STUDY OF THE SOLAR IRRADIATION PATTERN OF BANGLADESH FOR ELECTRICITY GENERATION

This thesis submitted in partial fulfillment of the requirements for the Award Degree of Bachelor of Science in Electrical and Electronic Engineering

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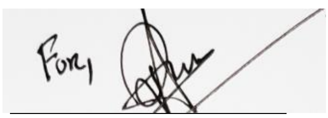
Certification

This is to certify that this project and thesis entitled "**STUDY OF THE SOLAR IRRADIATION PATTERN OF BANGLADESH FOR ELECTRICITY GENERATION**" 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.

Countersigned



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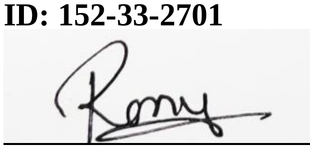

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Dedicated to

Our Parents
&
Teachers

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List of Abbreviations

CIGS	Copper Indium Gallium Solenoid
BCSIR	Bangladesh Council of Scientific and Industrial Research
LGED	Local Government Engineering Department
BPDB	Bangladesh Power Development Board
TMSS	Thengamara Mohila Sabuj Sangha
CMES	Centre For Mass Education In Science
PC	Personal Computer
RF	Ripple Factor
RTD	Resistance Temperature Identifier
FF	Fill Factor
SP	Solar Panel
PDB	Power Development Board
REB	Rural Electrification Board
LGED	Local Government Engineering Direction
IDCOL	Infrastructure Development Company Limited
NGO	Non-Government Organization
SHS	Solar Home System
RE	Renewable Energy
PV	Photovoltaic
AC	Alternating Current
DC	Direct Current
IV	Instrument Measuring

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Firstly, we give thanks to God. Then we would like to take this chance to express our admiration and gratitude to our project and thesis supervisor Professor Dr. M. Shamsul Alam, Professor, Department of EEE for being dedicated in supporting, encouraging and guiding us in the course of this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

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ABSTRACT

Everyday electric power demand is increasing in present era. Beside that require of present energy resources lead today's engineers and scientists to think about the substitute sources of energy. The solar energy is a potential source for producing electric power. Now this solar system is gaining its popularity more and more. In home system applications, the use of solar energy is also attractive. The following research paper is based on analyzing the solar irradiation model of Bangladesh for electricity generation. Irradiation and power are talked about with their optimum capacity. Power is one of the most important factors in developing country and for sustainable economy. Like the rest of the countries of the planet, in Bangladesh the demand for power is enhancing day by day. The main aim of our research is to find out the irradiation of sun in Dhaka city in the month of January and February 2019 so that the power production by the solar panel can be estimated and the data to get average irradiation and find the correlation between solar irradiation and power. By using this data we can easily understand the electricity production by SHS and create a standard form of power production of SHS in 2019.

Chapter 1
Introduction

1.1 Introduction

Bangladesh is now a densely populated & developing country. Because of developing of electricity sector day by day the renewable energy demand also increasing. We worked on performance testing and analysis of roof top solar panel in our university's roof top. Solar energy is very important for our country. But in rainy or a foggy day the solar system's most faced problem is low light from sun. Our work is performance and analysis of the roof top solar system in Dhaka the capital of Bangladesh. We worked to see performance of three solar panel. There are 45 watt, 60 watt and 100 watt. We tested its performance, efficiency, short circuit current, short circuit voltage, peak circuit and voltage and the fill factor (FF).

World energy utilization is changing every 16 years. The increment is significantly higher in America, where 6% of the total populace expends 33% of the world's vitality. [1].Some point or another, the exhaustion of energy resources will compel us to change the energy consumption behavior. The solution to the energy crisis in the future is partly dependent on the use of nuclear energy. The safety of reactors has already become an issue. It is contended that the predicament center cooling arrangement of the reactors has not been tried and along these lines there is no assurance that it will function true to form in a genuine crisis. For that safety reason the solar power is more secure and it can say that solar energy is approximately hundred percent safe.

The present situation of our country we have capacity to generated 19000MW electricity but it is not enough of our country so we produce new installation side every day. These are the solar system on grid and roof top SP off grid.

1.2 Statement of the problem

Solar energy type the rural electrification began in Bangladesh in 1988 at Norshingdi Power Development Board (PDB), Rural Electrification Board (REB), Local Government Engineering Direction (LGED), Infrastructure Development Company Limited (IDCOL) and a significant number of private sector agencies including Non-Government Organization (NGO) are involved in solar electricity development. In city area this time SHS demand is increasing day by day. Huge building owners has solar panel on the roof top of their building. It generates the electricity of on grid in this building so their electricity bill can reduce.

In 2010 all most 25%-27% of global energy ultimate usage came from the renewable energy which reduced cost.13% came from biomass energy, such as wood-burning. Hydro electricity was the second source of the biggest renewable energy providing 3%-5% of the world energy consumption and 15% the global electricity generation. The yearly 30% rate is growing the wind power. It is very important and we produce a lot of energy of from these source. The solar power are playing role to generate in our RE. The Photovoltaic (PV) cells are depends of sunlight. The PV energy annually manufacturing output of the photovoltaic industry which reached 6900MW in 2008.The biggest plant is 354 MW.SEGS power plant which situated in the Mojave Desert. The world largest geothermal power generation is Geysers in California. This capacity with rated of 750MW.

The renewable energy is now playing noteworthy role in power sector worldwide. These are helpful to produce energy of our own country. The RE is generated from the natural resources-these are sunlight, wind, tides, geothermal, biomass, and biogas.

Our government are starting various steps to develop our renewable energy. The SHS system are now obligatory for all building owner of the Dhaka city and all other city. The government office, private office, school and colleges, hospitals roof top solar panel which are compulsory and its connection are connected to on grid. It is very helpful our daily energy consumption and cost reduce for our electricity bill. The pi-chart below shows the whole renewable energy in world [2].

