Solar PV Grid Connected power plant analytical design by RETScreen in Daffodil International University, Bangladesh

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

Bachelor of Science in Electrical and Electronic Engineering

By

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DAFFODIL INTERNATIONAL UNIVERSITY

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On Grid Solar PV Power Plant

ABSTRACT
The Plant is designed in Daffodil International University, Permanent Campus Academic Building-04. Whereas the power is supplied to the national Grid if the generated power will be extra.

Mobasshir Kaisar & Md. Shadman Al Sakib

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Units and Symbols

AH: Ampere hour

KW: Kilowatt

KWh: Kilowatt hour

KWh/m^2: Kilowatt hour per square meter

KWh/m^2/d: Kilowatt hour per square meter per day

MW: Mega Watt

m^3/day: Cubic meter per day

TK: Taka

V: Volt

W: Watt

Wp: Watt Peak

W/m^2: Watt per square meter

^{0}C: Degree Celsius

Km: Kilometer

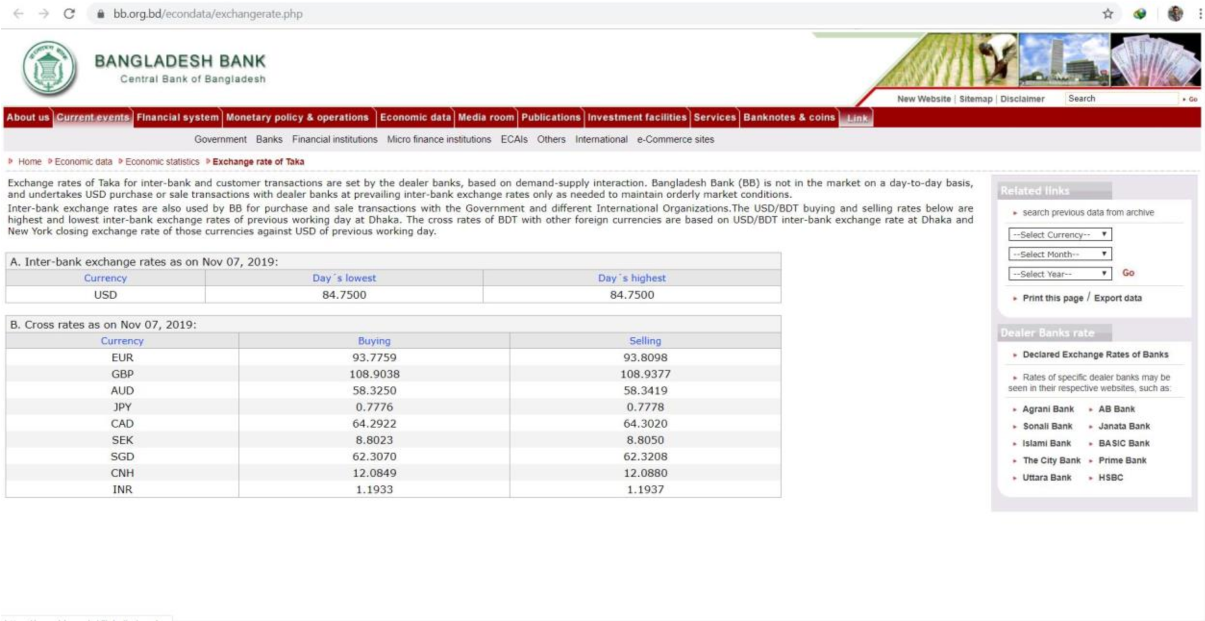
%: Percentage

m/s: meter per second

Currency and Conversion Rate

Bangladeshi Currency : Taka

1 United States Dollar (US$) = 84.75Taka


bb.org.bd/econdata/exchangerate.php

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Exchange rates of Taka for inter-bank and customer transactions are set by the dealer banks, based on demand-supply interaction. Bangladesh Bank (BB) is not in the market on a day-to-day basis, and undertakes USD purchase or sale transactions with dealer banks at prevailing inter-bank exchange rates only as needed to maintain orderly market conditions.

Inter-bank exchange rates are also used by BB for purchase and sale transactions with the Government and different International Organizations.The USD/BDT buying and selling rates below are highest and lowest inter-bank exchange rates of previous working day at Dhaka. The cross rates of BDT with other foreign currencies are based on USD/BDT inter-bank exchange rate at Dhaka and New York closing exchange rate of those currencies against USD of previous working day.

A. Inter-bank exchange rates as on Nov 07, 2019:

Currency	Day´s lowest	Day´s highest
USD	84.7500	84.7500

B. Cross rates as on Nov 07, 2019:

Currency	Buying	Selling
EUR	93.7759	93.8098
GBP	108.9038	108.9377
AUD	58.3250	58.3419
JPY	0.7776	0.7778
CAD	64.2922	64.3020
SEK	8.8023	8.8050
SGD	62.3070	62.3208
CNH	12.0849	12.0880
INR	1.1933	1.1937

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Dealer Banks rate
- Declared Exchange Rates of Banks
- Rates of specific dealer banks may be seen in their respective websites, such as:
- Agrani Bank
- AB Bank
- Sonali Bank
- Janata Bank
- Islami Bank
- BASIC Bank
- The City Bank
- Prime Bank
- Uttara Bank
- HSBC

(Source: http://bb.org.bd/econdata/exchangerate.php , Printed on November 07, 2019)

Acknowledge

We, as students of Daffodil International University, have long been planning to improve the university and do something for the students. From that plan and attraction to renewable energy, I plan on that power plant. According to the plan, the placement comes first. For this, I will be forever grateful to Dr. Alam Hossain Mondal sir.

A larger space was needed to determine the location. In determining the location, I will discuss the selection with Dr. Alam Hossain Mondal sir and Major Arman Ali Bhuiyan sir, Project Director of the University Permanent Campus. My sincere gratitude to Major Arman sir. By collecting the design of the building from the University Development Board, we determined the area of the roof of the building.

From the design of the building, we have determined the load demand of the building according to the plan of each floor of the building.

Our designated place is the Academic Building - 04. It is currently the largest building in the university. We have future plans, the whole university will one day be lit with solar power. Each building of the university will be a solar building. University Chairman, with the help of Mr. Sabur Khan Sir, one day we will be able to cross the boundaries of the University and work on our projects in different places of the country.

The name of our project will be "Solar Bangladesh". I hope that this project will make the university students interested in employment and young entrepreneurs.

Executive Summary

The power division in Bangladesh is profoundly subject to non-renewable energy sources, as petroleum gas and coal are the commanding hotspots for control age in the nation. About 62.9% of Bangladeshi produced power originates from petroleum gas, while 10% is from diesel, 5% originates from coal, 3% of overwhelming oil, and 3.3% is of inexhaustible sources.

Regardless of the way that the Bangladeshi vitality division uses and covers differed items; power, oil based goods, petroleum gas, coal, biomass and sun powered, yet the strategy and leaders are for the most part pre-busy with power, as it is the most well-known utilized type of vitality in the nation. In this manner, in light of the fact that there is a consistent and quickly enlarging hole between power organic market, in this manner it is a significant test for the vitality division in Bangladesh.

In 2016, the absolute number of buyers associated with the lattice is 21.8 million. Out of the 21.8 million, 16 million are local associations (family units), which would speak to generally half of every single Bangladeshi family (30-40 million). Another 15% of the family units approach off-framework power.

The nation have extraordinary potential for sun powered vitality, with normal sun powered vitality occurrence around 4-6.5 kWh/m^2/day, and averaging 10.5 long periods of sun every day, of which 4-4.5 are top daylight hours and 300 clear bright days out of each year. Right now, the nation is viewed as a market chief with regards to SHS, and independent PV frameworks.

Regardless of that incredible sun powered potential the nation have, yet the vast majority of the arranged sun based tasks in the previous barely any years have been habitually deferred. This is because of the way that Bangladesh is an agrarian culture, consequently securing non-farming, reasonable land for sun oriented ventures speaks to an obstruction for these projects. All things considered, Bangladesh has effectively charged two sunlight based plants over the most recent 5 years; one is 20 MW plant in Cox's Bazar, and the other is a 3 MW plant in Sarishabari, Jamaplur.

Our designated place is the Academic Building - 04. It is currently the largest building in the university. We have future plans, the whole university will one day be lit with solar power. A software named PVSol used to design power plants and a software named RETScreen to analysis on solar pv grid connected power plant.

CHAPTER 1

INTRODUCTION

1.1 Background

A grid-connected PV system, is a power-generating solar PV power system that is connected to a utility grid. On grid-connected PV systems consist of solar panels, inverters, a power control unit and grid connection equipment's. They range from small residential and commercial roof top systems to large solar power plants. When the conditions will be right, the on grid-connected PV system supply additional power beyond the use of connected loads on the utility grid.

Grid-connected photovoltaic systems consist of PV panels connected to the grid through a power control unit are designed to operate in parallel with the electronic utility grid.

The intensity of the sun is the thing that makes life on Earth conceivable. Endeavors to outfit sunlight based vitality in concentrated structure have for quite some time been a human interest. The historical backdrop of sun based power isn't as later as some may might suspect as the innovation has existed since the nineteenth century and has gotten generous government support since in any event the 1970s. Regardless of immense measures of endowments, sun based power includes under 1 percent of US power age and should never again be propped up by citizen dollars.

The improvement of sun oriented cell innovation, or photovoltaic (PV) innovation, started during the Industrial Revolution when French physicist Alexandre Edmond Becquerellar first exhibited the photovoltaic impact, or the capacity of a sun based cell to change over daylight into power, in 1839. Around four decades later, American creator Charles Fritts made the world's first housetop sun oriented exhibit in New York in 1883, one year after Thomas Edison opened the world's first business coal plant. Fritts covered the boards with selenium to create an exceptionally feeble electric flow. In any case, the procedure of how light creates power wasn't comprehended until Albert Einstein composed a paper clarifying the photoelectric impact in 1905, which won him the Nobel Prize in material science in 1921. Becquerellar's and Einstein's examination framed the premise of future advancements in sun powered innovation.

The advanced photovoltaic (PV) cell was created by Bell Labs in 1954 and keeping in mind that sun oriented power remained unreasonably exorbitant for business use, the U.S. military subsidized research on PV innovation's capability to control satellites during the 1950s. The U.S. Maritime Research Laboratory propelled Vanguard I, the main rocket to utilize sun based boards, in 1958, and NASA propelled the primary satellite furnished with boards that followed the Sun, Nimbus I, in 1964. The U.S. government spearheaded a significant part of the early PV innovation.

1.2 Research significance

The traditional matrix framework is particularly unsafe for Bangladesh, financially just as earth. A critical segment of Bangladesh is low and flood plain. Streams, lakes and other water bodies are various and just about 33% of the land is ordinarily submerged during the storm season. Then again, broadening electrical cables on such a scene is incredibly unreliable, expensive and risky.

Bangladesh is lavishly blessed with sun oriented vitality. Sun oriented Photovoltaic (PV) framework is by all accounts the main fitting type of sustainable power source in spite of the rainstorm sort of atmosphere in Bangladesh. Sun based vitality is an incredible wellspring of vitality for the earth. Notwithstanding, sun's vitality is persistent, clean and contamination free, accentuation ought to be given on this sustainable power source, especially to secure ecological fiasco. "Bangladesh has an all out region of 1.47E + 11 m2 and a normal of 3.5 kWh/m2 sunlight based power falls on this land more than 300 days for every annum. Regardless of whether one percent of this land used to outfit sun oriented vitality for control age at a proficiency of 10%, a sum of 5.2E + 09 kWh power can be produced every year". (Source: Sarkar, et al. 2001, p. 183 and 184). Along these lines, the possibility of sun based vitality in Bangladesh is very ideal and consequently, the nation simply needs patronization and approach wanting to use this asset.

Be that as it may, the prominence of Solar Grid Systems (SGSs) in Bangladesh is to a great extent decided by the financial components. The most appealing utilization of sun oriented home framework in Bangladesh is the lighting framework. Individuals in provincial Bangladesh prevalently use lamp fuel oil based lights for enlightening their homes around evening time. Dry cell batteries are utilized for radio and slowly vehicle batteries are getting well known for running TV close to matrix zones where the charging offices are accessible. The expense of lamp oil and charging cost of battery are very high and sun powered home frameworks can contend with them in this specific field.

The sun based home frameworks have been being used by different foundations for quite a while. The issue is that there is up 'til now not excessively much research has been completed to decide the genuine specialty for SGS in Bangladesh. Absence of specialized expertise, money related oblige, absence of mindfulness, lacking data are the obstructions for supportability of SGS in the rustic Bangladesh. Along these lines, this examination has been wanted to break down the money related practicality and discover the specialized viewpoints and social effects of the average uses of little sun based home frameworks in chose towns. By following this examination one can get a diagram of the dispersal status of photovoltaic innovation and practical suitability of sunlight based home frameworks in rustic region of Bangladesh. Then again, this investigation ought to be sought after so as to fill in as reference to survey the effect of sunlight based home framework for future photovoltaic endeavor.

1.3 Research Query

This field research aims to answer the following questions.

- Is the solar grid system a financially viable option?
- How are the system components performing?
- Is there any impact after SGS?
- What is the general impression of SGS?
- How much energy consumption for a typical building?
- How much unit cost of different types of energy option?

The followings are the specific concerns for the above research questions.

