DESIGN AND ECONOMIC ANALYSIS OF SOLAR PHOTOVOLTAIC POWER PLANT FOR GAFARGAON GOVT. COLLEGE.

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

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24 January 2021

Certification

This is to certify that this project and thesis entitled **"Design and economic analysis of solar photovoltaic power plant for gafargaon govt. college**" 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 24 january,2021

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The project and thesis entitled **" Design and economic analysis of solar photovoltaic power plant for gafargaon govt. college,"** submitted by **Md.Billal Hossen**, ID No: **172-33-466**, & **Md. Sahidul Islam**, ID No.**172-33-465** Session: Fall 2020 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on 24 January, 2021.

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Dedicated to

Our parents

With love & Respect

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List of abbreviations

PV	Photovoltaic
MPPT	Maximum power point tracking
EJ	exajoules
PW	petawatt
KM	Kilometer
MW	Mega-watt
GW	Giga-watt
SHM	Solar Home System
GIS	Geographic Information System
AC	Alternating Current
DC	Direct Current
PGF	Panel Generation Factor

List of Symbols

$	US Dollar
A	Ampere
V	Voltage
%	percent
º	Degree

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ABSTRACT

Solar power technology was present in Bangladesh from very long time. But due its high purchase cost only few were able to reap its benefits where coal based thermal power energy can not reached in Rural area. In previous years solar equipment was very costly and less efficiency but now a days due to the increase in efficiency of solar module and price drop of solar equipment. Govt. also takes a step to reach solar photovoltaic energy in rural area. In this paper, we carried out design, economic cost analysis of solar power plant for Gafargaon Govt. college, Mymensingh. This paper has two final result one is power plant design and another is its cost analysis. At first we find out the total energy demand for the college and that is 111.28 KWh. According to this energy demand we proposed PV power plan. We have used PV GIS software to calculation solar irradiation data and find out 4.78/day & solar energy production 344KWh/day. For proposed plant is required 556.2m^2 land area 124 modules, 40KW Inverter size. Total cost of the power plant is 11946810tk and per unit energy cost is 7.6tk with power plant life time warranty 25 years. It's don't need fossil fuels to generate solar energy as the result reduction in C$o_2$from the environment so, we choose solar energy for Govt. college as secondary energy source.

Chapter 1

Introduction

1.0 Background

Solar is clean and renewable energy sources. It can be used in the generation of electricity without polluting the environment. The photovoltaic discovered by French physicist in 1839, at the time of experimenting with a cell that is made of metal electrodes in a conducting solution. But in modern solar panel we use silicon in cell. Bangladesh is a highly population country. So it is not so easy task to providing electricity to everybody. The needs of alternative and renewable energy sources of Bangladesh can not overemphasize. According to" Bangladesh Energy Resources and renewable Energy prospects". the fuel import bill is over 70% of total export earning of Bangladesh (Quader 1999, p.487). The only sizeable fossil fuel resource in Bangladesh is natural gas. In Bangladesh gas is also used for cooking. Solar power is not always completely predictable because it depends on the amount of sunlight, if it gets more sunlight it will be able more electricity. If weather is not perfect, amount of electric power generated will reduced. And other sides, Solar energy cannot able to produce during night time. Moreover, Solar system is clean renewable energy sources. It's not polluted environmental during generated electricity. The above literatures clearly indicate that renewable energy especially solar photovoltaic can play an important role to electrify to industry of Bangladesh.

1.1 Significance of study

Bangladesh is high invested with solar energy. Although Bangladesh is the monsoon type of climate even solar Photovoltaic (PV) system seems to be the only adequate form of renewable energy. Solar energy is a great source of energy for the earth. However, sun's energy is continuous, clean and pollution free, emphasis should be given on this renewable energy, particularly to protect environmental disaster. Solar energy is a cheap energy in nature. It finds power from sun and its clean resources sunlight. It's the most important thing that solar energy is a uncommon source of energy. It's one of the non-polluting energies and helps few numbers of amount the greenhouse effect. Solar power generation has flowed out as one of the most quickly growing renewable sources of

electricity. The conventional energy sources like as oil, natural gas etc., these are face a number of challenges including increase prices and grow up environmental responsibility. Renewable energy known as clean energy that comes from natural sources and naturally restock human timescale. Many types of renewable energy such as, solar, wind, hydroelectric, geothermal, ocean, hydrogen, biomass and others. Solar energy is more helps us improve public health and environmental conditions than fossil fuels.

1.2Objectives

The main objective of our work is design and cost analysis of solar power plant for Govt. college. Moreover, some specific purposes of this exploratory thesis are:

- To determine solar energy production of selected site,
- To determine the energy demand of the selected site.

1.3 Methodology

The energy of solar depends on sum radiation. Where sun radiation is more there more solar energy is creation. So, a solar power plant must be situated at place where sun gives shine much time of day. According this condition, we selected such a suitable place for solar power plant. To complete this thesis paper approaches two way-----

1.Find techno-economic analysis and various parameters to generation electricity in manually.

2.we identify the sun path using a small app that is name SunCal. We see the location for solar power plant in google map. How much energy can possible to generation for this site to measure this we use software PV GIS. This has helped us to calculate the cost expenditures much closer to that would be spent in building this plant in the future. In this paper, we have estimated the energy demand of the Govt. college, and based on the energy demand and location.

1.4 Outline of this paper

This paper present a complete analysis and assessment of a PV plants for Govt. college, Gafargaon, Mymensingh. In this paper a 31 KWp on site solar PV power was designed, how much land required for it and how much cost to build up. We should understand the opportunity to build the most suitable environmental PV power plant. Considering this as an opportunity to propose a clean source of energy for complete energy demand of the Govt's college, a solar PV plant design and its assessment has been carried out.