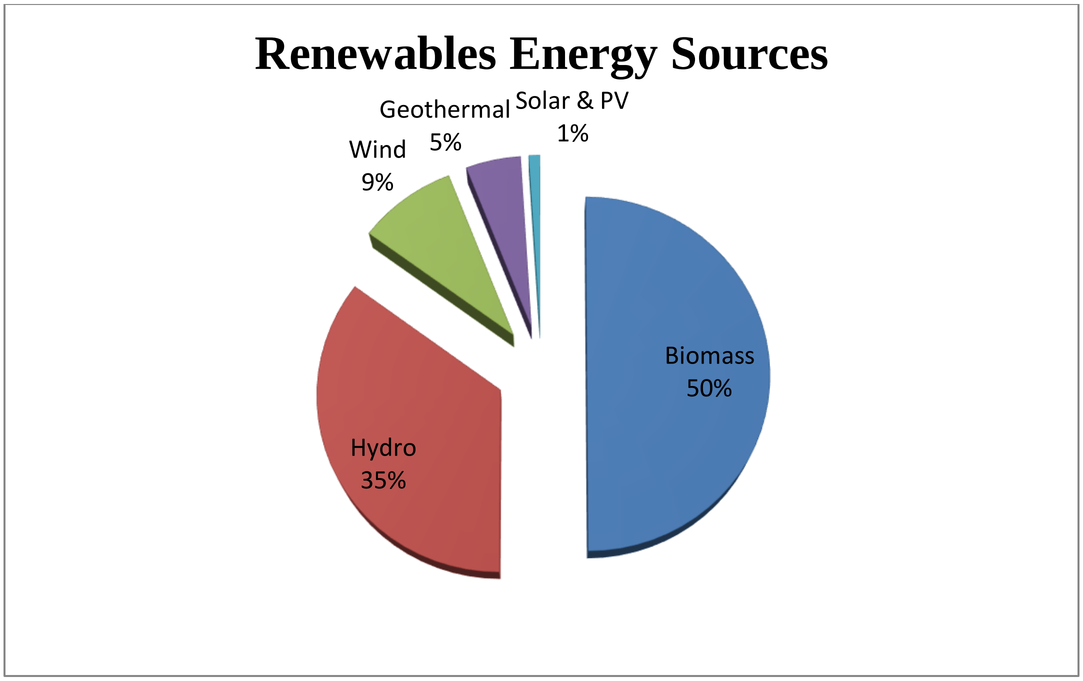

Figure 1.1: A pi-chart of RE in the world

1.3 Energy Classification

Energy is mainly classified into three categories:

1. Primary and Secondary energy
2. Renewable Energy and Non-renewable Energy
3. Commercial and Non-commercial Energy

1.3.1 Primary and Secondary energy

The various existing energy sources can be classified in many ways. Primary sources can be used directly, because we get it from the natural environment like coal, oil, natural gas and wood, nuclear fuels (uranium), the sun, the wind, tides, mountain lakes, the rivers (from which hydroelectric energy can be obtained) and the Earth heat that supply [25]. Secondary sources derive from the transformation of primary energy sources: for example petrol that derives from the treatment of crude oil and electric energy obtained from the conversion of mechanical energy (hydroelectric plants, Aeolian plants), chemical plants (thermoelectric), or nuclear (nuclear plants). Electric energy is produced by electric plants, i.e. suitable installations that can transform primary energy (non-transformed) into electric energy.

1.3.2 Renewable Energy and Non-renewable Energy

Non-renewable energy includes coal, gas and oil. Most cars, trains and planes use non-renewable energy. They are made by burning fossil fuels to create energy. Renewable energy includes solar, hydro and wind energy. Wind energy is made when the wind moves the blades on a wind turbine. This movement creates wind energy which is renewed into electrical energy [26].

1.3.3 Commercial and Non-commercial Energy

The sources of energy which are used by the people for commercial purposes. The use of commercial source of energy can be used as an indicator of economic development of the country. Coal, petroleum, natural gas, hydro-electricity are the major commercial sources of energy.

The sources of energy which are used by the people for home purpose. The use of non-commercial source of energy can be used an indicator of living standard of the country. Fire wood, cow-dung and agriculture waste are the major non-commercial sources of energy.

1.4 Objectives

i. To col1ect the solar irradiation and maximum power output data in Dhaka for (January and February) two months.
ii. To analyze the collected data to get average irradiation and find the relationship between solar irradiance and power.
iii. To study solar PV system for Bangladesh.
iv. To access the role of SHS on socio-economic development in Bangladesh.
v. To introduce Renewable Energy (RE) as an alternative source of power generation from fossil fuels.

1.5 Scope of our work

We worked on our university’s administrative building’s roof top. Here we measured various types of data like solar irradiances, efficiency, voltage, current etc. It is a German provided project. Bangladesh has a lot of demand for power. Bangladesh commonly faced the unconquerable demand supply gap of electricity mainly during summer season. The energy gap is one of the largest losses in Bangladesh and hamper for growth economic. In this time the solar system is developing in our country. SHS is developing in a social context and economically in Bangladesh.

1.6 Thesis Outline

This thesis is organized as follows:

Chapter 1 Introduction.

Chapter 2 Literature reviews

Chapter 3 Methodology.

Chapter 4 Data analysis.

Chapter 5 conclusions

CHAPTER 2
LITERATURE REVIEWS

2.1 Introduction

Renewable energy demand is increasing day by day. It comes from natural and that's why it is constantly useable. For example, sunlight or wind keep shining and blowing, even if their availability depends on weather and time.

While renewable energy is often thought of as a new technology, dressing nature's power has long been used for heating, transportation and lighting. Wind has powered boats to sail the oceans and windmills to grind grain. The sun has provided temperature during the day and helped circumspective heat to last into the night fall. But over the past many years or so, humans increasingly ripened to available, nonrenewable energy sources such as coal and franked gas.