Before the solar grid system installation

- Total fuel cost for lighting
- Awareness of SGS
- Reason for choosing Solar PV
- Factor affecting to adopt solar system
- Household/business working activities

After the solar grid system

- Information about daily social activities
- Information about income generation activities
- Opinion regarding impact of SGS
- Performance of the system components
- General impression regarding the performance of SGS
- Overall impression regarding the SGS

(Source: https://energyinformative.org/where-is-solar-power-used-the-most/)

1.4 Purpose

Purpose with specific aims:

(i) **Save energy:** Sun powered uses lower fueled things, for example, LED/CFL lights, lower controlled hardware, and so forth that don't use as a lot of intensity as standard electric frameworks.

(ii) **Save electricity bill for our university:** Generated power can be save the power what we import from utility grid. Using the solar energy we need some power to import from grid previous system.

(iii) **Clean Energy:** Solar energy is a clean energy. Clean energy is very suitable for climate, as there have no bad effect on natural.

(iv) **Natural-friendly:** To advance naturally maintainable development while tending to India's vitality security challenges. To make empowering condition for infiltration of sun powered innovation all through the nation Mission's objective was modified in 2015.

(v) **Accessible Anywhere:** Sun oriented can be introduced anyplace, in any event, when what it is driving is in the shade. Regardless of what the situation, if there is a bright spot close by the sunlight based can be introduced to control something remotely introduced. There is even innovation today transforming material or windows into photovoltaic sources.

1.5 Methodology of research

1.5.1 Location Select

The first step for set up a solar pv power plant is location select. To do overall work there need to calculate the area of the location.

1.5.2 Plant Designing

After selecting the location and calculating the area of the location, then the place is ready for design. To design the solar pv plant, need to select the solar panel model/brand. Cause of there are many kinds of solar pv panels. For this project, I have selected the place is Daffodil International University, Ashulia Permanent Campus, Academic Building-04 rooftop.

1.5.3 Data Collection

For observation need to many types of data.

(i) Building design, (ii) Selected Location Climate data, (iii) Area of the building, (iv) Power consumption every hour in a year, (v) Panel Instrument information.

1.5.4 Data Analysis

Data whose are collected, then there need to analysis step by step.

1.5.4.1 Climate data analysis: To calculate the power generation from solar pv panel need to daily solar radiation and average temperature of every month.

1.5.4.2 Power Consume calculation: To observation the total power use in a building need to data for a year of power consumption.

1.5.4.3 Power Generation per year calculation: To collect the climate data, then can be calculate the power generate per year.

1.5.5 Financial Calculation

Financial condition is the major factor of the power plant project. Overall process is for the save money and also use the free energy. The solar pv grid connected power plant project life is 30 years.

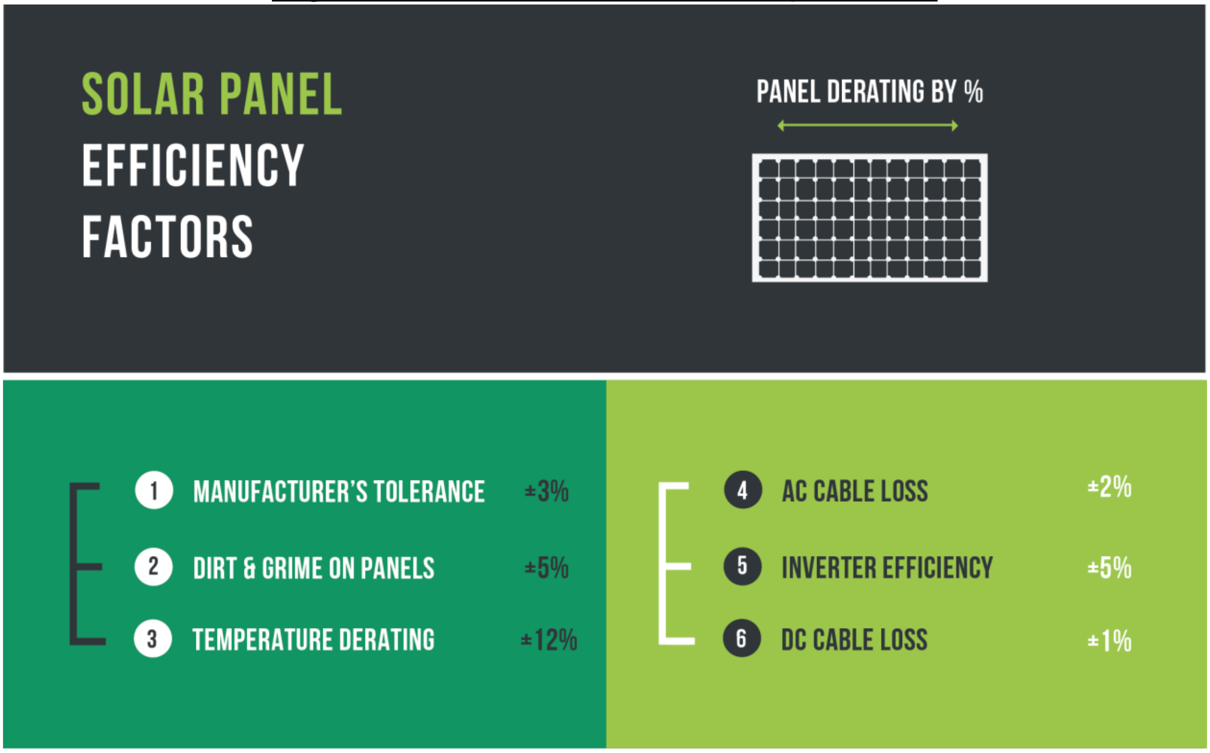
There are three types of cost (i) Fixed Cost, (ii) Semi-fixed Cost, (iii) Running Cost.

1.5.6 Problem Find & Solution

1.5.6.1 Problems: There have to many problems to install solar pv plant.

Efficiency of solar PV is low due to some factors.

Figure 1.1: Solar Panel Efficiency Factors



(Source: https://solarcalculator.com.au/solar-panel-efficiency/)

1.5.6.2 Solutions:

- Make an Informed Decision
- Use a Solar Concentrator
- Correctly Install Your Photovoltaic Panels
- Avoid Shaded Areas
- Keep Your Solar Panels Clean
- Prevent an Increase in Temperature
- Use solar two-axis tracking system

1.6 Restrictions:

Followings are a portion of the impediments of this research study:

□ The exploration was led by a smaller scale overview. The particular spotlight on just five floor overview is an essential restriction of contextual servey.

□ Because of the brief timeframe accessible for field investigate no long haul checking for the specialized exhibition of the framework on storm was conceivable

- In Bangladesh no careful research take a shot at specialized, social and financial part of SGS has up 'til now not completed. The deficient seat mark information to contrast and the discoveries.

CAHPTER 2

STUDY BACKGROUND

2.1 World Status of Solar Energy

Sunlight based power stays, after hydro and wind, the third most significant sustainable power source as far as all-inclusive introduced limit. In 2012, more than 100 GW of sun powered photovoltaic (PV) control was introduced on the planet — a sum equipped for delivering at any rate 110 TWh of power each year.

Chart 2.1: Country Status of Solar PV Installed

What countries have the highest installed capacity of solar PV power?

The table below is based on data from EPIA`s annual Global Market Outlook (2013).[1]

Ranking	Country	Installed PV [MW]
1	Germany	32,411
2	Italy	16,361
3	China	8,300
4	USA	7,777
5	Japan	6,914
6	Spain	5,166
7	France	4,003
8	Belgium	2,650
9	Australia	2,650
10	Czech Republic	2,072

(Source: https://energypedia.info/wiki/Portal:Solar)

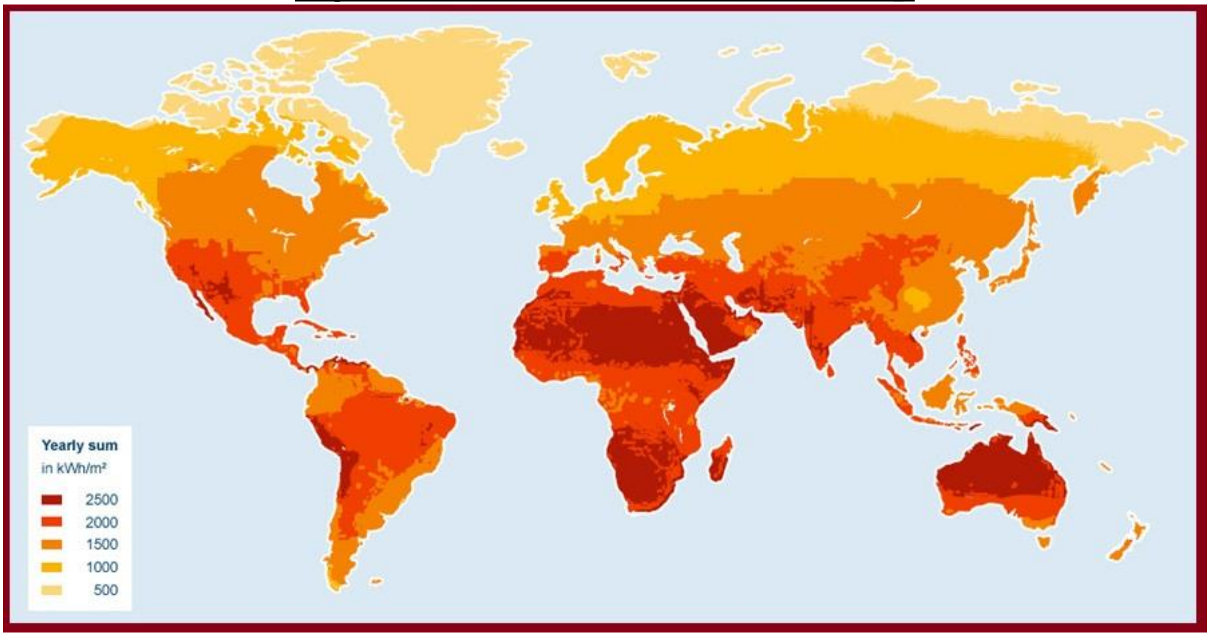
Germany has by a long shot the most elevated limit of sunlight based photovoltaic power (PV) on the planet at 32,4 GW (31%) toward the finish of 2012. Recently associated PV frameworks worth 7.6 GW were included this current year.Germany's sunlight based boards created around 23 TWh (terawatt long stretches) of power in 2012, which is noteworthy, yet just covers 3% of the nation's complete power utilization. Market examiners accept this number will increment to 25% before 2050. Germany focuses on an absolute limit of 66 GW by 2030 with a yearly development of 2.5-3.5 GW.

Germany is definitely not a nation with mind boggling measures of sun based vitality – what they do have is a superb financing system, which guarantees that sun based power can contend available. With a well-created feed-in tax plan, little and enormous scale sunlight based PV frameworks can send overabundance power generation to the utility network for benefit.

Sun oriented vitality exists in wealth everywhere throughout the globe, yet only one out of every odd spot would be reasonable for sun oriented PV boards, sun oriented warm authorities or different methods for changing over daylight into helpful vitality.

"Where on the planet is the capability of sunlight based vitality the best?" would be a superior inquiry. A world insolation map is the best answer:

Figure 2.1:World Solar Radiation map



(Source: https://energyinformative.org/where-is-solar-power-used-the-most/)

2.2 Country State

Renewable energy is energy that is obtained from renewable resources, which are naturally restocked on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat. The present renewable energy arrives from biogas, hydro power, solar and wind. Bangladesh is a developing country which offers many options and opportunities for utilizing renewable energy sources for generating electric power. In Bangladesh there are many natural resources such as coal, gas and petroleum. The main source of energy in Bangladesh is natural gas (24%) which is likely to be depleted by the year 2020. The government issued its prospect and policy assertion in February 2000, with the plan to provide electricity service to the entire country by the year 2020. At present, total electricity generation capacity is 15,351 MW as of February 2017 (ES in Bangladesh) and this energy sector is increasing day by day. To meet the cumulative demand of electricity coal, gas, diesel, etc. based power generation methods are being used. However, this is not sufficient. The government and non-government organizations are working both independently and jointly to promulgate renewable energy technologies (RET) throughout the nation as reported in the extant literature. Therefore, prospective planning and comprehensive understanding of this dynamic field require continuous assessment. Moreover, the progression, as well as regressions, in this sector should be continually scrutinized.

2.2.1 Present Electricity Generation Situation in Bangladesh

Power Generation limit has expanded from 4,942 MW in 2009 to 13,883 MW in 2015.

Table 2.1: Power Sector Details in Bangladesh

Item	September, 2016
Power Generation Capacity	15,755 MW
Transmission Line	10,436 circuit km
Distribution Line	341,000 km
Access to Electricity	77%
Per Capita Power Generation	371 kWh
Nos, of consumers	25,26,594
Average System Loss	14%

(Source: http://article.sapub.org/10.5923.j.ep.20180801.01.html)

As a feature of this technique to increase power generation, a Power System Master Plan was drawn up in 2010 with the accompanying objectives as outlined in table 2.2.

Table 2.2: Power System Master Plan

Year	MW
2016	16,000
2021	24,000
2030	40,000

(Source: http://article.sapub.org/10.5923.j.ep.20180801.01.html)

All out power utilization is anticipated to increment to 132 TWh by 2035 in Bangladesh.

The legislature has set an objective to create 2000, MW of electrical power from sustainable power source by 2021. Right now, the complete power age from such sources is 404 MW. The new focus of sustainable power source would be 10% of the all out power age in 2021 and would increment to 20% percent by 2030. Activities have been taken to create 30 MW control from sustainable power source from Dhaka, 60 MW from Rangunia, 3 MW from Sharishabari, 55 MW from Gangachhara, 200 MW from Mymensingh, 20 MW from Cox's Bazar and 200 MW from Sun Edition Solar venture at Teknaf. Likewise, forms are in progress to introduce Solar Home Systems (SHSs) at Kaptai, Hatia, Thakurgaon, Ishwardi and Sirajganj.