CHAPTER 2

LITERARATURE REVIEWS

2.1 What is Solar PV System?

Photovoltaics are best recognized as process for generating electric power by utilizing of solar cells to alter energy from the sun into a flow of electrons. Solar cells generate direct current electricity using sunlight. A singe solar panel include some PV cells and all the cells created current in solar panel. PV cells is one kind of solar cells that change the intro electrical energy. The solar module is built by involving the single solar cells and combinations of some solar modules called solar panel. And the same way solar PV system is strung of one or more solar panels. Solar PV system is combinations of some components such as solar panels. Inverter, combiner, wiring and solar meter. The sun gives light, made prepared up of packets of energy that is called photons and falls on to a solar panels and makes an electrical current during a process called Photovoltaic appearance. Every solar panel generate a fairly little amount of solar energy but in total solar panel in together generate large amount of solar energy. Inverter used to convert direct current to alternator current.

2.2 Why use solar power

The major sources of world's energy production are the fossils fuels (gas, oil, coal) and atomic power plant. Solar energy is clean renewable energy. It's decreases confidence on oil, coal and natural gas for generation energy. Solar power is a big approach decreases carbon footprint. There's nothing in solar power that pollutes our mother nature. Solar power doesn't free any greenhouse gasses and not including for requiring a resource clean water to purpose. Its uses totally no other option. it's harmless also environmentally friendly. solar power is self-adequate and installing solar panels on our roof is a secure and simple way to supply to maintainable in future. A great example for increase of use solar energy is decreases of price

of solar components. The main energy source oil gas and natural gasses they are not only bad for environment but also they are limited resources. We can use under-utilized land or solar power plant. To build solar power plant don't require highly prices land that is suitable for other applications. Electricity requires transported from power plant to end consumers using a large network. Between power plant and consumer its long distance so it may power losses. But rooftop solar power increase efficiency because its short distance. It's a domestic energy and control own bill. Just 2017, a big electric power zone coal, natural gas, along with fuel produced 1743 million metric tons Carbon Dioxide. Among of them geothermal sector produced 0.5 million metric tons. So, it's clear that in future, only solar energy is clean energy for environment.

Considering the above aspect we decided the design and analysis of solar power plan of a Gafargaon Govt. College.

2.3 power PV system in Bangladesh

Bangladesh witnessed a 27 percent year-on-year jump in the number of solar home systems installed last year, thanks to a drop in the production cost aided by technological advancement. A total of 5.2m [1] solar home system (SHS) have been installed until 2017.which are stand just photovoltaic prosses to offer cost-effective method providing power of light. These installation can be produce about 15MW[3] of electricity according to the "Renewable 2018-Global status Report".

Fig:1 Solar home system of Bangladesh (SHS).

This report also tells that about 17 million Bangladeshis use SHSs and this is the 2nd country in the world uses SHSs. According to a study of the Bangladesh Investment Development Authority, renewable energy currently makes up 2.5 percent of the total electricity

generation. A solar power plant having a power generation capacity of 28 MW has recently started its operation in Teknaf of Cox's Bazar. According this, to complete this power plant, power generation capacity from renewable energy sources exceeds 5% country's total demand.

2.3.1 Works on solar technologies around the world

Solar is one of the fastest-growing industry, the leading nation is never clear for long. The nations pulling ahead in the sunny sector are China and the US, which together account for two-thirds of the global growth in solar power. Solar energy capacity has renewable power sources in the earth and with the nations husting to riches their authority in the burgeoning increased by approximately 60% over the last five years, rising to 485.82GW [4] in 2018. But where are the biggest solar power plants? Power Technology profiles the biggest operational solar power plants in the world, depend on installed capacity

Here. Given bellow largest 5 solar power plant in world & their rating

1.Tengger Desert Park, China-1547MW.

2.Sweihan Photovoltaic Independent Power Project, UAE-1,177MW.

3.Datong Solar Power Top Runner Base, China, -1070MW

4.Yanchin Ningxia Solar Park, China-1,00WM.

5.Kurnool Ultra Mega Solar Park, India-1,000MW

Given short description about The Tengger Desert Park, which is the largest solar power Plant in the world. Tengger Desert Solar Park in one of the biggest photovoltaic power plant in the world. It's situated in Zhongwei, Ningxia, in China. Total area of this plant 43km2.The largest peak power capacity is 1,547 MW. While this solar farm produces significant amounts of solar power, China does not currently make use of all of it as the country is too vast to transmit the power across such a large geographical area. The majority of the population lives in the eastern part of the country as the west consists of 20% [5] desert as well as mountainous regions. As its desert area few people live there and there is not requirement for electricity on the same scale. So, it is needed to transmission the power to areas of the country where the population is higher.

Fig:2 Largest solar power plant in world [5]

2.4 Potential of solar energy

There is a huge potential of solar energy. It's so massive that the whole power requirements of the total world can be satisfied by the solar energy. The world gets 174[6] Petawatt PW received of sun power rays at the higher atmosphere. About 20% of the worldwide people lives in 70 countries gloating outstanding conditions for solar PV. Solar PV output remain constant between different month in whole year those countries potential energy level is high. About 30% of radiation of sun back to space and have a rest of them absorbs by clouds, oceans and masses. The scale of solar radiance at the earth's plane is chief reach over the visible along with near-infrared ranges with a little piece in the bright. Insolation level reach to 150-300watts/m^2 where most of the world population live. The earth's atmosphere, oceans and land masses absorbed about 385000 exajoules (EJ) of the whole solar energy per year. It was a record 2002 this was so much energy in one hour this larger than the world used in one year. The approximate worldwide potential of solar energy found is 1600 to 49800 exajoules (4.4*1014 to 1.4*1016 KWh) per year. 6]

A measuring relatives worldwide possible energy vs world basic energy consumption.