2.2 Renewable Energy usage in Bangladesh

1. Solar

2. Wind Power

3. Biomass Energy

4. Biogas Energy

5. Hydro Power

6. Geothermal Energy

7. Tidal Power

2.2.1 Solar energy

Solar energy**,** irradiation from the Sun capable of yielding heat, creating chemical reactions, or generating electricity. All amount of solar energy incident on Earth is extremely in excess of the world's current and expected energy requirements [12].

Figure 2.1: Solar power

2. 2.2 Wind Power

Wind power is the change of state of wind energy into more useful structure, like electricity, using wind turbines. Most modern wind power is turned in the form of electricity by changing the spin of turbine blades into electrical current by means of an electrical generator. In windmills, wind energy is used to change mechanical machinery to do physical work, like crushing grain or pump water [27].

Figure 2.2: Kutubdia Wind power

2.2.3 Hydro power

Hydropower prescribes to the conversion of energy from drifting water into electricity. It is deliberate that it is a renewable energy source because the water cycle is eternally renewed by the sun.

Figure 2.3: Kaptai Hydro power

2.3 Present situation of renewable energy and conventional energy generation of Bangladesh

Power generation capacity has increased from 4,942 MW in 2009 to 13,883 MW in 2015 [3].

Table 1 below summarizes the power sector capabilities and distribution in the nation [4].

Table 2.1 Power Sector Details in Bangladesh

Item	**September 2019**
Power generation Capacity	15755mw
Transmission line distance	10436 ckt km
Distribution line distance	341000km

Access. To electricity	77%
Per capita power. Production	371kwh
Number of consumers	2526594
Average. System loss	14%

As part of this strategy to raise electricity production, a Power System Master Plan was drawn up in 2010 with the following goals as summarized in table 2 [3].

Table 2.2 Power Generation's Master Plan

Year	**Mw**
2019	16000
2021	24000
2030	40000

Total electricity consumption is prominent to increase to 132TWh by 2035 in Bangladesh [5].The government has set a aim to generate 2000 MW of electrical power from renewable energy sources by 2021.Now a days, the total electricity production from such sources is 404 MW. The new aim of renewable energy would be 11% of the total electricity generation in 2021 and would raise to 22% by 2030.Implantation have been take generate 3 MW from Sharishabari,200 MW from Mymensingh,20 MW from Cox's Bazaar district, 55 MW from Gangachhara and 200 MW from Sun Edition Solar project at Teknaf. In addition processes are underway to install Solar Home Systems (SHSs) at Kaptai, Hatia, Thakurgaon, Ishwardi and Sirajganj [6].

2.4 Renewable Energy Generation in Bangladesh

Desirable development has been made in the renewable energy sector in the last few years. At present, 404 MW is being generated from renewable energy sources. Solar home system is a triumph story in our country and day by day its popularity is increasing in the rural areas, particular in the off-grid regions. Table 3 below shows the progression complied so far in the renewable energy segment in Bangladesh [3].

Table 2.3 Progress in the Renewable Energy Sector

Methods	**Mw**
Installation of solar home system (3.5 million)	150.00
Installation of roof top photovoltaic at govt./semi govt. offices	3.00
Installation of PVs on commercial building and shopping centers	1.00
Installation of PVs by consumers during new electricity connections	11.00
Installation wind based power plants	2.00
Installation of biomass based power plants	1.00
Installation of biogas based power plants	5.00
Solar irrigation	1.00
Hydroelectric power generation	230.00
Total	404.00

2.5 Global Scenario of Renewable Energy

Based on Renewable Energy Policy Network for the 21st century, renewable seated 19.2% of human's global energy usages and 23.7% to their production of electricity in 2014 and 2015,gradually[7].This energy usage is divided with 8.9% coming from traditional biomass,4.2% as heat energy,3.9% from hydroelectricity and 2.2% is electricity from wind, solar, geothermal and biomass. Global investments in renewable technologies amplified to more than US$ 286 billion in 2015, with countries like China and the United States, Russia hugely investing in wind, hydro, solar and befouls. Worldwide, there are an allotted 7.7 million jobs linked with the renewable energy industries, with solar photovoltaic being the largest renewable employer [7].Solar PV is principle technology for capturing the benefits namely having no misuse, no moving parts, no emissions, less transportation costs, not requiring water during power production and no mischievous effects on the environment [6].

2.6 Renewable Energy Sources in Bangladesh

The prospect of renewable energy in Bangladesh is very hopefully, mainly in the case of solar energy. In present, for the near future, renewable energy will remain involve to the current energy regeneration by non-renewable conventional means. Yet, renewable energy will play a momentous role reaching consumers outside the national grid or in places where grid connection is delayed.

2.7 Basis of use of Solar Energy

Solar energy is that the power shifted by the sun controlled through a technology known as electric photovoltaic cells that flip directly sunlight into electricity. All over the years, power costs have been growing and the cost of energy is projected to continue to enlarging over time .Home possessors around the nation and town communities around the world are introducing solar panel systems on their roofs to exploit this immaculate, renewable way to generate power. Solar energy is generated from daylight, not sunlight. So even on cloudy, rainy days, your panels are working to provide energy. All that energy accumulates within the morning and afternoon hours, the complete time that the sun is up, producing more electricity than you can use. There is a unit numerous reasons why we should all the time all use solar panels to manufacture a source of clean, cheap and renewable energy for our homes. I believe the major reason why we should use solar panels at home is that its energy is essentially is in use from the sun that means that it's natural and less unsafe for our planet therefore it might keep our adjoining clean. One more reason why we must constantly use solar panels is that this can abridged your electricity invoice.

2.8 Research on Solar Energy

M. Asaduzzaman, Mohammad Yun, Shahidur R. Khandker, Hussain A. Samad [8], They investigation their research declining the solar home system charge among 2004 to 2012 about 10% which was about of the average price 25% in 2004 . Also viewing that the demand for SHS is price-inelastic. This way POs will charge a better value for a system at its price possibly without considerable diminution of market demand for SHS.