2.2.2 Sustainable power source Prospects in Bangladesh

Admirable movement has been assembled in the sustainable power source area over the most recent couple of years. At present, 404 MW is being created from sustainable power sources. Sun powered home framework is an example of overcoming adversity in Bangladesh and step by step its fame is expanding in the provincial regions, particularly in the off-lattice areas. Table 2.3 beneath shows the movement consented so far in the sustainable power source segment in Bangladesh.

Table 2.3: Progress in the Renewable Energy Sector

Methods	MW
Installation of Solar Home System (3.5 million)	150.00
Installation of Rooftop Photovoltaic (PV) at Government/Semi-Government offices	3.00
Installation of PVs on commercial buildings and shopping centers	1.00
Installation of PVs by consumer during new electricity connections	11.00
Installation of Wind Bases power plants	2.00
Installation of Biomass-based power plants	1.00
Installation of Biogas-based power plants	5.00
Solar Irrigation	1.00
Hydro Electric Power generation	230.00
Total	404.00

(Source: http://article.sapub.org/10.5923.j.ep.20180801.01.html)

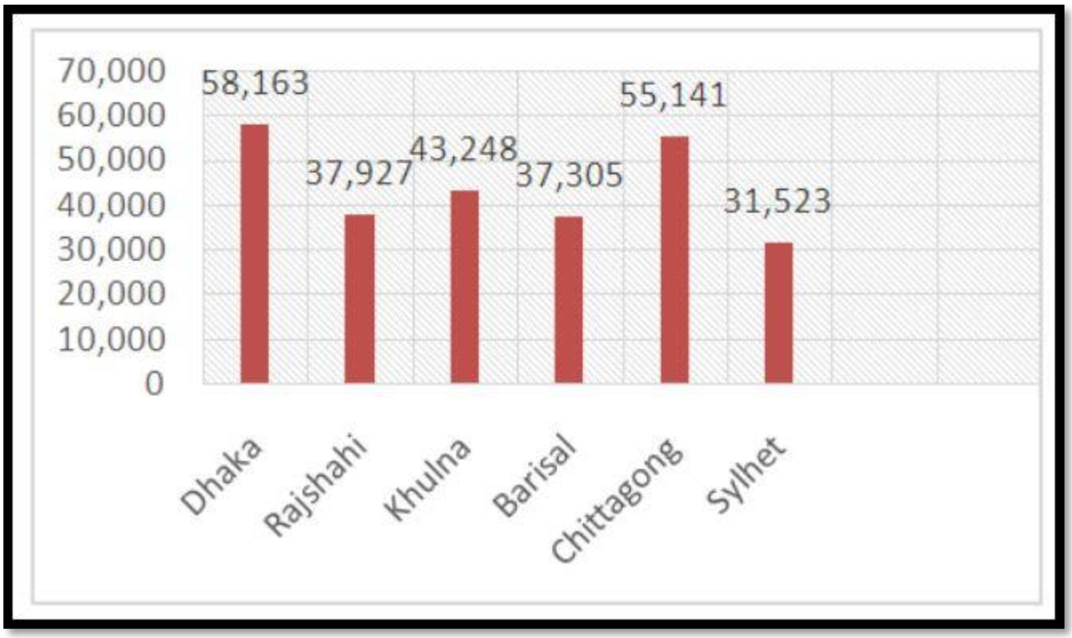
2.2.3 Solar Energy Sources in Bangladesh

Bangladesh is a south Asian nation situated in the middle of scopes 20°34' and 26°39' north and longitudes 80°00' and 90°41' east. Accordingly, it is a perfect area for sun oriented vitality use. Likewise, as it is a subtropical nation, 70% of the year daylight is abundant. This utilizes sunlight based boards extremely successful in Bangladesh. Day by day sunlight based radiation is 4-6.5 kWh/m² and most extreme radiation is commonly gotten in the long periods of March-April and least in December-January. Thus, sun oriented vitality can be a reasonable answer for the power emergency in Bangladesh.

Additionally sunlight based vitality offers some key characteristics like having no waste and emanation, coming about no antagonistic consequences for the earth and undeniably appropriate for circulated asset applications. The legislature has as of late found a way to address this reality. Simultaneously, some Non-government Organization (NGO) is attempting to give sunlight based boards to purchasers and the cost of these boards, at present, is truly moderate.

Figure 2.2 underneath shows the estimated circulation of SHSs establishment division insightful and enlightens that the dispersion of the SHSs is most noteworthy in Dhaka area and least in Sylhet region.

Figure 2.2: Future Prospect of Solar Energy in Bangladesh



(Source: http://article.sapub.org/10.5923.j.ep.20180801.01.html)

2.2.4 Worldwide Scenario of Renewable Energy

In view of Renewable Energy Policy Network for the 21st century, inexhaustible contributed 19.2% of mankind's worldwide vitality utilization and 23.7% to their age of power in 2014 and 2015, individually. This vitality utilization is partitioned with 8.9% originating from customary biomass, 4.2% as warmth vitality, 3.9% from hydroelectricity and 2.2% is power from wind, sun oriented, geothermal and biomass. Overall interests in sustainable innovations added up to more than US$ 286 billion of every 2015, with nations like China and the United States intensely putting resources into wind, hydro, sun oriented and befouls. Internationally, there are an expected 7.7 million occupations related with the sustainable power source enterprises, with sun oriented photovoltaic being the biggest inexhaustible manager. Sunlight based PV is a key innovation for catching the advantages specifically having no waste, no moving parts, no discharges, less transportation costs, not requiring water during power generation and no unfriendly impacts on the earth.

Inexhaustible power producing limit saw its biggest yearly increment ever in 2016, with an expected 161 gigawatts (GW) of limit being included. The world kept on including more inexhaustible power limit every year than it included (net) limit from every single petroleum product joined. In 2016, sustainable represented an expected 62% of net increments to worldwide power producing limit.

2.2.5 Future Demand

The Future of solar is bright. The Sun emits enough power onto Earth each second to

Satisfy the entire human energy demand for over two hours. Given that it is readily available and renewable, solar power is an attractive source of energy. At first blush, solar energy is perhaps the most elegant solution to our energy needs. The sun blasts our planet's surface with more than enough energy to keep us going forever. The United States government estimates that the Earth receives over 173,000 terawatts of energy every year, which is more than 10,000 times what humanity needs.

The challenge has always been collecting that energy. Even though most people are aware of photovoltaic cells, solar panels have been expensive enough to keep them firmly in the luxury bracket. For years the low efficiency of solar panels and the high costs per square inch of these panels made solar power economically unviable

That has now changed. In the five years between 2008 and 2013, the cost of solar panels fell by over 50 percent. Between 2015 and 2017, experts estimate the cost will fall another 40 percent. Researchers in the United Kingdom say they are surprised by how quick solar adoption is growing. They estimate that the costs will fall fast enough to allow solar to contribute 20% of our energy consumption by 2027. That benchmark would have been unimaginable a few years back.

(Source: https://www.solarpowereurope.org/wp-content/uploads/2018/09/Global-Market-Outlook-2018-2022.pdf)

2.3 Circumstantial of Study

2.3.1 Geography

Solar energy is the technology used to harness the sun's energy and make it use as of 2011, the technology produced less than one tenth of one percent of global energy demand

Many are familiar with so-called photovoltaic cells, or solar panels, found on things like spacecraft, rooftops, and handheld calculators. The cells are made of semiconductor materials like those found in computer chips. When sunlight hits the cells, it knocks electrons loose from their atoms. As the electrons flow through the cell, they generate electricity.

On a much larger scale, solar-thermal power plants employ various techniques to concentrate the sun's energy as a heat source. The heat is then used to boil water to drive a steam turbine that generates electricity in much the same fashion as coal and nuclear power plants, supplying electricity for thousands of people.

2.3.2 Key statistics in the field of study

10 Solar Statistics We Need to Know About that's study fields

1. The Number of the Global Solar PV Installed Worldwide Has Been Growing Since 2011
2. Solar Energy Employment has increased
3. For the 6th Straight Year, Solar Was One of the Top Two Sources for New Electricity Generating Capacity
4. Multiple Manufacturers Offer Solar Panels Today Above 20% Efficiency
5. California Is the Leading State for Solar Generation
6. Legacy Markets Will No Longer Be the Primary Engines of Growth
7. Residential Installation Growth Exceeded Expectations for 2018
8. However, Non-Residential PV Shows 8% Decline from 2017
9. In Germany, Renewables Generated More Electricity than Coal in 2018
10. IEA projects 4.3 GW-AC of Global CSP Installations from 2018 to 2023

(Source: http://sitn.hms.harvard.edu/flash/2019/future-solar-bright/)

2.3.3 Climatic Situation of the Study Location

Weather conditions:

A clear, bright day is the best weather condition for optimal solar panel output. On a clear, non-cloudy day the panels receive the maximum amount of light possible. As solar panels run off light and not heat, it does not have to be a particularly warm day for the panels to work well.

Wind and rain do not affect the output of solar panels and can actually help to keep them clean and free of debris. Cloudy days are the least optimal for producing solar power. However, even on very cloudy days your panels can still potentially produce up to a third of their maximum output.

Time of year:

The length of daytime changes throughout the year in the UK. Our days are longer in the summer months and shorter during winter. The most optimal time for producing solar energy is the summer months, between June and August. In June, July and August, there is an average of 16 daylight hours each day in the UK. In April, May and September there are still on average 13-15 hours. Even in the shortest daylight months, December and January, the UK still has around 8 hours of light every day.

Type of panels:

It used to be accepted that the most expensive, monocrystalline, type of solar panels were the most efficient. Recent developments have lead to monocrystalline and polycrystalline panels becoming very similar in both price and output. There is another, fastly growing, type of solar panel called 'thin film' panels. Thin film panels are thought to work better than traditional crystalline panels in cloudy conditions. Therefore, if you live in an area of the UK with traditionally low light conditions, it may be worth considering thin film. Thin film panels are a newer technology, and whilst they are showing some promising qualities, they are typically not yet as efficient as traditional panels.

(Source: https://www.conserve-energy-future.com/future-solar-energy.php)

CHAPTER 3

DESIGN & COMPONENTS

3.1 Grid Connected PV Power Plant Model

3.1.1 Types of Grid Connection System

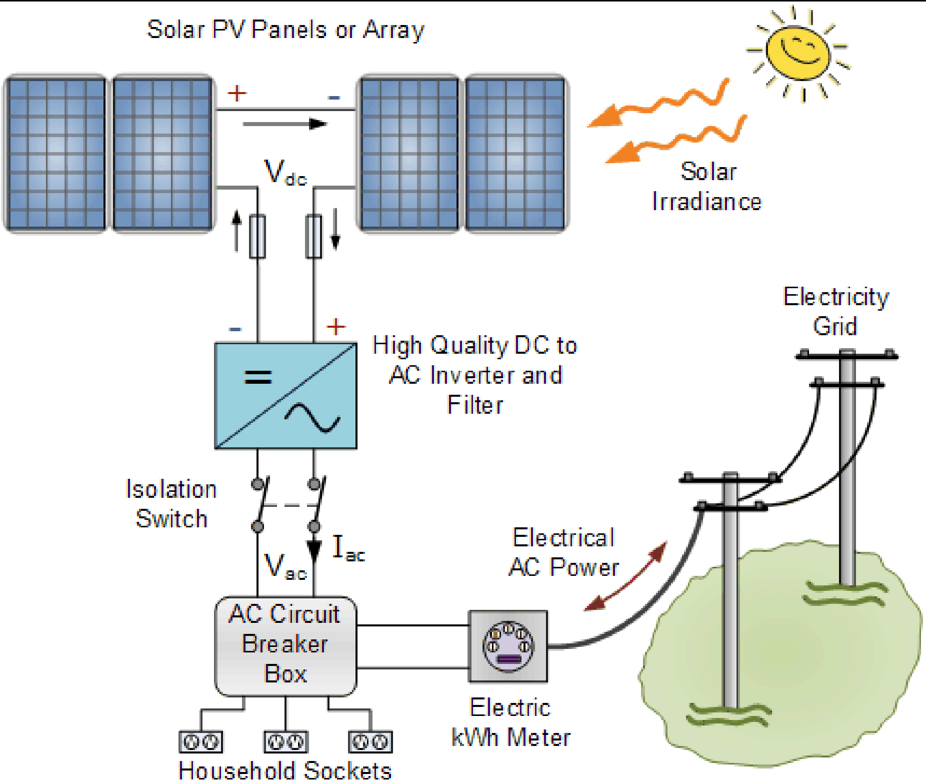
GRID Connected system are two types.

(i) Without Battery Storage,
(ii) With Battery Storage

(i) Without Battery Storage :

This system is designed without battery connection. It can only be use in day time, when sunpower is available.