1. Proportion of potential vs present consumption as year (402 EJ :3.9-124)
2. Proportion of potential vs prominent consumption by 2050 (590-1050:EJ:1.5-2.7 to 47-84)

3. Proportion of potential vs prominent consumption by 2100 (880-1900:0.8-1.8 to 26-57)

This is collected from United National Development Program. In 2000

2.4.1 Solar panel

A solar panel has another named that is called PV panel. These are used to exchange radiance from the sun which is made of particles called photons. Generally a solar panel familiar to absorb sun's ray after than those are exchange electricity or heat. At first in 1958 Hoffman electronics was propelled solar panel powered city state.

A solar panel form with few number of Photovoltaic (PV) solar cells and these solar cells not only connected in series but also connected in parallel. The cells of solar panels form at two semiconductors materials. Among of two layers one layers carries negative charge and another layers carries positive charge. While sunshine hit the solar panel photons from the light are engrossed by the semiconductors atoms, then free electrons. Electrons moves from negatives layer(n-type) to positive layer (p-type) semiconductors to generate electricity. Because of flowing electric current in one directional like a battery it's called a direct current.

A solar panel works by permitting photons, otherwise particles of light, to hit electrons without charge from atoms, producing a run of electricity. solar panel don't produced energy at night

2.5 Types of solar system design

There are various types of solar system design. Here, mainly three types of design mentioned. They are-

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

2.6 Solar PV technologies

The require of solar power growing up day by day latest advances are presented and relatively advances are also developing. There are different types of photovoltaics. Four types Solar PV cells given bellow-

- Single crystalline or mono crystalline
- Multi- or poly-crystalline

- Thin fill
- Amorphous silicon

2.6.1 Mono Crystalline silicon

Mono crystalline silicon solar cells are the oldest type of solar cells. They are prepared on pure silicon precious stone. It's properties high efficiency of light conversion typically 15% [08] recent development of sun power its aspect improve efficiency up 22-24%.They make the majority power per square foot of module. Every cell is cut from a separate crystal.

2.6.2 Poly-crystalline

Polycrystalline cells are prepared by gather several gains and plates of silicon precious stones into thin wafers. It is simpler and cheaper into create smaller pieces of silicon, so the production cost of this type of PV is less than monocrystalline. Its approximately ~ 12%. This type of cells are long lasting and can have a facility life of more than 25 years.

2.6.3 Amorphous Silicon:

The thin photovoltaics cells are formed by storing silicon film against substrate glass. In this system fewer silicon is utilized for producing compared to mono or polycrystalline cell, but this is expensive of conversation efficiency. Thin film PV have efficiency of ~6%-15% for single crystal silicon cells. The chief advantage of thin-film PV technology is that the unformed silicon can be variety of substrate. Which can be made flexible and come in different shapes and these are used in many applications. The unformed silicon also less prone to overheating.

2.6.4 Thin-film

Thin -film solar panel is the latest technology presented to solar cell technology. A thin- film solar panel is form one or more thin layer by depositing photovoltaic material. For example glass, plastic or metal. Some of thin film materials are copper indium diesel, cadmium, telluride, and gallium. The efficiency of thin-film solar 21.7% in laboratory and efficiency in the field condition is 18.7%. to install thin film solar panel require more land but installation is

very simple, require less labor so cost is fewer. Some of thin film perform better in low light conditions.

2.7 Component of solar PV system

Many types of component include in solar PV system, such as solar panels, charge controller, battery stores, AC power, DC power, wires, Inverters. A typical block diagram of solar PV system given in bellow-

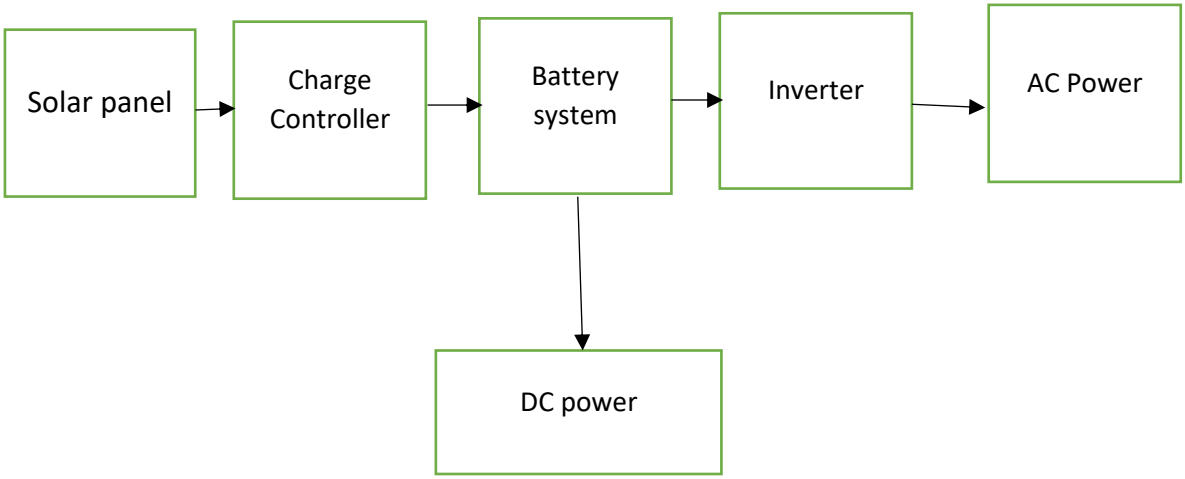


Fig: 03 Typical Block diagram of solar component system [09]