SHS supposition increase evening study hours of both boys and girls; reduces fuel gathering time of women and reduces women's and children's morbidity from respiratory diseases by dropping kerosene utilization. SHS adoption additionally promotes house welfare by increasing per capita expenditure.

M.F. Hossain,S. Hossain and M.J. Uddin their study researches whether sun-based business industry should actualize a typical technique to situate itself in everywhere throughout the nation. There working are increasing mindfulness among the clients and providers of the recompense and SHS should be used of the correct and also there study of the project with Data fulfillment with the solar energy system, period of using solar energy, Service of solar panel on condition that company. At last this data analysis indicates that show of solar energy systems is a lot better as it needs very little upholding [10].Their result the benefits of using solar energy and the prospect concerning different energy system in Bangladesh at rest the because the issues with reference to this sector.

Kevin DeGroat, Terry Peterson, and Greg P.Smestad, Joseph Morabito for their explaining solar energy to a wide range of decision makers and to the public. It emphasizes two major, related challenges in achieving widespread, one are rapid implementation of solar energy technologies in time with global energy and environmental problem impact widespread that was facilities by a "Smart Grid" infrastructure. In addition, another to continue to drive down mechanized and deployment costs for solar energy systems enlarge manufacturing facility in order to speed up deployment of solar energy systems. [9] PV modules are created by assembling many types of materials into an integrated wrap up that must endure long-term outdoor coverage.

2.9 Solar Home System

The Sun and the matter that are frankly or obliquely focused on orbits, eighteen worlds from Solar system gravitationally hurdle technique which resolute by the International Astronomy Union and five dwarf planets. Between the objects that light the Sun directly, eight planets exist in eight planets, the other little objects, like dwarf planets and little solar system bodies. In the obliquely illuminated sun-moon-two little planets, larger than Mercury. Solar energy was created from the gravitational fall down of the molecular cloud of a giant interstellar 4.6 billion years ago [28].

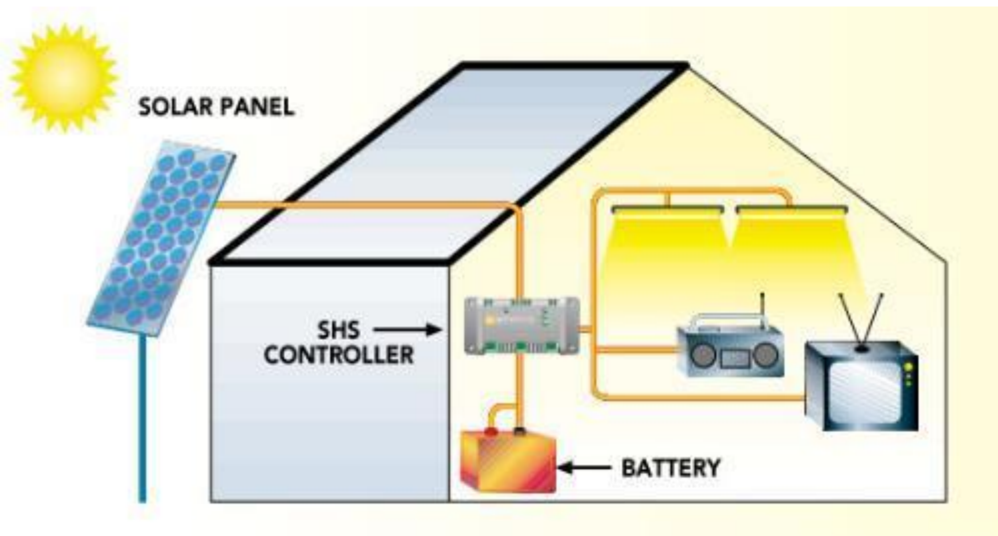

Figure 2.4 The whole mechanism of solar home system

There are four things need to run a solar system:

1. Panel 2. Battery 3. Charge Controller 4. Inverter

2.9.1 Panel

Solar panels are those devices which are used to soak up the sun's rays and change them into electricity or heat. A solar panel is truly a compilation of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are approved in a grid-like pattern on the surface of solar panels. When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow [29].In a year, their efficiency decreases only about one to two per cent. Most solar panels are fabricated using crystalline silicon solar cells. Setting up of solar panels in homes helps in combating the harmful discharge of greenhouse gases and thus helps reduce global warming. Solar panels do not guide to any form of pollution and are clean. They also are reducing our dependence on fossil fuel and usual power sources.

Figure 2.5 Solar panel

2.9.1. A Types of Panel

1. Monocrystalline solar panels

We see a solar panel with black cells, it's most likely a mono crystalline panel. These cells show black because of how light interacts with the pure silicon crystal.

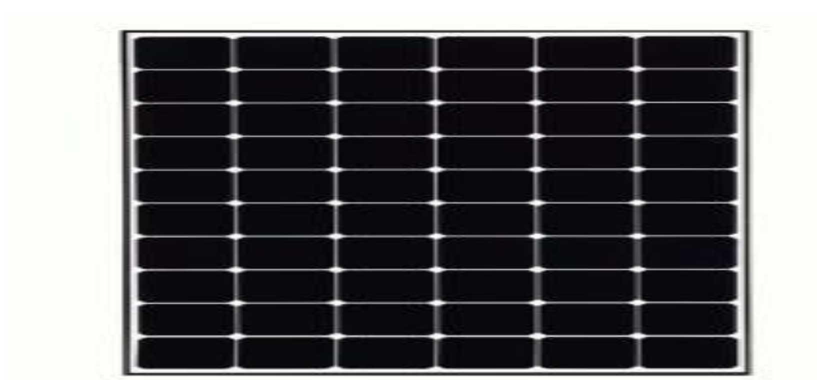

Figure 2.6 Mono crystalline solar panels

While the solar cells themselves are black, mono crystalline solar panels have a variety of colors for their back sheets and frames. The back sheet of the solar panel will most regularly be black, silver or white, while the metal frames are naturally black or silver. These efficiency rate is 15-17% [14].