Figure 3.1: Solar Grid Connection System without battery storage

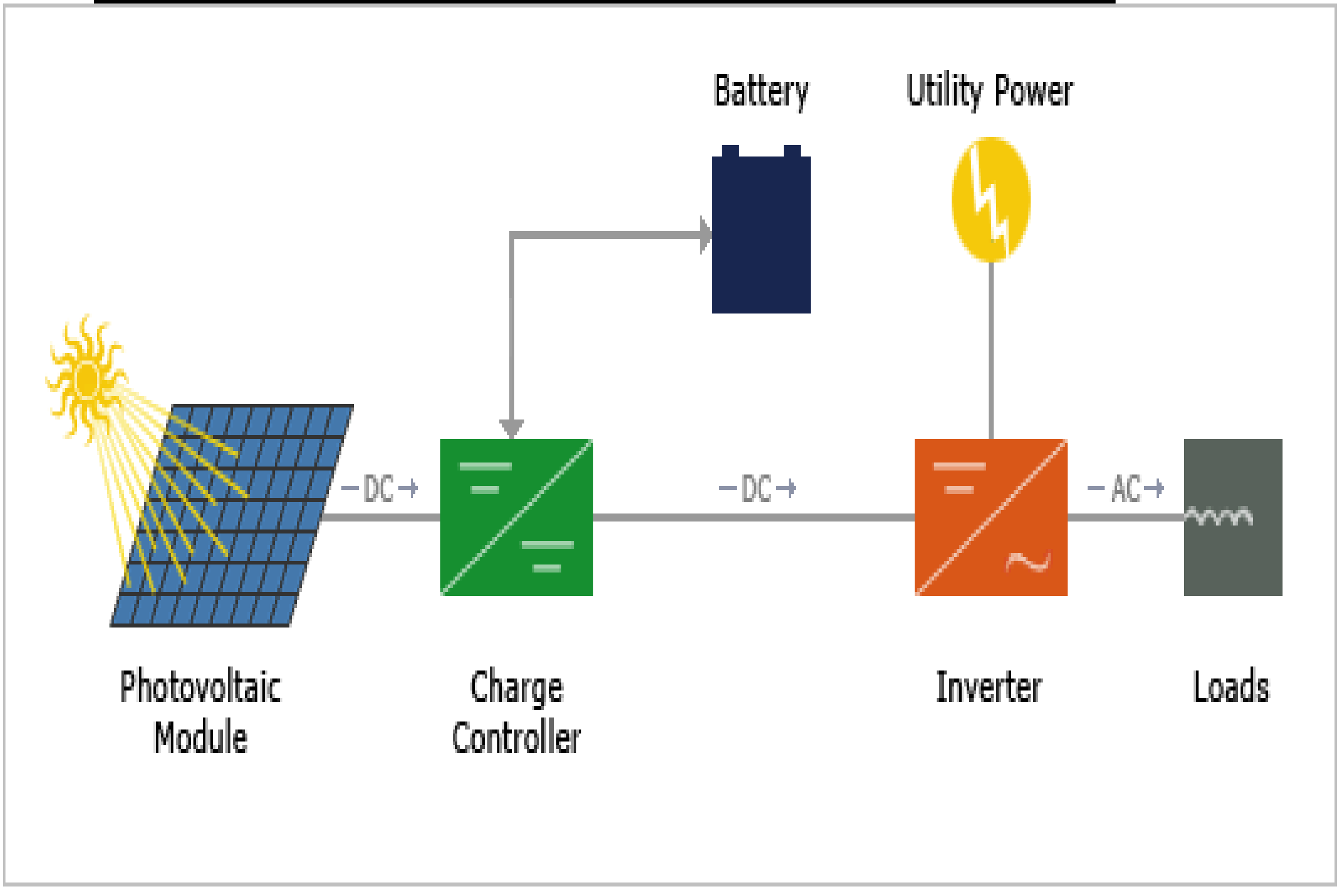


(Source: https://www.pilabsbd.com)

(ii) With Battery Storage:

This system is designed with battery connection. It can be use both day & night time. For day time, power supply from panel & night time power will supply from battery storage.

Figure 3.2: Solar Grid Connection System With Battery Storage



(Source: https://solarfeeds.com/statistics/)

3.1.2 Grid Connected PV Plant design

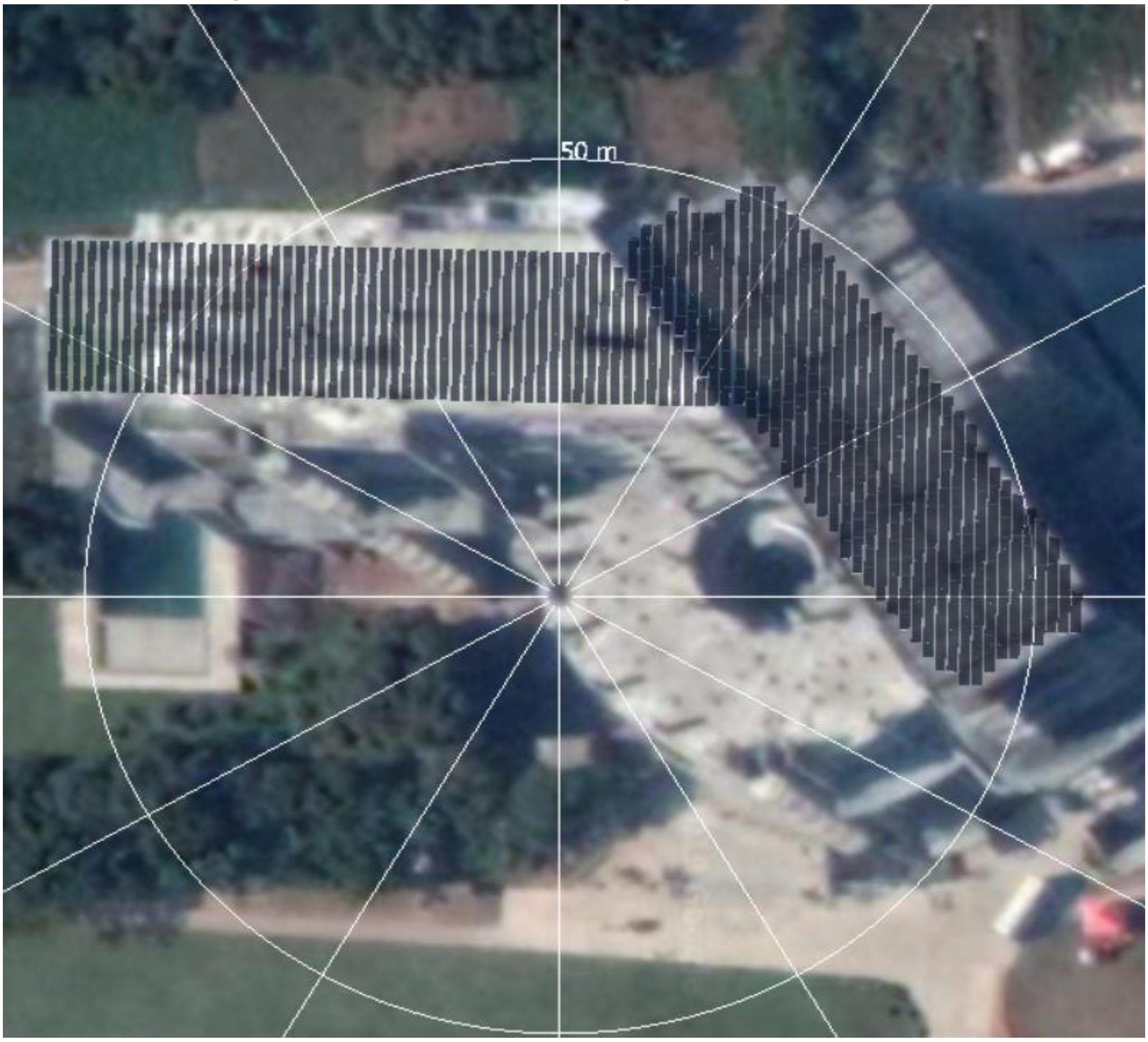
This Solar PV power plant is designed by a software named PVSol. For design, 1st there need to select the location of the power plant. Than plant need to some instruction, how the panel will be connect.

In this power plant, solar pv panels are connected by 4 cell in a row.

In total, there is used 1113 cell of solar panel. There each cell capacity is 320 watt.

In total plant capacity will be 356KW.

Figure 3.3: Solar Panel Design in AB-04 Roof Top

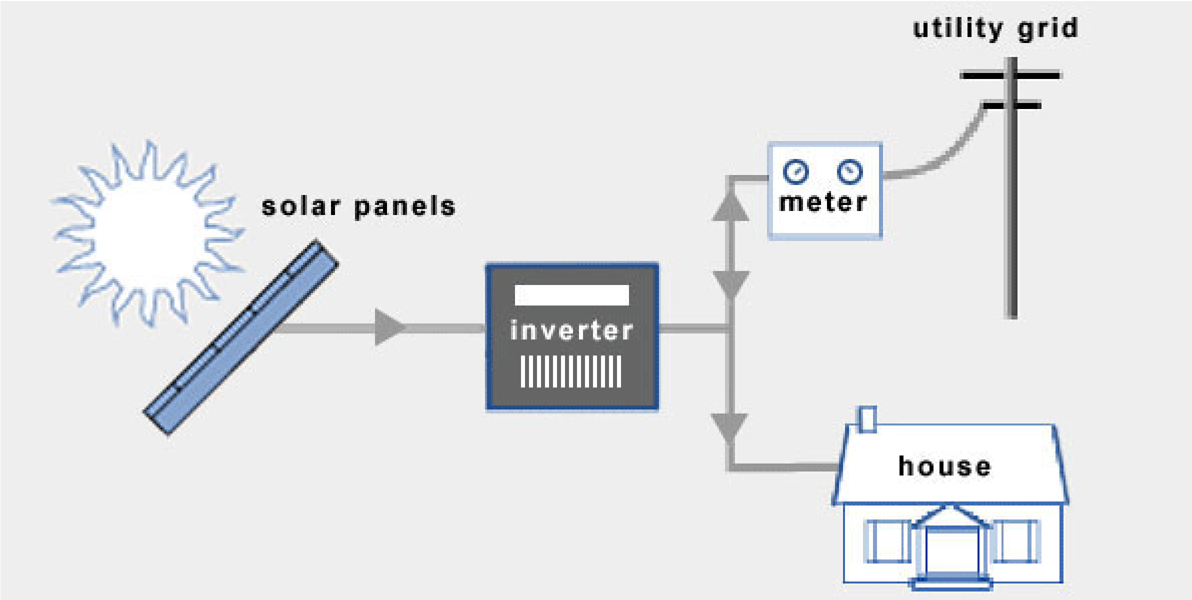


(Source: Scribe)

3.1.3 Grid Connected PV Plant Diagram

For grid connection, solar pv panel connect with charge controller, than charge controller are connect with solar inverter. Than inverter is connect with Bi-Directional meter which can export and import power with grid. Bi-directional meter is connected with building and grid.

Figure 3.4: Solar on Grid Connection



(Source: https://www.researchgate.net/post/What_is_the_best_climatic_condition_for_solar_thermal_electric_power_application)

3.2 Components of Grid Connected PV Plants

3.2.1 Solar PV Panel

Photovoltaics (PV) is a method of changing light energy into direct current electricity using semi conducting materials that exhibit the photovoltaic effect, a phenomenon commonly studied in physics, photochemistry and electrochemistry. This system employs solar panels composed of a number of solar cells to supply usable power. Two common PV panel types are mono- and polycrystalline panels. In this paper, mono-crystalline PV panels were used with the characteristics shown in Table

Table 3.1: Solar Panel Configuration

Electrical Data Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C		
Nominal Power (+5/-3%)	Pnom	320 W
Efficiency	η	19.6 %
Rated Voltage	Vmpp	54.7 V
Rated Current	Impp	5.86 A
Open Circuit Voltage	Voc	64.8 V
Short Circuit Current	Isc	6.24 A
Maximum System Voltage	IEC	1000 V
Temperature Coefficients	Power (P)	-0.38% / K
	Voltage (Voc)	-176.6mV / K
	Current (Isc)	3.5mA / K
NOCT		45° C +/-2° Series Fuse RatingC

3.2.2 Charge Controller

Solar charge controller is a gadget to create power from the main wellspring of our close planetary system that is sun. It's green and viable to accomplish the day by day control request. Power utilization is an essential monetary key player of each area. Generally speaking generation and benefit can be hampered for impromptu utilization of business control. Here, sun oriented charge controller can give an opportunity to deliver claim power with a solitary contribute of establishment/foundation. This single speculation protect turning benefit and help from the weight of alleged electric bill.

Figure 3.5: Solar Charge Controller

(Source: https://tedfo.com/product/onnorokom-solar-charge-controller/)

Features:

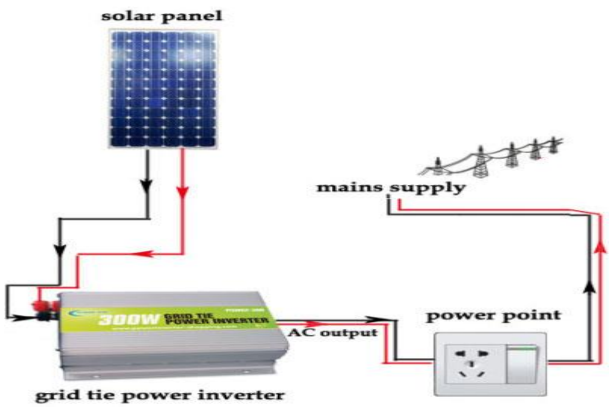
- Battery is charged through PWM method which increase the battery life in the long run.
- Mobile charger built in.
- For the Battery, Panel and Load safety, high voltage disconnect, low voltage disconnect and surge, short circuit and reverse polarity protections are added.
- To show different states of the battery, 3 LEDs are used.
- IDCOL Certified.
- 3 Years warranty.