2.7.1 Charge Controller

Solar charge controller works as a regulator. It's prevent battery damage. At what time battery is connected in a procedure, the essential of charge organizer comes forward. A charge regulator is used to controls the unnecessity voltage build up. When comes bright sunny day the solar cells generate extra that can be run to battery harm. A charge regulator or controller used to maintain the balance controlling extra voltage in charging the battery. The best charge controller is EPEVER MPPT Charge Controller [10]

2.7.2 Batteries

Battery is used in solar power system to store charges. There are various types of battery find in market but all battery are not appropriate for solar power. Mostly used batteries are nickel/cadmium batteries. There are several former sort of high energy concentrations such as- sodium/Sulphur, zinc/bromine run batteries. But used for the middle

term batteries nickel/metal hydride battery has the top cycling performance. To use for long time selection iron/chromium redox and zinc/manganese batteries are best. Number one battery in the world is Sun grow SBP4K8.

2.7.3 Inverter

Solar panel produced direct current (DC) electricity but the majority of the household and industrial apparatus require ac current. Inverter is used to convert dc current to ac current from solar panel or battery. There are three different types of solar inverter and there work are slightly different.[11]

- On-grid solar inverter
- Off-grid solar inverter
- Hybrid solar inverter

CHAPTER 3
THEORETICAL MODEL

3.0 Site Location

Gaffargaon Govt. College is located at gaffargaon in Mymensingh division besides of the Brammoputro river. The college campus is located (latitude 24º 24’ N. longitude 74º36’E). The climate of the place varies from subtropical to temperature. Figure 3 shows satellite location of the Govt. College.

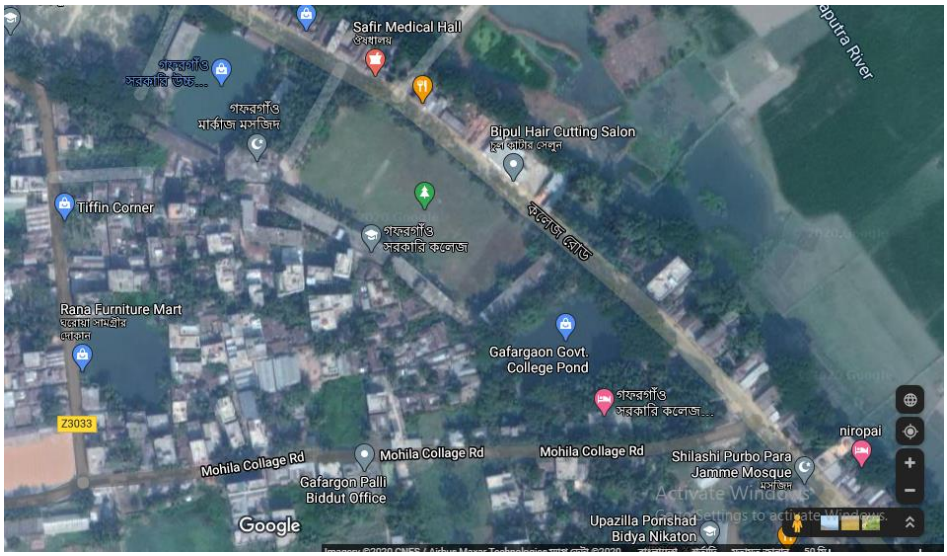


Fig. 4 Satellite aerial view of location for installation of solar PV. Source Google maps.

3.1 The Sun Path

The sun lane that the sun shows up to track across the sky as the Earth turns and orbits the sun.it also refers during a given season, length of daylight ant amount of day light in a certain latitude. The relations site of the sun is key issue in the temperature achieve of building as well as in the presentations of the solar energy. The sun path of Gaffargaon Govt. college given bellow-----

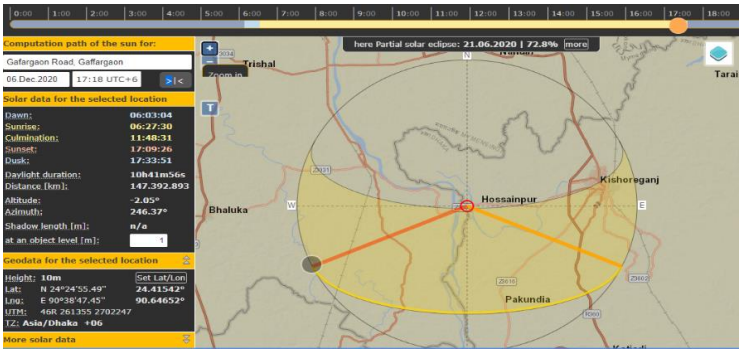


Fig.5The sun path of Gafargaon Govt. college[12]

3.2 Energy demand of the college

The college has Three academics buildings and two hostels one is boys another for girls. There are also has a big hostel for teachers. A big mosque include to college that is known Gafargaon central mosque. A details survey of each room of college, hostel and mosque carried out to identify the amount of load connected to it. Tables 1 provides the complete details of different equipment's their wattage and hours of operation.