2. Polycrystalline solar panels

Polycrystalline solar cells be likely to have a bluish hue to them due to the light reflecting off the silicon wreckage in the cell in a different way than it reflects off a pure mono crystalline silicon wafer.

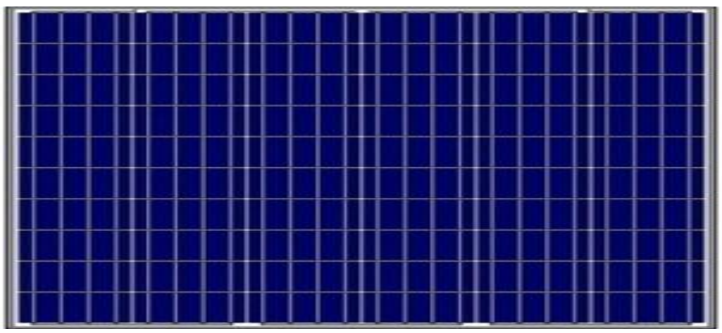

Figure 2.7 Polycrystalline solar panels

3. Thin-film solar panels

The biggest perceptive aesthetic reason when it comes to thin-film solar panels is how thin and low-profile the technology. This is because the cells within the panels are generally 351 times thinner than the crystalline wafers wormed in polycrystalline and mono crystalline solar panels.

Figure 2.8 Thin-film solar panels

It is significant to keep in mind that while the thin-film cells themselves may be much thinner than common solar cells, an entire thin-film panel possibly same as thickness to a mono crystalline or polycrystalline solar panel if it consist of a thick frame.

4. CIGS (Copper Indium Gallium Solenoid)

The cell is built-up by deposited a small layer of gallium, indium, copper and plastic or glass. This is the other thin film. Indium, copper and plastic or glass. This is the significant it opens up to the prospect of the holy grail in solar, silicon kind of efficiencies at low thin film. The CIGS full meaning copper indium gallium solenoid and is also versatile.

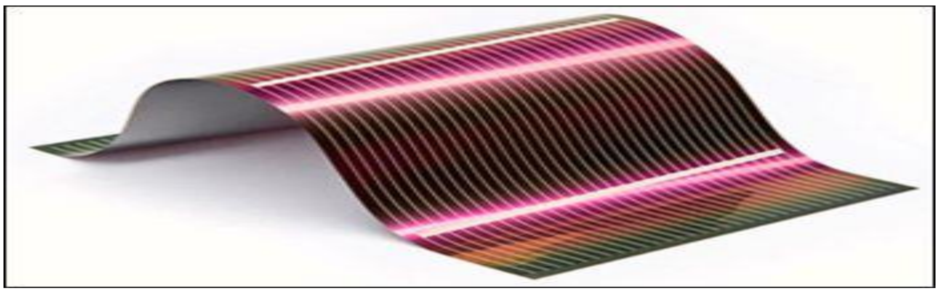

Figure 2.9 CIGS

2.9.2 Battery

Batteries are especially helpful in the solar system. In day time sunlight is here the panel soak up the heat and produce current and this time the energy charge to the battery. Then the dark time battery is help to give to flow bulb, television, fan, light, etc. There are three component liquid lead acid, lithium ion and saltwater [30].

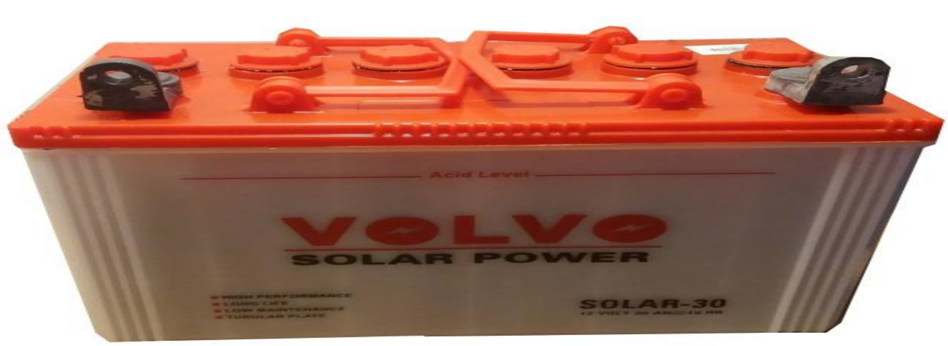

Figure 2.10 Solar Battery

2.9.3 Charge Controller

Solar charge controllers conclude the energy streaming from the PV range and move it directly to the batteries as a DC-coupled system, which is the most capable and useful mode. Giving batteries as long of a life as possible is an important function of a charge controller. Charge Controller is mainly a voltage and or current controller for observance battery from extra charging.

Fig 2.11 Charge controller

2.10 NGOs on Rural Solar Electrification

1. Bangladesh Rural Electrification Board (BREB)
2. Infrastructure Development Company Limited (IDCOL)
3. Greemen Shakti (GC)
4. BRIDGE
5. Mukti Cox's Bazaar
6. BRAC Solar
7. Bangladesh Solar & Renewable Energy Association (BSREA)
8. Greenfinity Energy Limited etc.

2.11 Energy Efficiency policy

For energy reduction in tension and motivation at the use of CFLs by customers, free CFL (Compact Fluorescent Lamp) giving out agenda in different offices of PDB alongside with headquarter has been leaded.CFLs,T-5 tube light instead of radiant bulb will be installed in all offices of BPDB in different stage. For the capable use of energy, stepladder has been taken to promote the use of heat thoughtful glasses for inactive cooling of commercial buildings. In addition to that energy effectiveness measures, substitute and renewable energy topic have been defined in the national Text Book Curriculum of schools and colleges. Energy Star cataloging Program has been started by BSTI to inspire the users to use energy skillful appliances. Electricity Week Program has already been recognized since 2010 with a view to increase energy savings movements at customer and school level. This curriculum is nationally consummate by 7th December every year. [11]

2.12 Summary

In his chapter we try to shows the all other belongings in RE and solar home system all elements. First we start explanation of energy and solar energy the RE technology preferable and the current permanence in renewable energy of Bangladesh. Our Government assist and make environment of Bangladesh. Entire solar system element explains this chapter and many types of solar panel also. There are many running mission in Bangladesh this are demonstrates also.