- As a MPPT based charger it has efficient charging technique, which lengthen the battery lifetime.
- Disconnect the panel upon charge completion to prevent from overcharging.
- Single Load output with a maximum 20A load current.
- Three levels of battery voltage indicators to monitor the battery status.
- Charging and Load Connect LED.
- Load fuses from Over Current protection.
- Overload, transit Surge, Lightning and Short Circuit protection.
- Reverse Polarity Protection.
- Automatic Recovery from all protection.
- High and Low voltage disconnect

3.2.3 Solar Inverter

A solar inverter or PV inverter, is a sort of electrical converter which changes over the variable direct flow (DC) yield of a photovoltaic (PV) sun powered board into an utility recurrence substituting flow (AC) that can be encouraged into a business electrical matrix or utilized by a neighborhood, off-framework electrical system. It is a basic equalization of framework (BOS)–segment in a photovoltaic framework, permitting the utilization of common AC-fueled gear. Sunlight based power inverters have exceptional capacities adjusted for use with photovoltaic clusters, including most extreme power point following and hostile to islanding assurance.

Figure 3.6: Solar Inverter



(Source: http://www.solarinverter.guide/working-principle-of-a-solar-inverter/)

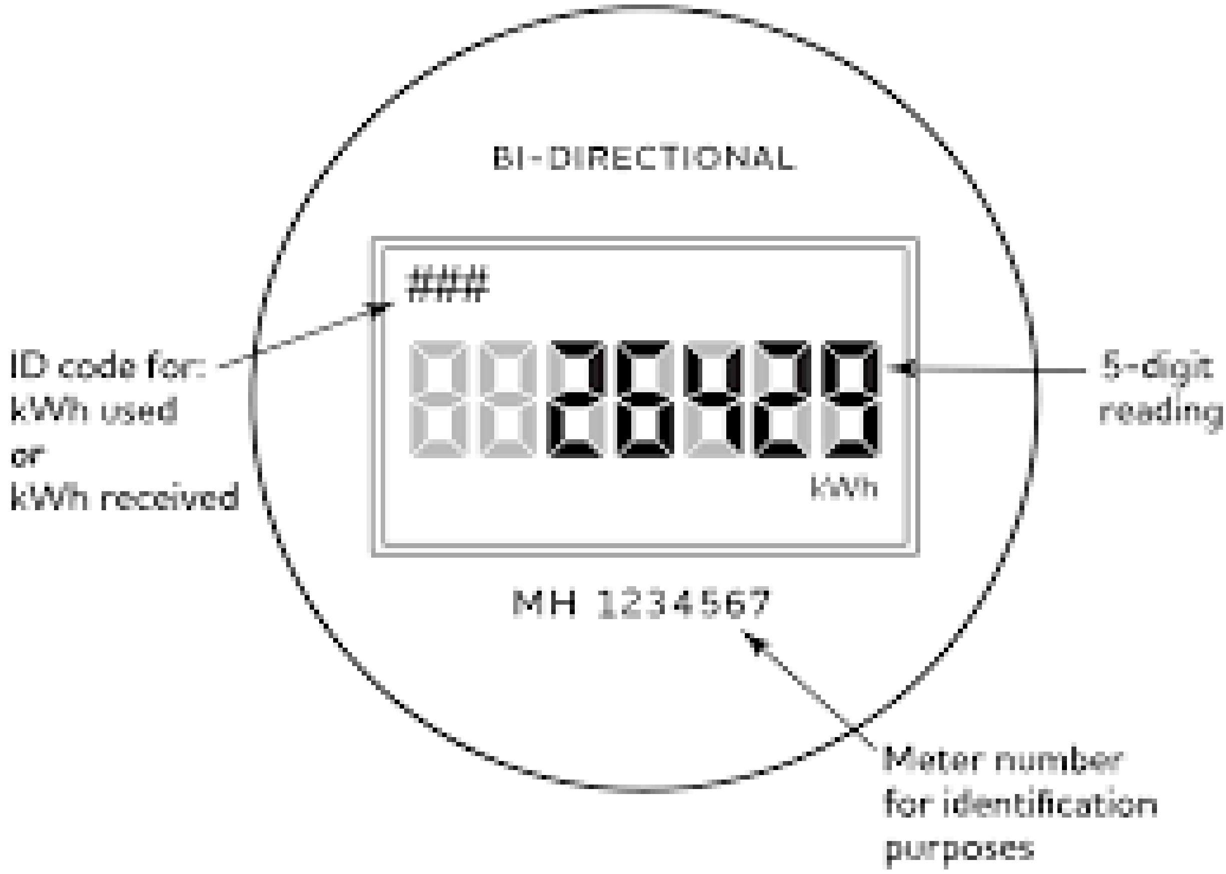
The inverters work by taking in power from a Direct Current (DC) Source, i.e., the solar panel. The power is generated in the range of 250 Volts to 600 Volts. DC power is converted into AC power by the inversion process taking place in the inverter. This process of DC to AC Conversion is achieved by using a set of solid state devices like Insulated Gate Bipolar

Transistors (IGBT's.). These devices when connected in a typical H-Bridge arrangement oscillate the DC power thereby creating AC power.

A step up transformer is used in between the devices. At this stage, the AC power output is obtained, which is either consumed by the local loads or can be fed to the grid. A few manufacturers have started manufacturing transformer-less inverters which have higher efficiencies as compared to inverters having transformers.

3.2.4 Bidirectional Meter:

Figure 3.7: Bidirectional Meter



(Source: https://www.firstenergycorp.com/content/dam/feconnect/files/retail/Net-Metering-Primer.pdf)

The term bi-directional metering refers to the fact that the meter can measure the flow of electricity in two directions. It measures how much energy comes from your electric company – "kWh delivered." It also measures the difference between the generators production and the customers load demand – "kWh received." Our meter does not measure the generators electricity production. The generator can offset a customer's electric energy usage with any excess electricity produced. As the generator system produces electricity, the kilowatt-hours are first used to meet the customer's electric requirements such as lighting and appliances. If more electric energy is produced from the system than the customer needs, the additional kilowatt-hours are measured, fed into the utility's electric system and utilized by other customers.

3.3 Difference between solar Off Grid and On Grid PV system

On-grid means your solar system is tied to your local utility's GRID. This is what most residential homes will use because you are covered if your solar system under or over-produces in regard to your varying energy needs. All this means for you is that your utility system acts as your battery space. If you are producing more energy with your solar panels or system than you are using, the excess energy is sent to your grid's power company, allowing you to build credit that you can cash out with at the end of the year, in a process called net metering. Being grid-tied is beneficial because you don't have to buy an expensive battery back-up system to store any excess energy. Being off-grid means you are not connected in any way to your grid's power system or utility company. This is appealing because you are 100% self-sustaining your energy use. However, there are disadvantages because off-grid systems require you to purchase back-up battery which can be expensive, bulky, and not very environmentally friendly which defeats the purpose of going solar (save money and live greener).

CHAPTER 4:

POWER GENERATION

4.1 Information collection

The information of the power plant are collect from various source.

4.1.1 Climate Data Location

For observe to power generation need to climate data at power plant. Firstly we have selected the plant area.

Chart 4.1: Plant Location

	Unit	Climate data location	Facility location	Source
Latitude		23.7	23.9	
Longitude		90.4	90.3	
Climate zone		1A - Very hot - Humid		User-defined
Elevation	m	9	14	NASA – Map
Heating design temperature	°C	14.6		NASA
Cooling design temperature	°C	31.6		NASA
Earth temperature amplitude	°C	14.2		NASA

(Source: Scribe)

After selection the area, than we observed the climate data from NASA by RETScreen.

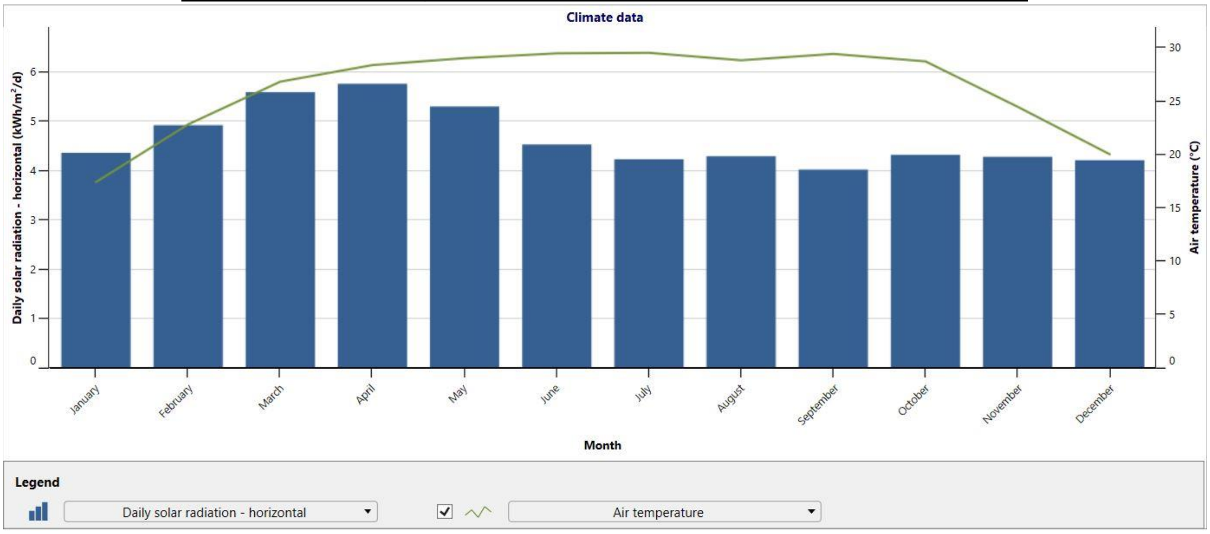
Chart 4.2: Climate data of the located plant

Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days 18 °C	Cooling degree-days 10 °C
	°C	%	mm	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	17.4	51.6%	5.58	4.36	101.4	2.5	18.1	0	260
February	22.8	42.6%	13.16	4.92	101.2	2.5	22.2	0	342
March	26.8	40.0%	31.93	5.59	100.8	2.8	28.0	0	539
April	28.4	51.9%	84.90	5.76	100.6	3.6	31.8	0	618
May	29.0	65.3%	182.28	5.30	100.3	3.8	31.6	0	639
June	29.5	79.4%	233.70	4.53	99.9	4.3	30.0	0	585
July	29.5	85.1%	256.06	4.23	100.0	4.3	29.0	0	580
August	28.8	85.6%	218.86	4.29	100.1	3.7	28.8	0	574
September	29.4	85.3%	197.40	4.02	100.4	3.0	28.1	0	537
October	28.7	77.9%	118.73	4.32	100.8	2.2	26.6	0	512
November	24.5	68.4%	21.30	4.28	101.2	2.1	22.9	0	393
December	20.0	61.8%	8.06	4.21	101.4	2.2	19.0	0	291
Annual	**26.2**	**66.4%**	**1,371.96**	**4.65**	**100.7**	**3.1**	**26.4**	**0**	**5,869**
Source	User-defined	User-defined	User-defined	User-defined	User-defined	User-defined	User-defined	NASA	User-defined
Measured at					m	10	0		

(Soucre: Scribe)

In climate data, basically we need daily solar radiation & air temperature.

Chart 4.3: Daily Solar Radiation vs Air Temperature



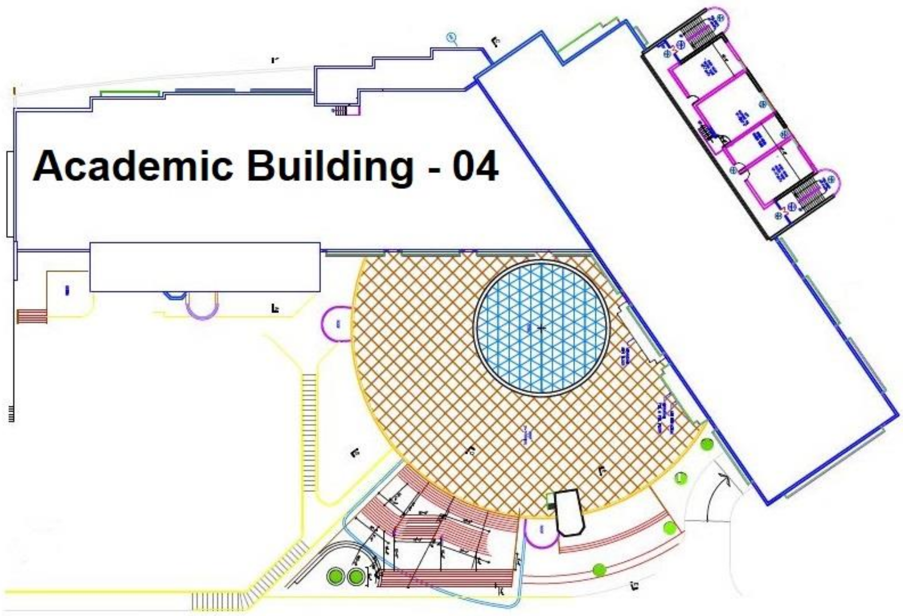
(Source: Scribe)

Picture: Daily Solar Radiation vs Air Temperature Curve

4.1.2 Location Area Measured

Location area have measured by AUTOCAD software. To select the area, than we have collected the building design from university development board. After collecting the building then we have calculated the building roof top area. The location of this power plant is Daffodil International University, Permanent Campus Academic Building-04. The area of academic building-04 roof top we get is equal to **1900** meter square.