Table 1

Serial no	Equipment	Quantity	Ratting	Hours of operate	Approximate watt hours
O1	Energy lights	275	20	7	38500
02	Fans	125	75	5	46875
03	laptops	35	60	4	8400
04	Scanners	2	35	1	70
05	Printers	2	50	1	100
06	Motor 1 HP	4	746	0.5	1492
07	Air Conditioner 0.5 Ton	2	1752	4	14016
08	Mobile charger	70	5	2	700
09	Speakers	15	25	3	1125
10				Total demand	111278

Total demand =1,11,278Wh
=111.28KWh

3.3 Solar irradiation data of selected site

PVGIS-5 geo temporal irradiation database

Provided inputs

Latitude/Longitude 24.25,90.55

Horizon : Calculated

Database used : PVGIS -SARAH

Start year : 2016

End year : 2016

Variables included in this report :

- Global horizontal irradiation
- Average temperature
- Direct normal irradiation
- Global irradiation optimum angle

Table 2 Solar radiation data for different months of the whole year, 2016 [13]

Month	E_d	E_m	H_d	H_m
Jan	310	9600	4.03	125
Feb	392	10980	5.18	145
Mar	409	12670	5.58	173
Apr	421	12630	5.87	176
May	316	9800	5.16	160
Jun	349	10470	5.03	151
Jul	301	9330	4.26	132
Aug	344	10670	4.83	150
Sep	315	9450	4.43	133
Oct	332	10300	4.58	142
Nov	317	9510	4.26	128
Dec	317	9830	4.16	129
Yearly average	344	10437	4.78	145

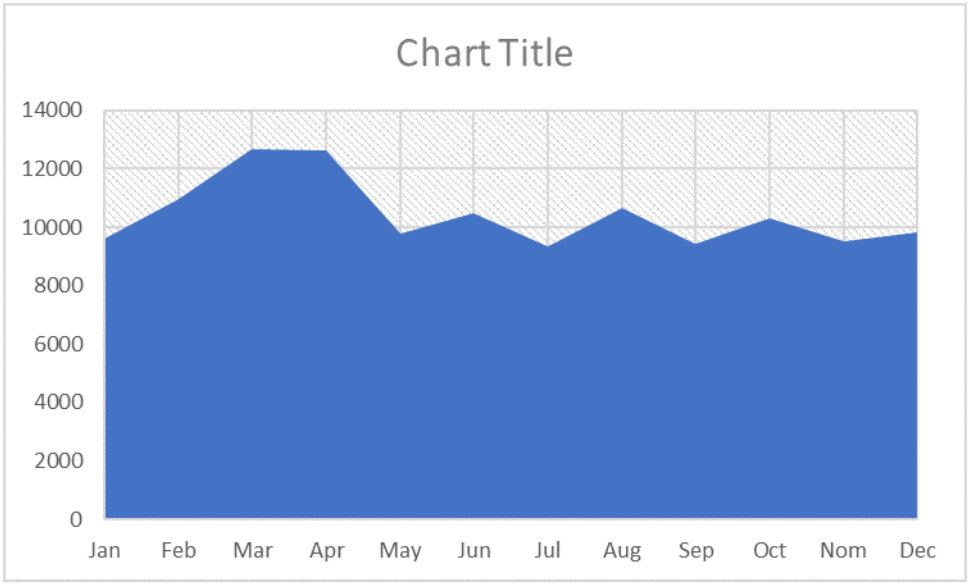
This is solar irradiation data for different month of the whole year that is used in solar power plant according to college demand. Fig. 5 shows monthly power production from fixed-angle PV method. Figure 6 shows the monthly in-plane illumination for permanent angle and fig. 7 also shows sketch out of perspective with the sun path for wintry weather and summer solstice for the panned site.

E_d: on a daily basis energy generation from the certain method (KWh).

E_m: on a monthly basis energy generation from the certain method (KWh).

PV estimate : 24°25’ North, 90°33’East

KWh/month

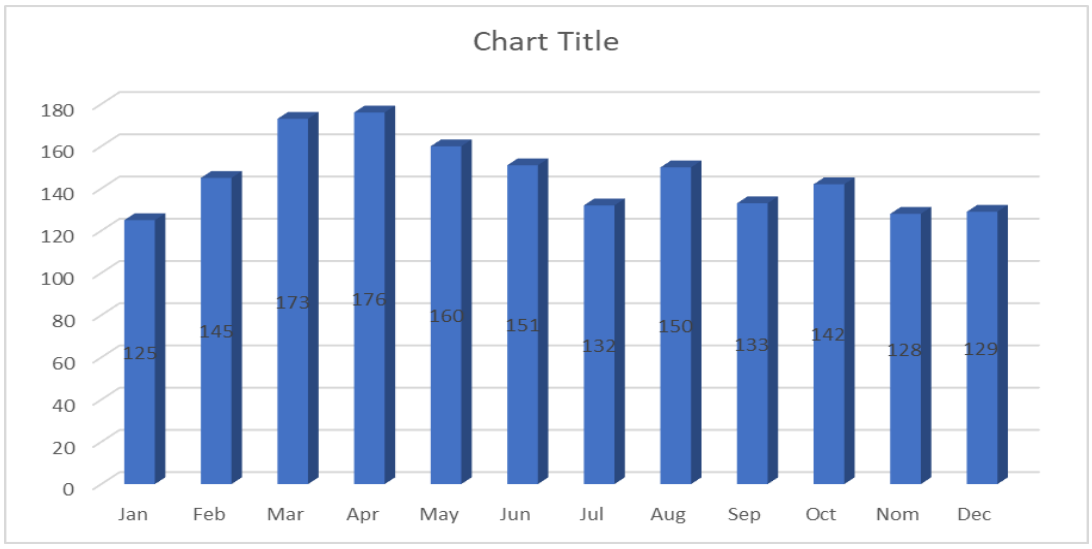


Graph: 1 Energy output (monthly) for fixed-angle PV system

3.3.1 Irradiation estimate: 24°25’ North, 90°33’East

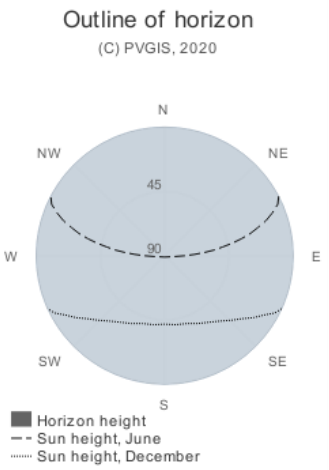
KWh/m^2

/month



Graph. 2 In- plane irradiation (monthly) for fixed angle.