Chapter 3
Methodology

3.1 Introduction

In the Indian sub-continent region Bangladesh is an ideal country for manufacturing of solar energy. We get extensive sunlight six to eight month of a year because here summer exists in very long period. Country area of our country where there is no current but these area are appropriate for generating of solar energy by using solar panel. At present in Dhaka city, building's roof top stand the solar panel and linked to on grid. An average size solar panel can diminish power bill cost and it is about 8 to 10 thousands taka save in electricity invoice per year.

3.2 Description Solar Study Area

We worked in Dhanmondi area of capital city of Bangladesh. It is generally a residential area of the city from the year 1950, and for decades it has become a small town in malls, schools, banks, offices and universities.

Figure 3.1 Our working place on DIU's rooftop

Figure 3.2: Satellite View

Dhanmondi is located in Dhaka district of Bangladesh. It has 33461 houses and 4.34 km² area. Apart from schools, universities, hospitals, restaurants and shopping centers there are apartment complexes [13].Satellite view of our study area (Figur3.2) is a place from where we collected data for our work. Our study area has recognized in Daffodil International University Administrative Building's rooftop. Figure 3.1 illustrate a recent captured picture of our working place. A variety of types of solar panel have set up their as 45W, 60W and 100W.

3.3 Solar Panel

Devices that convert sunlight into electric energy are called solar panels. Some call them photovoltaic, which is really a light-energy. Lightening a cell more, which produces electricity. Our workplace had three types of solar panels. Electricity is generated when the solar modules are enlightened on their front surface. There were three types of panel:

A. 45watt solar panel
B. 60watt solar panel
C. 100watt solar panel

The cells are no less than 90% of their original lowest stated power in the first 10 years, and also to turn out no less than 80% of their initial minimum stated power for a period of 25 years.

3.4 Off grid 100W System Design

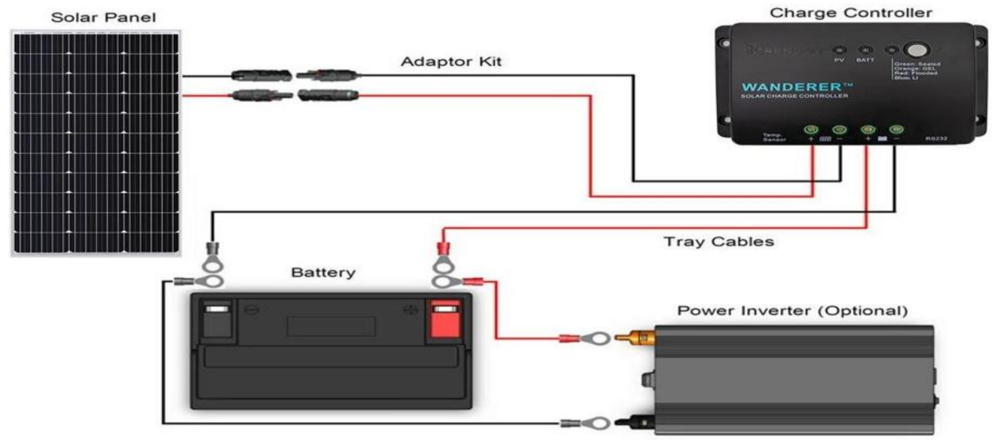

Figure 3.3: System Design (100W)

3.5 100 watt Solar Panel

Along with the three panels it was the small solar panel where we worked. Its area was 0.75m^2.The solar cell always set to 23 degree in south faced so the sun can directly shine on this solar panel shell. The cells of the solar made in Germany. To measure power in Standard Test Condition (STC) cell temperature is 25°C.

Figure 3.4: 100 Watt solar panel

3.5.1 Electrical Specifications of 100W panel

Figure 3.5 Electrical Specifications of 100W

3.6 Measurement Equipment

We measured the different data in this study like the open circuit voltage, maximum power's voltage, short circuit current, current at maximum power, maximum power, fill factor, irradiation and the temperature. There were three main types of dimension equipment in our work. They are-

1. Photovoltaic Meter
2. Irradiance meter
3. Temperature Sensor

3.6.1 Photovoltaic Meter

It was the mainly important extent equipment in our work. PV meters can refer to pyrometers, which are used to evaluate of solar radiation flux density (W/m^2) or devices used to appraise the kWh creation from a PV system. PV meters are very effectual for the arrangement and upholding of photovoltaic parks. PV meters allow for the display of real-time PV power production data. PV meters are normally used to check photovoltaic structure for the best position search and proficiency. [14]

Figure 3.6: Photovoltaic Meter

3.6.1.1 Electrical Specifications

Table-3.1: Range, resolution and accuracy

Parameter	Range (V)	Accuracy
V_{DC} Voltage @ OPC	5.0 -999.9	±(1.0%
I_{DC} Current @ OPC	0.10 -10.00	±1.0%
Max Power @ OPC	50-9999	±1.0%
V_{DC} Voltage (@ STC and OPC), IVCK	5.0 -999.9	±4.0%
I_{DC} Current (@ STC and OPC), IVCK	0.10 -10.00	±4.0%
Max Power @ STC (V_{mpp} >30V, I_{mpp} >2A)	50 -9999	±5.0%
Temperature of module (with auxiliary PT1000 probe)	-20.0 -100.0	±1.0%
Irradiance (with reference cell)	1.0 -100.0	±1.0%

3.6.1.2 General Specifications

DISPLAY AND MEMORY:

Features: 128x128pxl custom LCD with backlight

Memory capacity: 256kbytes

Saved data: 249 Inflect (I-V curve examination), 999 IVCK

POWER SUPPLY:

SOLAR I-V internal power supply: 6x1.5V alkaline batteries type LR6, AA, AM3, and MN 1500

Autonomy of SOLAR I-V: > 249 curve (I-V curve test), 999 IVCK test

Approx. 120 hours (yield test)

SOLAR-02 power supply: 4x1.5V alkaline batteries type AAA LR03

SOLAR-02 max recording time (@ IP=5s): approx. 1.5h

OUTPUT INTERFACE

PC communication port: optical/USB

Interface with SOLAR-02: wireless RF communication (max distance 1m)

MECHANICAL FEATURES

Dimensions (L x W x H): 235 x 165 x 75mm

Weight (batteries included): 1.2kg

ENVIRONMENTAL CONDITIONS:

Reference temperature: 23°C - 5°C

Working temperature: 0° - 40°C

Working humidity: <80%HR

Storage temperature (batt. not included): -10 - 60°C

Storage humidity: <80%HR

GENERAL REFERENCE STANDARDS:

Safety: IEC/EN61010-1

Safety of measurement accessories: IEC/EN61010-031 I

I-V curve measurement: IEC/EN60891 (I-V curve test)

IEC/EN60904-5 (Temperature measurement)

Insulation: double insulation

Pollution degree: 2

Overvoltage category: CAT II 1000V DC, CAT III 300V AC to ground

Max 1000V among inputs P1, P2, C1, c2

Max altitude of use: 2000m

3.6.2 Irradiation Meter

When we measured solar panel's data we connected the irradiation meter is to the PV meter then the meter illustrated the irradiance value in PV meter. Progress is distinct as a measure of solar energy and it is waning solar energy onto a plane. In the case of solar engagement we normally measured the strength of each unit area so that the dissolution is usually quoted as W/m²-it is per square meters per watts [15].The quantity of solar energy that cascade within the given phase is called the irony. A measure of the power of mocking. It is added to the power of the sun throughout some time. Now here comes the mystifying part if the sun is illuminated in steady 1000 watts/m for an hour, we can say it supplies power of 1 KW/m² [31].

Figure 3.7: Irradiation Meter

The power amount of power (1000 W/m²) is the length of the bar (1 hour) and the power unit is none. Another process commonly used term is the 'peak sun hour' that reflects the energy received during the daily hours, which is determined by the equal number of hours reaching the solar energy valued at 1000 W/m^2 of the total energy value. This term is transferable with kWh/m^2/day.

3.6.2.1 Technical terms

Table-3.2: Range & accuracy

Parameter	**Range [W/m^2]**	**Accuracy**
Irradiation	50 - 1400	±3.0% of readings

3.6.2.2 Common terms

Available reference cells: MONO Crystalline and MULTI Crystalline Silicon

Guidelines

Safety: IEC/EN 61010-1

Technical literature: IEC/EN 61187

Calibration: IEC/EN 60904-2

Mechanical protection: IP65 in compliance with IEC/EN 60529

Pollution degree: 2

Mechanical characteristics

Dimensions (LxWxH): 120x85x40 mm

Weight: 260g

Environmental conditions

Working temperature: -20°C - 50°C

Storage temperature: -20°C - 60°C

3.6.3 Temperature Sensor

Temperature sensor needs a thermocouple or RTD (resistance temperature identifier) for determine the temperature through a gadget, an electrical sign. This thermocouple is made by two dissimilar metals, which in turn produces proportional to the atomic voltage to modify the temperature. The work of the sensors is the voltage reading diagonally the base diode. [16]

Figure 3.8: Temperature Sensor

3.7 I-V 400 W Calibration

Before starting the dimension, we must have to calibrate I-V 400 W. For I-V 400 W calibration consideration has given below Table-

Table-3.3: I-V 400 W Calibration.

Parameters	**Value**
P_{max}	50 W
V_{oc}	21.42 V
V_{mpp}	17.10 V
I_{sc}	3.20 A
I_{mpp}	2.92 A
Toll-	1.0 W
Toll+	1.0W
Alpha	0.033 %/°C
Beta	-0.34 %/°C
Gamma	-0.42 %/°C
Noct	45 °C
Tech.	STD
Rs	1 Ω
Degr	0.0 %/yr

3.8 Process of our Data collection

We worked approximately nine months of the year since February to October 2019.We collected the data in day time in every hours. Only in sunny days we could determine the data. We staffing data in day time which usually started from 6 AM to 6 PM. It depends on the irradiance of sun light. Total ten to twelve times metering in the data in every hour. Figure 3.9 shows our work place where we exacted the data.

Figure 3.9: Measuring data

3.8.1 Steps of data collection

1. First we took the tool box from the top floor then went to the roof top of the AB building of our university.
2. Then we linked the solar panel to photovoltaic meter and irradiance meter.
3. We also connected the temperature sensor.
4. Then we metered data in 100 watts along with 45 & 60 watt also.
5. The solar panel connected the all meter then the data illustrated in the photovoltaic meter. After measuring data we took a picture in all data.

6. Again we connected the 60 watt solar panel to photovoltaic meter and temperature sensor. Again we snapped in our mobile phone the all data the 60watt solar panel.
7. At final we connected the 45 watt cell to photovoltaic meter and the temperature sensor. All data collection finished and took a picture in our smart phone.

It was well-suited for a sunny day. In this day we measure all data. In rainy, foggy or a heavy overcast day the sun irradiance is lower than 200 then there is no data showed in that time. System setting was set to irradiance boundary to 200.

3.9 Data entry in Lab Sheet

We collected the data in a day ten or twelve times. We were about 10-12 person in our full team. Everyday 6-7 person collected data by subsequent time schedule. We collected it and put up in the Google sheet [17] provided by our co-supervisor sir. The set all data these are maximum power, open circuit voltage, short circuit current, voltage at maximum power, current in maximum power, fill factor and irradiance. Given the table 3.4 as example from Google sheet, the all elements which are measure a panel and put them.