Figure 4.1: Academic Building – 04 Roof Top



(Source: Scribe)

4.1.3 Solar Panel Selection

There are 3 types of technology used in solar panels in the market today, these are monocrystalline, polycrystalline and thin film formless. We used monocrystalline solar panel for our power plant. Monocrystalline solar panels have the highest efficiency rates since they are made out of the highest-grade silicon. The efficiency rates of monocrystalline solar panels are typically 15-20%. Sunpower produces the highest efficiency solar panels on the U.S. market today. We used Sunpower mono-Si - SPR-320E-WHT for our analysis, which efficiency is about 19.62%.

Figure 4.2: Solar Panel – Sunpower mono-Si – SPR – 320E-WHT

(Source: Scribe)

Solar panel model: Sunpower mono-Si - SPR-320E-WHT

Panel efficiency: 19.62%

Panel Capacity: 320W

Frame area: 1.621 m^2

4.1.4 Power Capacity and Numbers of Units Calculation

Total area of academic building-04: 1900 m^2

So we can use under 1900 m^2 area. We have designed the power plant by PVSol and analysis the power plant capacity & unit by PVSol & RETScreen.

Chart 4.4: Plant Power Capacity & Unit of Solar Panel

Photovoltaic		
Type		mono-Si
Power capacity	kW	356.16
Manufacturer		Sunpower
Model		mono-Si - SPR-320E-WHT
Number of units		1,113
Efficiency	%	19.62%
Nominal operating cell temperature	°C	45
Temperature coefficient	% / °C	0.4%
Solar collector area	m^2	1,815
Miscellaneous losses	%	10%

(Source: Scribe)

In 1900m^2 area, we can use 1113 number of unit's solar panel of selected model, which collector area is 1815.2905m^2. Completing the analysis, we get 356.16KW plant capacity.

Power Capacity: 356.16KW

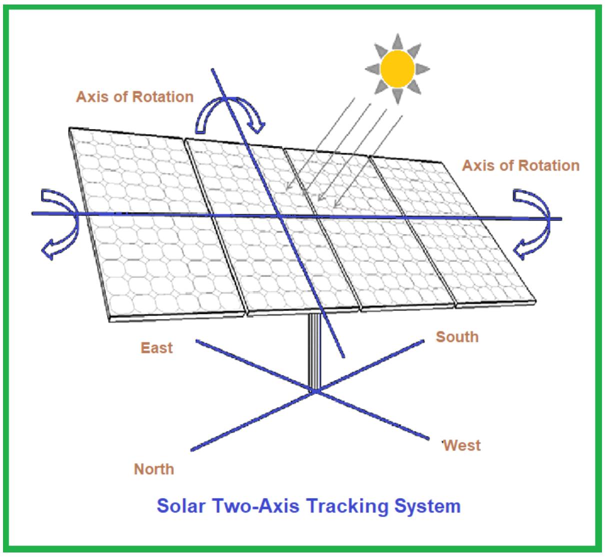
Number of Units: 1113

4.1.5 Solar Tracking Mode selection

Solar power can be track by 4 system. (i) Fixed, (ii) One-Axis, (iii) Two-Axis & (iv) Azimuth.

For getting highest efficiency, two-axis tracking system is mostly used. We have used solar two-axis tracking system for our design. Single-axis trackers follow the sun across a horizontal plane, but dual-axis trackers move in a more direct, circular path. Two axis trackers have two degrees of freedom that act as axes of rotation. Double or Dual Axis Tracker have two different degrees through which they use as axis of rotation. The dual axis are usually at a normal of each rotate both east to west and north to south.

Figure 4.3: Solar Two Axis Tracking System



(Source: Scribe)

4.2 Generated Power

Solar power generated by solar radiation.

Let, Power Generation= P_G

Daily Solar Radiation Horizontal=R_s

Temperature = T_i

From analysis, we get solar power generation proportional to daily solar radiation. $\therefore P_G \propto R_s$ ………………………………………………………… (1)

Also get another,

We get solar power generation is anti-proportional to temperature.

$\therefore P_G \propto 1/T_i$ …………………………………………………..... (2)

From eq^n (1) & (2) we get
$P_G \propto R_s/T_i$

4.2.1 Monthly Generated Power

Analysing the location climate & plant capacity, we get the result from RETScreen. The generated power in different month are not same, causes of different climate from January to December.

Chart 4.5: Solar Monthly average Radiation & Monthly Electricity Generation

Month	Daily solar radiation - horizontal kWh/m²/d	Daily solar radiation - tilted kWh/m²/d	Electricity Generated kWh
January	4.36	7.23	64,648.810
February	4.92	7.57	59,910.650
March	5.59	7.65	65,951.928
April	5.76	7.15	59,530.339
May	5.30	6.46	55,905.114
June	4.53	5.21	43,881.244
July	4.23	4.78	41,734.340
August	4.29	4.84	42,307.486
September	4.02	4.74	39,905.287
October	4.32	5.96	51,420.170
November	4.28	6.72	56,642.163
December	4.21	7.30	64,533.923
Annual	**4.65**	**6.29**	**646,371.453**

(Source: RETScreen)

4.2.2 Annual Generated Power

Annual Generated Power = Sum of every month generated power

Table 4.1: Power Generation Monthly & Annual

Power Generation (Day) Monthly & Annual		
Month	Power in KWh	Power Gen in MWh
January	64648.8097	64.6488097
February	59910.6496	59.9106496
March	65951.9275	65.9519275
April	59530.3389	59.5303389
May	55905.1143	55.9051143
June	43881.2442	43.8812442
July	41734.3402	41.7343402
August	42307.4859	42.3074859
September	39905.2873	39.9052873
October	51420.1699	51.4201699
November	56642.1627	56.6421627
December	64533.9225	64.5339225
Annual=	646371.4527	646.3714527

(Source: Scribe)

Annual Generated Power will be about **646MWh**.

CHAPTER 5:

POWER CONSUMPTION

5.1 Load Information Collection

We have collect information of load by survey. We visit ground floor to top floor for collect data. We have got information from academic building 04 development board. An example is given below for 1st floor:

Table 5.1: AB-04 1st floor load information

Equipments	Unit	Per Unit Demand in Wh	Total Demand in Wh
Fan	131	65	**8515**
Light	257	20	**5140**
Projector	18	200	**3600**
Computer	25	100	**2500**
Printer	1	100	**100**
Photocopy Machine	1	200	**200**
			Total Demand= 200055

(Source: Scribe)

It is about 20KWh.

5.2 Full Load measure from ground floor to top floor

Load Calculation:

Table 5.2: Academic Building – 04 load measurement

Floor	Load Demand (KW)
Ground Floor	20
1st Floor	20
2nd Floor	22
3rd Floor	10
4th Floor	90
5th Floor	80
6th Floor	20
7th Floor	20
8th Floor	20
9th Floor	20
10th Floor	20
11th Floor	20
12th Floor	20
13th Floor	20
	Total = 402

(Source: Scribe)

4th floor & 5th floor are computer lab. There need to large amount of power, that cannot supply from the plant. So we can analysis the model without 4th & 5th floor. It need to be supply from grid.

After avoid the 4th & 5th floor, total load will be= {402 – (90+80)} KW = 232KW

We assumed it 250KW, with some extra power. So full load of the building is 250KW.

5.3 Types of power consumption time

We divide the schedule in a year to 3 types of power consumption time. This is because university activities are different at different times of the year. At different times, the consumption of electricity in a day (24hours) is different. Three types are (i) Regular Time, (ii) Vacation Time & (iii) Examination Time.

5.3.1 Daily Power Consumption Regular Time

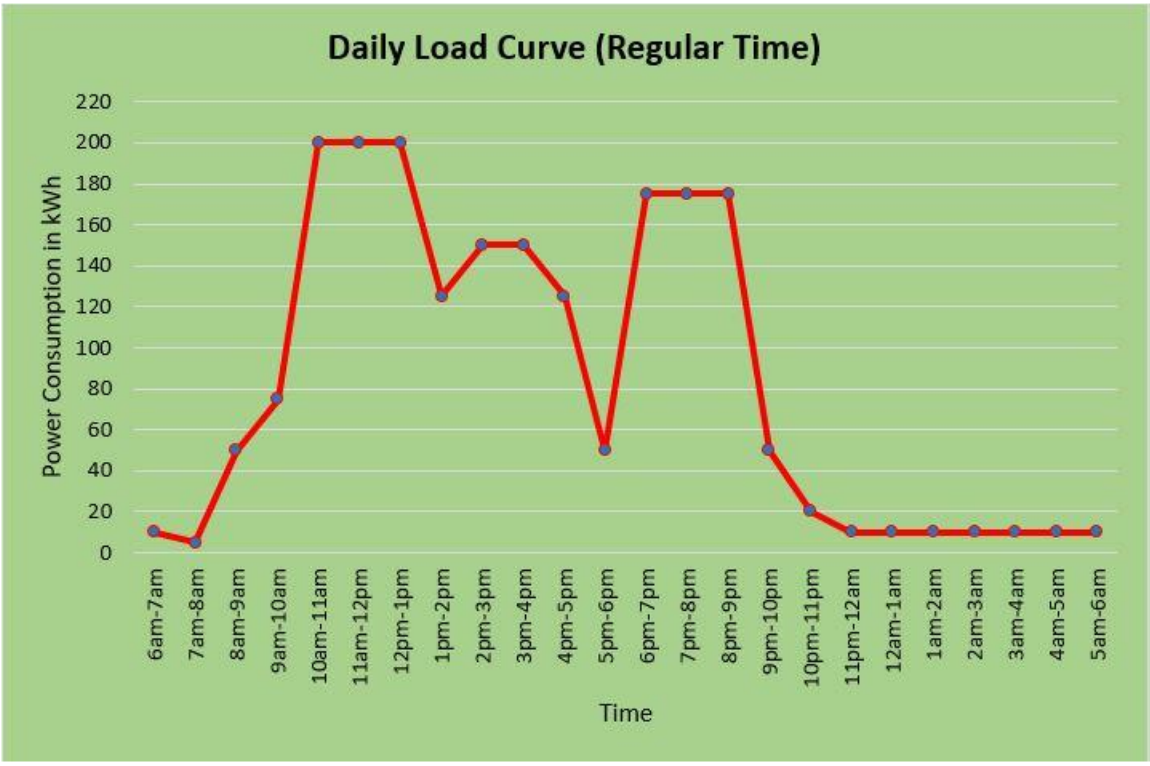
Table 5.3: Daily Power Consumption Data (Regular Time)

Time	Use % of full load	KWh	Time	Use % of full load	KWh
6am-7am	4	10	6pm-7pm	70	175
7am-8am	2	5	7pm-8pm	70	175
8am-9am	20	50	8pm-9pm	70	175
9am-10am	30	75	9pm-10pm	20	50
10am-11am	80	200	10pm-11pm	8	20
11am-12pm	80	200	11pm-12am	4	10
12pm-1pm	80	200	12am-1am	4	10
1pm-2pm	50	125	1am-2am	4	10
2pm-3pm	60	150	2am-3am	4	10
3pm-4pm	60	150	3am-4am	4	10
4pm-5pm	50	125	4am-5am	4	10
5pm-6pm	20	50	5am-6am	4	10

(Source: Scribe)

5.3.1.1 Daily Load Curve

Chart 5.1: Regular Time Daily Load Curve



(Source: Scribe)

5.3.2 Daily Power Consumption Vacation Time

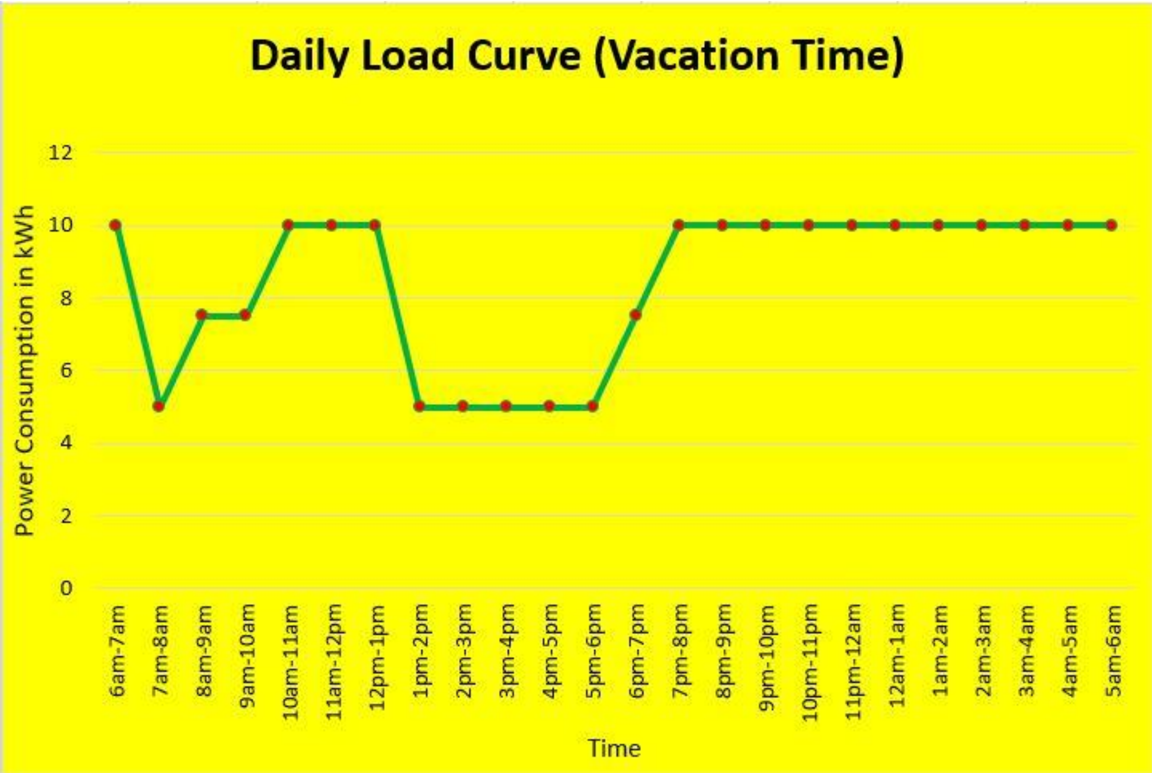
Table 5.4: Daily Power Consumption Data (Vacation Time)