3.3.2Horizon outline of 24°25’ North, 90°33’East



Horizon height
December height 42° at azimuth 0°
June height 89° at azimuth 0°

Fig. 6 Outline of horizon with the sun path for winter and summer solstice.

H_d: on daily basis of worldwide illumination for each square meter received by the module of the conferred method (KWh/m^2)

H_m: on monthly basis of worldwide illumination for each square meter received by the module of the conferred method (KWh/m^2)

It’s clear that it can possible 344 KWh energy generation on daily basis of selected site. which is very similar to the desired demand requirement of 111.28 KWh.

3.3.3 Irradiance

Irradiance of a site is given by the formula:

Irradiance=$\frac{average\ insolation}{average\ daily\ bright\ sunshine\ hours}$ KWh

It is very important to know the irradiation and insolation of a spot after anybody is going to design a solar PV system for selected spot. Depending on the sun shine, irradiance and insolation changes with place to place.

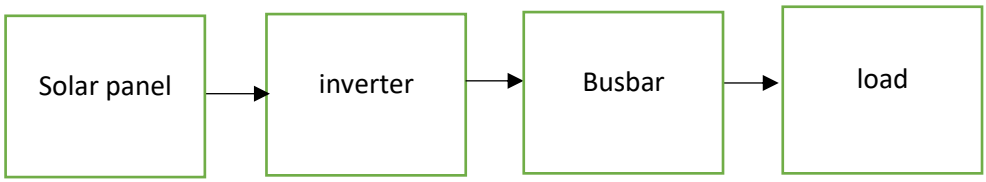
The irradiance of the Dhaka division can be calculated from Tables 2 and 3.

Table;3 daily average bright sunshine hours in Dhaka

Month	Daily mean	minimum	maximum
Jan	8.7	7.5	9.9
Feb	9.1	7.7	10.7
Mar	8.8	7.5	10.1
Apr	8.9	7.8	10.2
May	8.2	7.5	9.7
Jun	4.9	3.8	7.3
Jul	5.1	2.6	6.7
Aug	5.8	4.1	7.1
Sep	6.0	4.8	8.5
Oct	7.6	6.5	9.2
Nom	8.6	7.0	9.9
Dec	8.9	7.4	10.2
Average	7.55	6.03	9.13

The daily average sunshine in Dhaka is 7.55 hours and average solar irradiation of Gargano is 4.78 KWh/m^2 .From the above procedure, we obtain the irradiance of gaffargaon is 633.11 watt/m^2.This rate will be utilized for govt. college Solar PV design.

3.3.4 Theoretical model solar PV power plant for govt college



Chapter: 4

Power Plant Designing

4.0 Solar photovoltaic power plant designing

Scheming of photovoltaic power plant depend with some essential elements, those elements are PV module sizing, inverter sizing and battery sizing. To find better output from solar PV power plant also require geographical data and weather condition of selected site. Table 2 and fig. 6 provides a monthly average irradiation data for the gafargaon Govt. college at 24^o25N, 90^o33E in Mymensingh , Bangladesh.

4.1 Panel generation factor (PGF)

Panel generation factor is a main component in designing a solar PV plant. PGF is used in sizing solar photovoltaic system and is dependent on the irradiance for a given location. PGF is daily solar irradiation of proposed site divided by Standard test conditions Irradiance for PV panels. It's different in each site location, for Gafargaon Govt. college considering 4.78KWh/m^2.

Panel Generation Factor

$$=\frac{Daily\ Solar\ Radiation}{Standard\ Test\ Conditions\ Irridiance\ for\ PV\ panels}$$

$$=\frac{4.78*10^3}{1000\ [14]}$$

=4.78

4.2 Energy required from PV modules

Energy necessary from PV modules will be on daily basis energy require of the college , some of energy losses in procedure and restitution for the system losses that is usually taken as 30%, so the sum energy necessary will be-

Energy required

= (Energy Demand $*$ procedure Losses restitution Factor)

=111.28*1.3

=145KWh/day

4.2.1 Watt peak rating For PV modules

Watt peak rating for PV Modules is defined division of whole energy essential from PV modules by Panel generation factor. Its depends on energy demand of PV modules.

$$=\frac{Energy\ required\ from\ PV\ modules}{Panel\ Geneation\ Factor}$$

$$=\frac{145}{4.78}$$

$=31\text{k}W_p$

4.3 PV modules

A nearby supplier of PV module was identified for a realistic analysis and availability of the modules Samsung LPC250S was considering in this analysis. This modules price 659$. Table 3 given full specification of the selected module.

Table 4

PV module specification (Samsung LPC250S) product information [15]

Module type	Samsung LPC250S
Peak power output	250
Current at peak power output amp	8.2A
Voltage at peak power output volt	30.5V
Open circuit voltage	37.6v
Power tolerance	-2%/+3%
Number of cells	60
Type	Monocrystalline
80% power output warranty period	25yrs
90% power output warranty period	10yrs
Workmanship warranty period	5yrs

Samsung LPC250S highest output power is 250 watt. If illumination is 1000 watts per meter square meter. So 633.11 watt m^ irradiance 158.28 watt and short circuit current is 5.49 A.

Total no of modules essential for the planned plant rely on the peak evaluation of the modules.

No of modules required=$\frac{total\ watt\ peak\ rating}{PV\ modules\ peak\ rated\ output}$.

