30,10
100	170	45	47.5	LF	$0.381	$1.44M	$135,530	$192,445	15.9	113,851	5,927	345,068	113,851	30,22
95.0	170	45	57.0	LF	$0.381	$1.44M	$135,710	$191,000	15.8	113,967	5,927	345,529	113,967	30,22

Fig.6.3: Overall HOMER optimization results according to the total net present cost.

6.6 Sensitivity Analysis

To explore possible discrepancies in the results caused by key parameter variations, sensitivity analysis was performed for important parameters, such as Fit degression, initial investment cost, project lifetime and electricity export cost. COE production varied between 0.380,0.394 and 0.367 $ /kWh with a we considered degression rate of 8% per year. Results of sensitivity analysis of NPC varied significantly in terms of Fit rate (e.g., $1.44M, $1.13M and $1.95M), as shown in Fig. 4.4. sensitive variable is diesel fuel price 0.7 dollar per liter and nominal discount rate 12% shown in fig 4.5

Export... | Export All... | Sensitivity Cases — Left Click on a sensitivity case to see its Optimization Results. | Compare Economics | Column Choices...

Sensitivity	Architecture					Cost			
NominalDiscountRate (%)	SPR-X21 (kW)	Gen (kW)	SAGM 12 205	Inverter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial cap ($)
12.0	95.0	170	45	49.9	LF	$0.380	$1.44M	$135,607	$188,245
16.0	95.0	170	45	48.7	LF	$0.394	$1.13M	$135,089	$187,785
8.00	100	170	45	51.1	LF	$0.367	$1.95M	$135,520	$193,823

Fig.6.4: sensitive analysis

Variable	Value	Unit
Diesel Fuel Price	0.700	$/L
Nominal Discount Rate	12.0	%

Fig.6.5: Sensitive variable

6.7 Production and consumption of electricity:

Table 4 and Table 5 as shown below the production of electricity is shown by PV system is 491,533 kWh/year and the consumption is 410,521 kWh/year and Excess energy is 74110 kwh/yr energy is if in case any variability occurs in the load then the system can manage.

Component	Production (kWh/yr)	Percent
SunPower X21-335-BLK	145,863	29.7
Autosize Genset Generator	345,670	70.3
Total	491,533	100

Table 6.4: Production summary

Component	Consumption (kWh/yr)	Percent
AC Primary Load	410,521	100
Total	410,521	100

Table 6.5: Consumption summary

6.8 Environmental Impacts

In the proposed rooftop PV system, we can reduce 298,379kg/yr CO2 also reduced carbon monoxide, unburned hydrocarbons etc. Therefore, we can reveal that beside the monetary benefit it should also be mentioned that the current grid supply that is generated from the fossil fuel as a result of the CO2 emissions is much higher. Whereas using the proposed stand-alone system can reduce the demand of energy from the grid as a result reducing the overall CO2 emissions.

Pollutant	Quantity	Unit
Carbon Dioxide	298,450	kg/yr
Carbon Monoxide	1,881	kg/yr
Unburned Hydrocarbons	82.1	kg/yr
Particulate Matter	11.4	kg/yr
Sulfur Dioxide	731	kg/yr
Nitrogen Oxides	1,767	kg/yr

Table 6.6: Emissions

6.9 Result summary:

The total output of the optimization depends on Net Present Cost. All other parameters are defined according to the Net Present Cost and an overall result is obtained. The initial capital cost was $188,245 while the total cost comes out to be $97,260 in the solar PV system. The savings in this new system is not only through the cost but also through the carbon emission. The carbon emission result shows a huge difference of 298,450 kg/year.

6.10 Discussion:

The results highlight the fact that the use of HOMER Pro as a design and simulation tool in the design of off grids and optimization of various renewable energy installations is quite extensive. The study covers the design and implementation of a solar renewable energy system. The main objective of the research is to design and evaluate the performance of a rural electrification project using off grid renewable energy systems. Sources considered were solar PV systems. The results show that renewable energy can play a satisfying role in providing electricity to rural communities. The results of the design can be improved if actual costs are obtained from the manufacturers and suppliers. The study also illustrates the fact that off grid renewable energy systems, though small-scaled, are endowed with high operational and constitutive sophistication. However, modern technology allows reliable and cost-competitive energy generation in remote areas, surpassing the convenience of traditional solutions using grid extension or diesel generation by economic and environmental considerations.

The results demonstrate that the system offers the least cost of energy for the required quality and level of service. In some instances, the most practical system might not be the most cost-effective. In the simulation results, the optimal system provided by HOMER Pro has a net present cost (NPC) of $1.4M and cost of energy, $0.380. The researchers found the least cost of energy in the simulation is $0.367. An NPC of $1.95M, which is much lower than that proposed by the software, but NPC cost is higher.

CHAPTER-07

CONCLUSION

A careful prospection of resources must be made, as well as the characterization and analysis of the loads. This leads to the better design of the generating components and storage system that converts the variable and intermittent availability of resources into a continuous and reliable electric supply. Collecting meteorological data at the site is the first step of the hybrid design. The solar energy potential can be estimated by consulting solar radiation maps, satellite images, NASA and NREL databases, or by measuring global radiation at the site. With this data, it is possible to determine the available solar resource by the calculation of the peak sun hours. Sizing of these sources requires performing multiple simulations in scenarios of days or months.

The study indicates that the selected campus hostel, having considerable annual average global solar radiation (4.8 kWh/m2/day) is a good prospective candidate for the deployment of a Solar system comprising solar photovoltaic (PV) array, converter, a diesel generator and batteries. The simulation results indicate that the most economic, technical and reliable system for the off-grid system would be composed of a 95-kW solar PV array, a 170-kW diesel generator, and 45 batteries (each with has a nominal voltage of 12v and capacity of 205Ah) for Younus khan scholars garden-02, Daffodil International University. Due to high diesel cost, power generation based solely on diesel with a battery storage system, is not economically viable.

The cost of energy for the best-optimized system is $0.380 kWh. The (net present cost) NPC of the system is $1.44M; initial capital costs are $188,245; diesel requirement is 114,016 L per year; and the generator would operate for 5,930 h per year. The major share of electricity in the comes from Generator, which provides power at low cost. The solar PV modules, diesel generator contribute 29.7%, 70.3% respectively.

HOMER pro software was used to provide necessary data regarding the cost and financial analysis to determine the annual energy produced and the amount of GHG reduction according to the produced clean energy. Estimations of energy yield using HOMER software are in close agreement with the actual measured results and showed an error of 2.31%. In addition, the utilization of PV systems can implement green campus policies.

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