Time	Use % of full load	KWh	Time	Use % of full load	KWh
6am-7am	4	10	6pm-7pm	3	7.5
7am-8am	2	5	7pm-8pm	4	10
8am-9am	3	7.5	8pm-9pm	4	10
9am-10am	3	7.5	9pm-10pm	4	10
10am-11am	4	10	10pm-11pm	4	10
11am-12pm	4	10	11pm-12am	4	10
12pm-1pm	4	10	12am-1am	4	10
1pm-2pm	2	5	1am-2am	4	10
2pm-3pm	2	5	2am-3am	4	10
3pm-4pm	2	5	3am-4am	4	10
4pm-5pm	2	5	4am-5am	4	10
5pm-6pm	2	5	5am-6am	4	10

(Source: Scribe)

5.3.2.1 Daily Load Curve

Chart 5.2: Vacation Time Daily Load Curve



(Source: Scribe)

5.3.3 Daily Power Consumption Examination Time

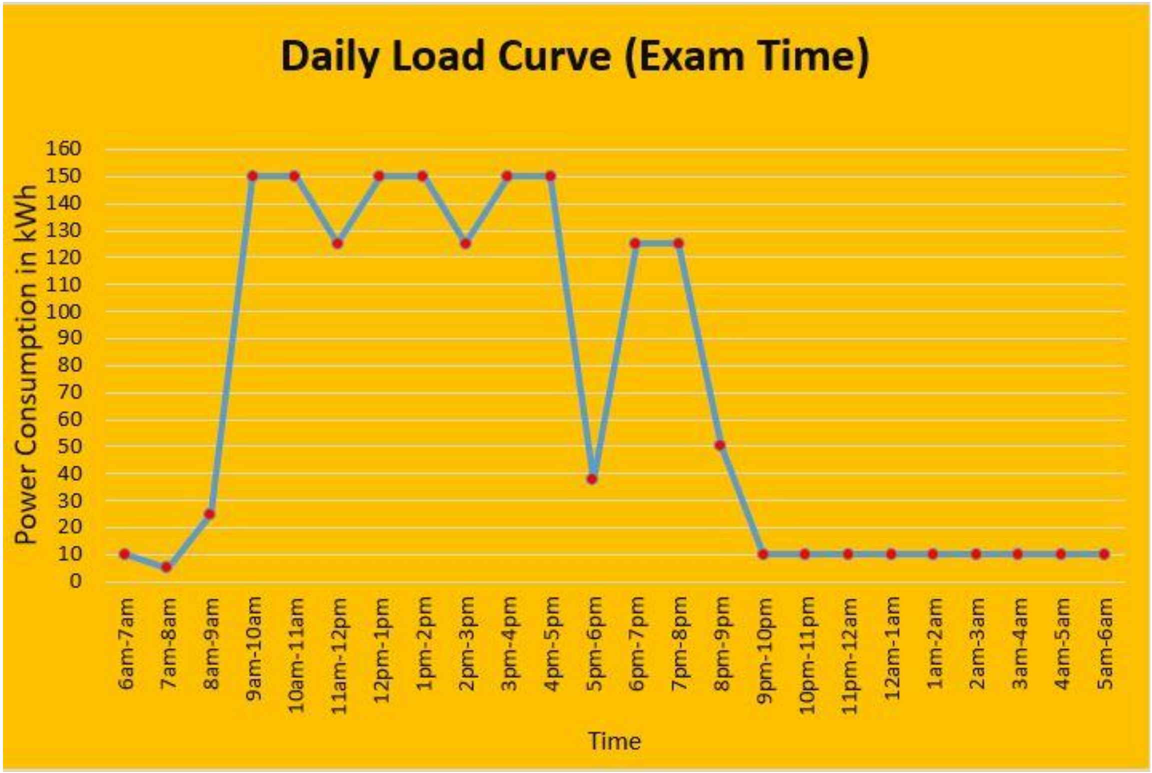
Table 5.5: Daily Power Consumption Data (Examination Time)

Time	Use % of full load	KWh	Time	Use % of full load	KWh
6am-7am	4	10	6pm-7pm	50	125
7am-8am	2	5	7pm-8pm	50	125
8am-9am	10	25	8pm-9pm	20	50
9am-10am	60	150	9pm-10pm	4	10
10am-11am	60	150	10pm-11pm	4	10
11am-12pm	50	125	11pm-12am	4	10
12pm-1pm	60	150	12am-1am	4	10
1pm-2pm	60	150	1am-2am	4	10
2pm-3pm	50	125	2am-3am	4	10
3pm-4pm	60	150	3am-4am	4	10
4pm-5pm	60	150	4am-5am	4	10
5pm-6pm	15	37.5	5am-6am	4	10

(Source: Scribe)

5.3.3.1 Daily Load Curve

Chart 5.3: Examination Time Daily Load Curve



(Source: Scribe)

5.4 Monthly Power Consumption

Power consumption of ab-04 for different month will be different. We calculate power consumption every day for every month in two part.

(i) Day Time (1st 12hours), (ii) Night Time (2nd 12hours).

5.4.1 January

We know that the month of January have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Vacation Time: January 01 to January 15

Regular Time: January 16 to January 31

Power consumption in full month for day time = 22715 KW

Power consumption in full month for night time = 12402.5 KW

Total power consumption in full month = 35117.5 KW

5.4.2 February

We know that the month of February have 28 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: February 01 to February 28

Power consumption in full month for day time = 37520 KW

Power consumption in full month for night time = 18620 KW

Total power consumption in full month = 56140KW

5.4.3 March

We know that the month of March have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: March 01, 02 & March 11 to March 31

Examination Time: March 03 to March 10

Power consumption in full month for day time = 42630 KW

Power consumption in full month for night time = 19375 KW

Total power consumption in full month = 62005 KW

5.4.4 April

We know that the month of April have 30 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: April 01 to April 15

Examination Time: April 16 to April 24

Vacation Time: April 25 to April 30

Power consumption in full month for day time = 31657.5 KW

Power consumption in full month for night time = 14190 KW

Total power consumption in full month = 45847.5 KW

5.4.5 May

We know that the month of May have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Vacation Time: May 01 to May 10 & May 29 to May 31

Regular Time: May 11 to May 28

Power consumption in full month for day time = 25228 KW

Power consumption in full month for night time = 13499 KW

Total power consumption in full month = 38727 KW

5.4.6 June

We know that the month of June have 30 days. As university schedule power consumption data designed by different power consumption time given below:

Vacation Time: June 01 to June 07

Regular Time: June 08 to June 30

Power consumption in full month for day time = 31415 KW

Power consumption in full month for night time = 16117.5 KW

Total power consumption in full month = 47532.5 KW

5.4.7 July

We know that the month of July have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: July 01 to July 07 & July 16 to July 31

Examination Time: July 08 to July 15

Power consumption in full month for day time = 40640 KW

Power consumption in full month for night time = 18415 KW

Total power consumption in full month = 59055 KW

5.4.8 August

We know that the month of August have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: August 01 to August 07 & August 18 to August 23

Vacation Time: August 08 to August 17

Examination Time: August 24 to August 31

Power consumption in full month for day time = 28090 KW

Power consumption in full month for night time = 12940 KW

Total power consumption in full month = 41030 KW

5.4.9 September

We know that the month of September have 30 days. As university schedule power consumption data designed by different power consumption time given below:

Examination Time: September 01 & 02

Vacation Time: September 03 to September 12

Regular Time: September 13 to September 30

Power consumption in full month for day time = 27425 KW

Power consumption in full month for night time = 13925 KW

Total power consumption in full month = 41350 KW

5.4.10 October

We know that the month of October have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: October 01 to October 31

Power consumption in full month for day time = 41540 KW

Power consumption in full month for night time = 20615 KW

Total power consumption in full month = 62155 KW

5.4.11 November

We know that the month of November have 30 days. As university schedule power consumption data designed by different power consumption time given below:

Examination Time: November 01 to November 08

Regular Time: November 09 to November 30

Power consumption in full month for day time = 39300 KW

Power consumption in full month for night time = 17750 KW

Total power consumption in full month = 57050 KW

5.4.12 December

We know that the month of December have 31 days. As university schedule power consumption data designed by different power consumption time given below:

Regular Time: December 01 to December 16

Examination Time: December 17 to December 24

Vacation Time: December 25 to December 31

Power consumption in full month for day time = 31855 KW

Power consumption in full month for night time = 14582.5 KW

Total power consumption in full month = 46437.5 KW

5.5 Annual Power Consumption

The Sum of Consumption power from January to December is declared as Annual Power Consumption.

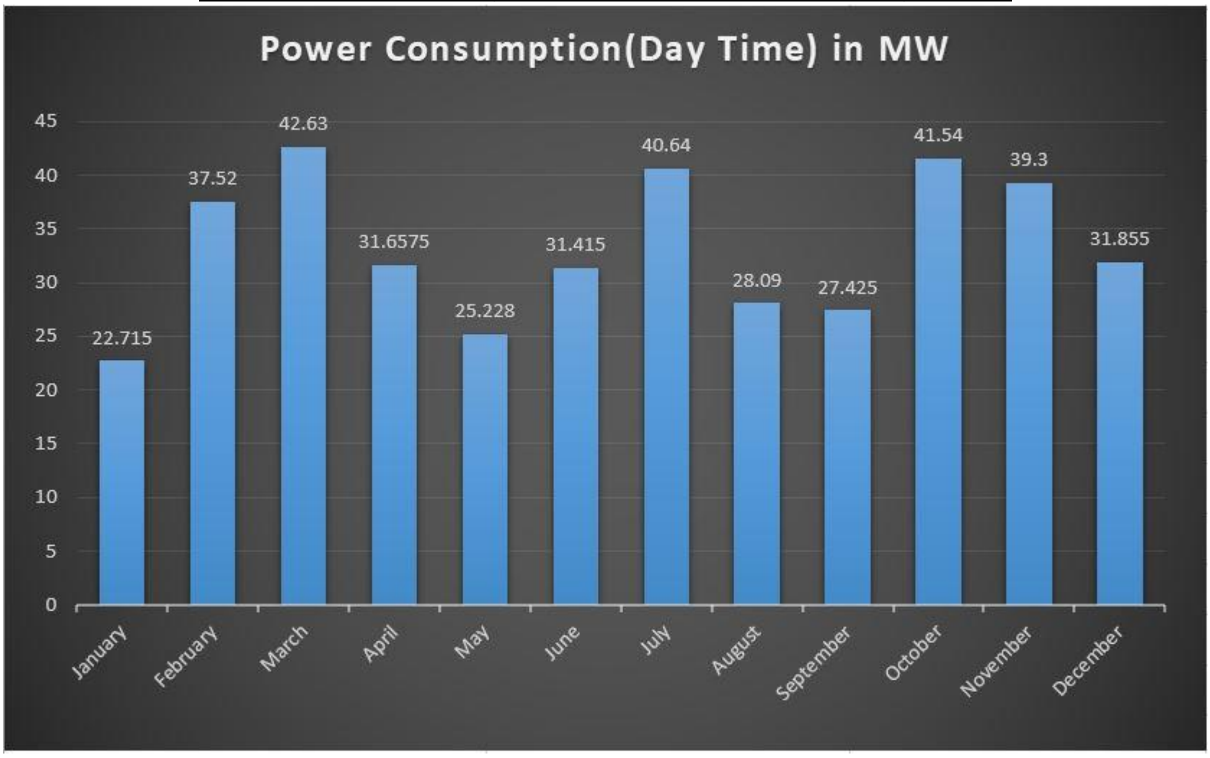
5.5.1 Annual Power Consumption Load Chart Day Time

Table 5.6: Annual Power Consumption

Power Consumption (Day) Monthly & Annual		
Month	**Power in kW**	**Power in MW**
January	22715	22.715
February	37520	37.52
March	42630	42.63
April	31657.5	31.6575
May	25228	25.228
June	31415	31.415
July	40640	40.64
August	28090	28.09
September	27425	27.425
October	41540	41.54
November	39300	39.3
December	31855	31.855
Annual=	400015.5	400.0155

(Source: Scribe)

Chart 5.4: Monthly Power Consumption Day Time



(Source: Scribe)