$=\frac{31*1000}{250}$

=124 modules

But we proposed to use 144 modules for solar plant design.

4.4 Inverter calculation

Inverter size is essential for PV power plant recline on how much watt peak necessity for the college. The peak requirement of the college is 31Kw_p .The inverter measure must be 25%-30% greater than overall watts necessity.

The inverter size=31*1.3

=40KW

We have proposed to use Solis-3P10K-4G Grid tired solar inverter. Its product of china. [16]

- The MPTT voltage range :160-850 V
- Output power 10 Kw
- Connection: 50 Hz grid frequency and 3 phase 4 wire connection
- The efficiency of this inverter: 97%
- AC voltage:230 V.

Number of inverter's is required =$\frac{total\ size\ of\ inverter}{Rate\ of\ per\ inverter}$

$=\frac{40}{10}\ kw$

=4 pieces.

4.5 Combiner

We proposed to use ZJBENY combiner Box model of BHS-3/1[17].

- The number of input string : 3
- Maximum input fuse rating: A, 1000V DC

Combiner box price per pieces $120 [18]

4.5.1 Number of combiner box

We will need combiner box is equal to the number of inverter. So, we will need 4 combiner boxes.

4.6 Mounting

There are different sorts of mounting of solar panel can be done. Depending on the position and procedure several form of mounting is done. There are several types of mounting. These are given bellow.

- Pole mounting
- Ground mounting
- Roof mounting

Roof mounting are two types-

- Pitched Roof mount
- Flat Roof mount

We were selected flat roof ballasted mounting for our proposal work.

4.7 PV array designing

There are several parameters to check for designing arrangement of solar plant. The majority vital thing to choose appropriate inverter and combiner box. Therefore, they can endure the PV modules

Solis-3P10K-4G inverter's MPPT voltage range=160-850V

Samsung LPC250S modules open circuit voltage =37.6 V

12 modules in series =37.6*12

=451.2v

This is within the inverter's MPPT voltage range. We can put 22 modules in series even it will be safety. But due to our easily PV design we proposed 12 modules in series.

Module's maximum power voltage=30.5V

Inverter MPPT voltage range =160-850

$\frac{(160-850)}{12}$ =13.33-70.83[module maximum power voltage=30.5]

So, highest power voltage is in the inverter voltage limit.

Solis-3P10-4G inverter's currents rating.

Inverter rated voltage=400V

Maximum current ($\frac{10*1000}{400}$) =25A

At 633.11W/m^2maximum short circuit current=5.49

If we keep 3 parallel strings [1 string consists of 12series module

=3*5.49

=16.45A

So, we cannot set extra sequence since if there grow up a weather condition with low temperature and high insolation extreme current can flow.

For safety considering 35% excessive current = 22.20 A

This is also in inverter's capacity. ZJBNEY BHS 3/1 combiner maximum fuse rating =1000 v 15A.

This is as well as can hold up 3 parallel sequence every comprise of 12 series modules.

Therefore, our chosen PV array design is 3 parallel sequence every comprise of 12 series modules for 1 combiner box and 1 inverter.

As we require to set up 144 modules, we essential such 4 configurations.

4.8 Wiring

Rated short circuit current is 8.66 A from the PV module. If there is an effect of higher insolation and lesser warmth admittance current can flow. To avoid these to happen the safety factor is considered. Average insolation at gafargaon is 633.11 W/m^2.

There for maximum short circuit current is=5.49 A

For, 3 parallel strings =3*5.49

=16.45 A

In view of 35% security thing highest current rating is 23 A.

So, we have chosen 25A rating wiring.

4.9 Required area for the plant

Number of PV modules 144, the array can be arranged as 4 and rows is 3. So the area required will be

Dimension of one module =1.63m*o.982m

Number of modules connected in series =12

Width of an array=0.982*12=11.784m^2

Width of the solar field=No of array *12

=4*11.784=47.136m

No. of rows in solar field =3

Asphalt space between two arrays (together with length) =3.2 m [19]