5.5.2 Annual Power Consumption Load Chart Night Time

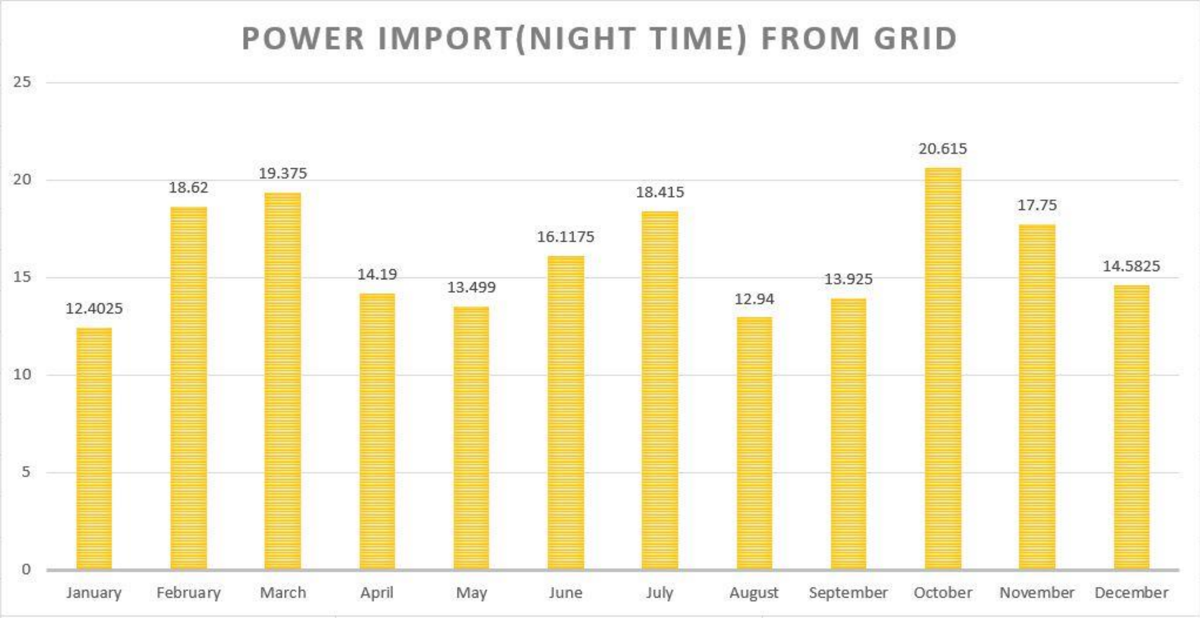
Table 5.7: Annual Power Consumption Night Time

Power Consumption (Night) Monthly & Annual		
Month	**Power in kW**	**Power in MW**
January	12402.5	12.4025
February	18620	18.62
March	19375	19.375
April	14190	14.19
May	13499	13.499
June	16117.5	16.1175
July	18415	18.415
August	12940	12.94
September	13925	13.925
October	20615	20.615
November	17750	17.75
December	14582.5	14.5825
Annual=	192431.5	192.4315

(Source: Scribe)

The power plant isn't work at night time. So we need to import night time consumption power from utility grid. That’s why we explained night time consumption power as power import from grid.

Chart 5.5: Power Import From Utility Grid



(Source: Scribe)

5.5.3 Annual Load Chart Total

Annual load is necessary to calculate total project life power consumption.

Table 5.8: Annual full time Power Consumption

Total Power Consumption Monthly & Annual		
Month	**Power in KW**	**Power in MW**
January	35117.5	35.1175
February	56140	56.14
March	62005	62.005
April	45847.5	45.8475
May	38727	38.727
June	47532.5	47.5325
July	59055	59.055
August	41030	41.03
September	41350	41.35
October	62155	62.155
November	57050	57.05
December	46437.5	46.4375
Annual=	592447	592.447

(Source: Scribe)

CHAPTER 6:

RESULT EXPLORATION OF ELECTRICITY EXPORT

6.1 Electricity Export per Month

Since solar power does not work during the night, we have to export electricity during the day.

We can export electricity, after using our demand.

Electricity export = Generated electricity – power consumption (day) …………….6.1

Table 6.1: Monthly Power Generation

Month	Generated Power in MW	Consumption Power (Day) in MW
January	64.6488097	22.715
February	59.9106496	37.52
March	65.9519275	42.63
April	59.5303389	31.6575
May	55.9051143	25.228
June	43.8812442	31.415
July	41.7343402	40.64
August	42.3074859	28.09
September	39.9052873	27.425
October	51.4201699	41.54
November	56.6421627	39.3
December	64.5339225	31.855

(Source: RETScreen)

Applied the equation 6.1 for every month,

Export Power in January = (64.6488097 - 22.715) MW

= 41.9338097 MW

Export Power in February = (59.9106496 - 37.52) MW

= 22.3906496 MW

Export Power in March = (65.9519275 - 42.63) MW

= 23.3219275 MW

Export Power in April = (59.5303389 - 31.6575) MW

= 27.8728389 MW

Export Power in May = (55.9051143 - 25.228) MW

= 30.6771143 MW

Export Power in June = (43.8812442 - 31.415) MW

= 12.4662442 MW

Export Power in July = (41.7343402 - 40.64) MW

= 1.0943402 MW

Export Power in August = (42.3074859 - 28.09) MW

= 14.2174859 MW

Export Power in September = (39.9052873 - 27.425) MW

= 12.4802873 MW

Export Power in October = (51.4201699 - 41.54) MW

= 9.8801699 MW

Export Power in November = (56.6421627 - 39.3) MW

= 17.3421627 MW

Export Power in December = (64.5339225 - 31.855) MW

= 32.6789225 MW

6.2 Electricity Export to GRID Annual

Table 6.2: Electricity Export to Grid Monthly & Annual

Electricity Export (Day) to Grid Monthly & Annual		
Month	Power Export in KW	Power Export(Day) in MW
January	41933.8097	41.9338097
February	22390.6496	22.3906496
March	23321.9275	23.3219275
April	27872.8389	27.8728389
May	30677.1143	30.6771143
June	12466.2442	12.4662442
July	1094.3402	1.0943402
August	14217.4859	14.2174859
September	12480.2873	12.4802873
October	9880.1699	9.8801699
November	17342.1627	17.3421627
December	32678.9225	32.6789225
Annual=	246355.9527	246.3559527

(Source: Scribe)

Electricity export per year = 246.3559527 MW

CHAPTER 7:

ECONOMICAL ANALYSIS

7.1 Total cost of Project

A project cost will be different types. (i) Fixed cost, (ii)Semi-fixed cost, (iii) Running cost.

We have calculated total cost jointly. There have some information missing for some restrictions.

Chart 7.1: Costing Chart

Cost Chart					
Items	Item Details	Unit	Unit Price BDT	Validity(Year)	Total Price BDT
Solar Cell	mono-Si - SPR-320E-WHT	1113	27040	30	30095520
Solar Inverter	500kW Pure Sine Wave On Grid Inverter DC to AC Power	3	4152750	30	12458250
Bidirectional Meter		2	21125	30	42250
Initial Cost					**42596020**
Operating & Management Cost		30	50000	30	1500000
Plant Cost					**44096020**

(Source: Scribe)

7.2 Total Income of Project

We have designed the power plant saving electricity and cost. Here we assumed, electricity export rate BDT 12/KWh and import rate BDT 8.3/KWh.

There we can export electricity for two case.

Case 1: When Full Generation Electricity Export & Full Consumption Power Import

We will get 64.5339225 MW generated power in a year. And we have consumed 31.855 MW power in a year. We can export electricity at the rate BDT 12/kWh and import from utility grid at the rate of BDT 8.3/kWh. In this case, if we export the full generated electricity than we get a huge amount from government. After export full electricity, than we import our demand at low rate, what we export to grid.

Case 2: When Day Time Extra Electricity Export & Night Time Consumption Power Electricity Import

We have consumed 31.855 MW power in a year. And we will get 64.5339225 MW generated power in a year. We can export electricity at the rate BDT 12/kWh and import from utility grid at the rate of BDT 8.3/kWh. In this case, if we export the extra generated electricity after using our demand. For this case, if generated electricity is higher than our demand, then electricity will be export to utility grid. If our demand is higher than generated electricity, then electricity import from grid.

7.2.1 Case 1: Full Electricity Export

Table 7.1: Income when Full Electricity Export

Subject	Unit	Unit Price BDT	Validity(Year)	Total Price BDT
Electricity Export	646371.453	12	30	232693723
Electricity Import	592447	8.3	30	147519303
Revenue				85174419.97
Plant Cost				44096020
Income			30	41078399.97

(Source: Scribe)

7.2.2 Case 2: Extra Electricity Export

Table 7.2: Income when Full Electricity Export

Subject	Unit	Unit Price BDT	Validity(Year)	Total Price BDT
Electricity Export	246355.953	12	30	88688142.97
Electricity Import	192431.5	8.3	30	47915443.5
Revenue				40772699.47
Plant Cost				44096020
Income			30	-3323320.528

(Source: Scribe)

7.3 Project Benefits

We cannot earn money by exporting electricity from this power plant. But we can save electricity & electricity cost by this power plant. The life time of this project is 30 years. In total 30 years, the plant will save the electricity bill for our university.

7.3.1 Case 1: Full Electricity Exported

Table 7.3: Project Benefit when Full Electricity Export

Subject	Unit	Unit Price BDT	Validity(Year)	Total Price BDT
Electricity Export	646371.453	12	30	232693723
Electricity Import	592447	8.3	30	147519303
Revenue				85174419.97
Plant Cost				44096020
Income			30	41078399.97
Cost Saving	592447	8.3	30	147519303
Total Project Benefit				**188597703**

(Source: Scribe)

7.3.2 Case 2: Extra Electricity Exported

Table 7.4: Project Benefit when Extra Electricity Export

Subject	Unit	Unit Price BDT	Validity(Year)	Total Price BDT
Electricity Export	246355.953	12	30	88688142.97
Electricity Import	192431.5	8.3	30	47915443.5
Revenue				40772699.47
Plant Cost				44096020
Income			30	-3323320.528
Cost Saving	592447	8.3	30	147519303
Total Project Benefit				**144195982.5**

(Source: Scribe)

CHAPTER 8:

DECISIONS AND REFERENCES

8.1 Decisions

8.1.1 Summary

Solar grid connected photovoltaic system are made out of PV exhibits associated with the matrix through a power molding unit and are intended to work in parallel with the electric utility network. The power molding unit may incorporate the MPPT, the inverter, the matrix interface just as the control framework required for proficient framework execution. There are two general kinds of electrical plans for PV control frameworks: frameworks that collaborate with the utility power grid.13a and have no battery reinforcement ability, and frameworks that cooperate and incorporate battery reinforcement just as appeared. The last kind of framework joins vitality stockpiling as a battery to keep "basic burden" circuits working during utility blackout. At the point when a blackout happens, the unit disengages from the utility and forces explicit circuits of the heap. On the off chance that the blackout happens in light, the PV exhibit can help the heap in providing the heaps.

For lacking of electricity, we need to more power produce to fulfill the demand. But there have no way to use renewable energy to fulfill the power demand. Solar power is the most usable power in renewable sources. Thus reason we use it in our university power plant's fuel.

8.1.2 Benefits

<u>The benefits of a Grid Connected PV System are given below:</u>

(1) Using clean, renewable natural solar energy to generate electricity, doesn't expend non-sustainable, constrained assets of carbon-bearing fossil vitality, no ozone harming substance and contamination outflows being used, agreeable with the natural condition, in accordance with financial and social maintainability advancement methodology.

(2) The power age can be sustained into the power grid, and the power network is utilized as the vitality stockpiling gadget to spare the battery. The interest in the development of the free sun powered photovoltaic system can be diminished by 35% to 45%, in this way enormously decreasing the power age cost. Taking out the battery dodges auxiliary sullying of the battery and expands the normal time between disappointments of the framework.

(3) The ideal combination of photovoltaic cell segments and structures can produce power as well as be utilized as building materials and enhancing materials, with the goal that the full usage of material assets can play different capacities, which diminishes development costs, yet in addition expands the innovative substance of structures. Increment the "selling point".

(4) Distributed development, close by neighborhood control appropriation, adaptable access to and exit from the power lattice, not exclusively to upgrade the capacity of the power framework to withstand wars and debacles, yet in addition to improve the heap parity of the power framework and diminish line misfortunes.

(5) It can be used for peaking. The organized sun oriented photovoltaic framework is the hotspot and focal point of the created nations on the planet in the field of photovoltaic applications. It is the standard improvement pattern of the world's sunlight based photovoltaic power age, with immense market and expansive possibilities.

8.1.3 Limitations

The limitations of a Grid Connected PV System are given below:

1. There are discontinuous and irregular applications in the ground. The measure of intensity age is identified with climatic conditions. It can't or seldom produces power around evening time or in blustery days.

2. The vitality thickness is low. Under standard conditions, the power of sun based radiation got on the ground is 1000W/M^2. At the point when utilized in huge size, it needs to possess an enormous territory;

3. The value is still moderately costly, 3 to multiple times the customary power age, the underlying speculation is high.

4. It can be used only in day time.

8.1.4 How its efficiency can be improved

A few Ways to Improve Solar Cell Efficiency:

1. Settle on an Informed Decision

2. Utilize a Solar Concentrator

3. Accurately Install Photovoltaic Panels

4. Dodge Shaded Areas

5. Keep Solar Panels Clean

6. Anticipate an Increase in Temperature

7. Use solar two-axis tracking system

8.1.5 Economic Viability

Solar energy is a free energy. It's a gift for us to use than any others energy source. Though it's installed cost is high, but total result of economic analysis will be positive to use it. We can't earn money to use this power plant for our university. But we can save university electricity bill.

We can save money for two conditions.

If we supplied full generated electricity than we can save about 18 crore TK in 30 year project life.

Another if we supplied extra electricity, than we can save about 14 crore TK in 30 year project life.

The economic viability is determined dependent on complete venture

cost, and fixed activity and support costs, life cycle of boards furthermore, inverters, buying cost offered by the administration, aswell as expanding vitality costs. The expenses and advantages of a lattice associated sunlight based PV framework all through its lifetime are then examined and evaluated utilizing the RETScreen PC reproduction programming.

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