Total length of the solar field

=(3.2*3)+1.63m

=11.8m

So total area required for the plant is =47.136*11.8= 556.2m^2

4.10 Energy supplied by the proposed PV system

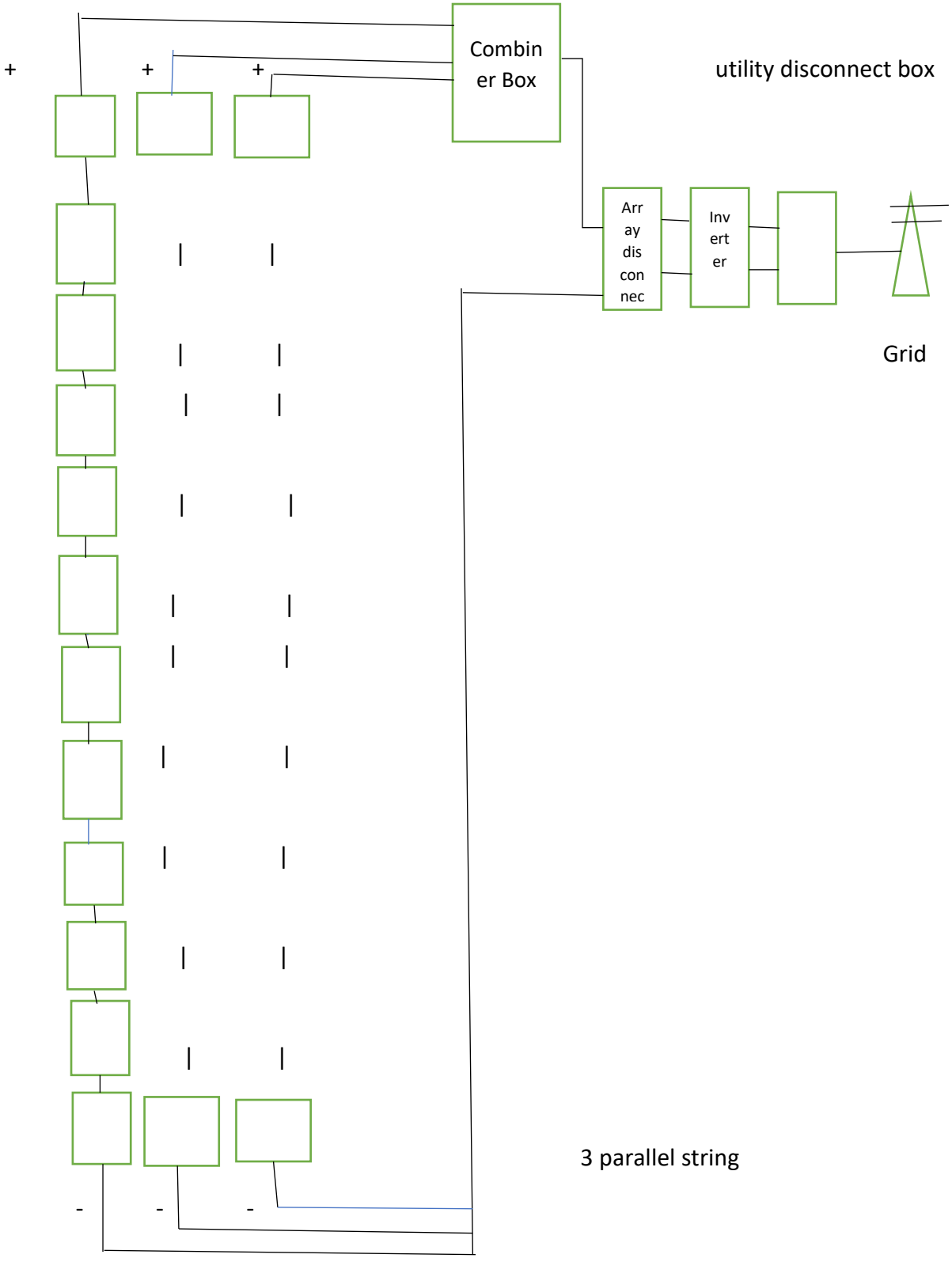


Figure 7: Designed solar PV system

Chapter 5

Results and Discussion

5.1 Cost calculation

To develop the proposed Solar pv system on Gafar Ganon Govt. College we need to have clear idea of the Installation and other cost. To have a proper idea, we have calculated the approximate cost in BDT.Table-7 shows all components that we need to implement the solar pv system. The components are: PV modules, inverters, combiner boxes, and surge arrestors, lightning rod, mounting, meters, wiring. In addition to that, we have to consider the transportation, installation, LC and maintenance costs. We have considered this as the 40% of all components costs.

Table 5 :Approximate cost calculation[20]

Component	Description	Quantity	Cost
PV module	Samsung LPC250S	144	94896$
Inverter	Solis-3P10K-4G	4	3200$
Combiner Box	ZJBNEY-3/1	4	344$
Surge Arrester	----	4	240$
Lightning Rod	----	1	100$
Mounting	-----	---	1728$
Meters	---	---	91$
Wiring	----	---	725$
		Total equipment cost	101324$
Transportation, installation LC, maintenance	40% of all cost	----	40529.6$
total			141853.6$
Discount of 1%			140435.064$

Total cost USD=140435.064$

Total cost BDT=11946810BDT

5.2 Per unit energy cost

Let, our proposed PV system life is 25 years. So, the cost per unit of energy by the designed system will be:

Total cost of the system : 11946810tk

Average daily bright sunshine hours :7.55

Estimated capacity of the designed system in KW : 22.80 KW

Average produced per day in KWh : 22.80*755=172.14

Energy produced in 25 years in KWh :172.14*25*365=1570777.5

Cost per unit of energy in BDT=$\frac{Total\ cost\ of\ the\ system}{energy\ produced\ in\ 25\ years}$

=$\frac{11946810}{1570777.5}$

=7.6Tk

5.3 Results

This paper has attempted as assessment of a Solar PV plant for Govt's college of Gaffargaon, Mymensing. It's financial viability with parameters associated and real time market prices. The average solar radiation at the proposed site was found 4.78 KWh/m^2/day which is having average daily energy production of 344 KWh that is vary for govt. college demand. The 31 KW_p system designed for the college required 124 modules and the plant required area of 556.2m^2. The cost of the plant is BDT 11946810 TK and per unit energy cost of the plant is 7.6 Tk . The plant life time is 25 year.

Table 6 Assessment of the proposed PV Plant

S. No	Particular	Value
1	Capacity of the plant	31Kw_p
2	Life of the plant	25 years
3	Area required for the plant	556.2 m^2
4	Energy demand of the college	111.28 KWh
5	Total cost of the plant	11946810Tk
6	Per unit energy cost	7.6 Tk

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The PV technology is not used only for Reducing the consumption of fossil fuels but it can be continuous source of energy for critical areas like an education institute where uninterrupted supply is demanded. Reduction in Co_2 emission from the energy generated with solar energy which could be otherwise generated with highly polluting coal based thermal power plant was also analyzed. In upcoming days fuel stock will decrease and the world will have to depend on renewable energy more and more. So, we choose solar energy for Govt. College as secondary energy source which will helps in developing a sustainable environment and improving policies for the better use of solar energy.

6.2 Future Scopes

- Reducing system cost
- System's cost payback analysis
- Cost analysis with battery backup.

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