Efficiency= Output/Input

Output= Power of solar panel

Input= Irradiance x Panel area

Suppose, P_{max} = 1.47w

Input= 54 w/m^2 x $0.75m^2$

Then efficiency= 3.63%

Table-3.4 Represents parameter-wise data of 100 watt solar panel of a single day (3rd January, 2019) starting from sunrise to sunset.

I_{RR} (W/m²)	Voltage (V)	Current(I)	V_{mpp} (V)	I_{mpp} (I)	Fill factor	P_{max} (W)	Area of Panel (m²)	Efficiency (%)
0						0		#DIV/0!
0						0		#DIV/0!
278	20.5	2.04	16.7	1.87	0.75	31.229		15.02%
419	20.3	3.03	16.3	2.78	0.74	45.314		14.46%
467	20.2	3.53	18.6	1.39	0.5	25.854		7.40%
343	20.4	1.81	17.7	1.57	0.76	27.789	0.75	10.83%
723	20.3	4.11	18.6	2.59	0.49	48.174		8.91%
581	20.1	3.96	18.3	1.85	0.42	33.855		7.79%
321	19.4	1.81	18.3	1.19	0.62	21.777		9.07%
269	19	1.78	17.3	1.12	0.44	19.376		9.63%
40	18	0.27	13.9	0.18	0.52	2.502		8.36%
0						0		0.00%

Where,

Voc=Open circuit voltage

Isc=Short circuit current

V_{mpp} =Maximum power at voltage

I_{mpp} =Current at Maximum power

Fill factor= V_{mpp} x I_{mpp} / V_{OC} x I_{OC}

P_{max} = V_{mpp} x I_{mpp}

Efficiency= P_{max} / Irradiance x panel area

3.10 Flow chart of the research

Figure 3.10 illustrate a flow chart is a graphical or symbolic demonstration of a process. Each step in the procedure is represented by a different symbol and contains a short explanation of the process step.

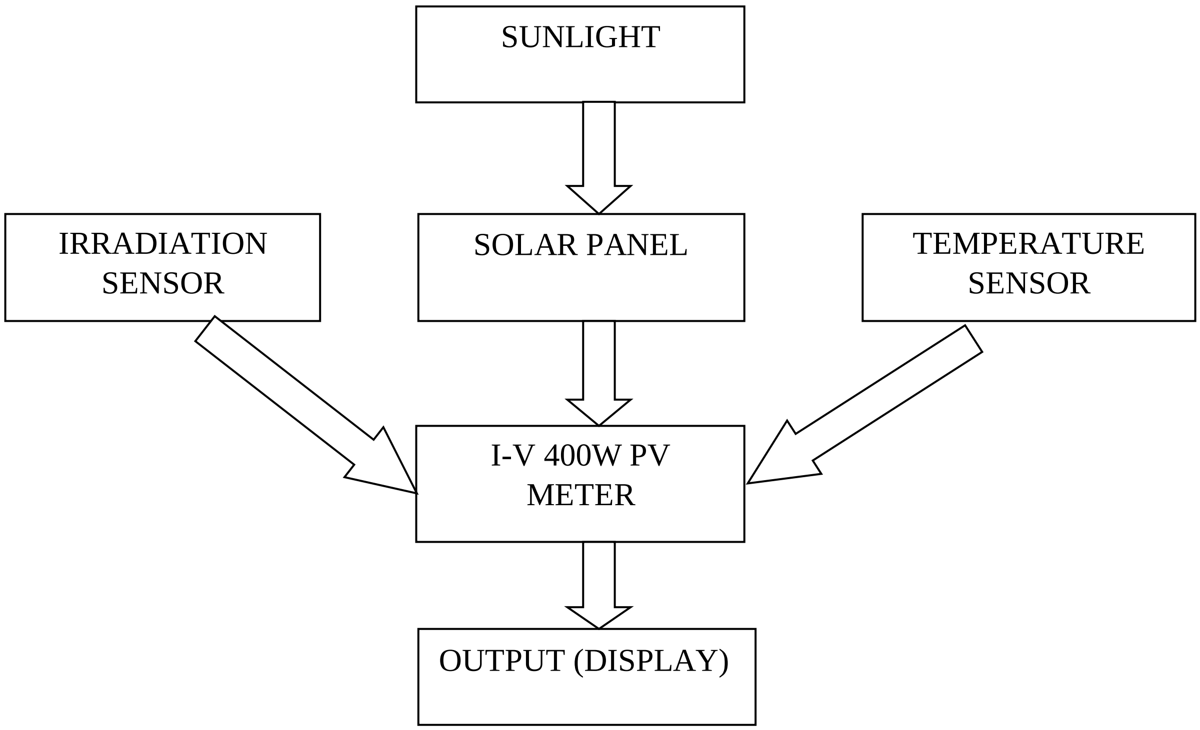

Figure 3.10 Flow chart of our work flow

We draw on flowcharts in analyzing, documenting or organization a process or program in various fields.

3.11 Summary

This chapter name is methodology so we explain in this chapter all of our working process and work fundamentals like as photovoltaic meter, irradiation meter, temperature sensor. We show the technical, electrical specification of I-V 400W calibration and a flow chart which is viewing how to work sunlight on a solar panel. We obeyed all the method how to work, which are necessary and which meter is attach is all things describe this chapter. At last using element measured data and this data was put up the in the lab sheet.

Chapter 4
Data Analysis

4.1 Introduction

The nearby situation of solar electrification propagation for bringing socio-economic development in town and rural areas been discussed. We all distinguish that the energy plays the key role for progress of a nation. The solar home system can compensate the discontinuous power problem in Bangladesh. Solar energy can play enormous role play for secure energy source for sustainable development. The core reason of our study on it is to access the solar power is given the output of our country principally in Dhaka city [32].The survey results are analyzed as follows in the following sections. This study result can help in solar power division in upcoming research.

4.2 Analysis & Result

Graph of two months Irradiation shows below-

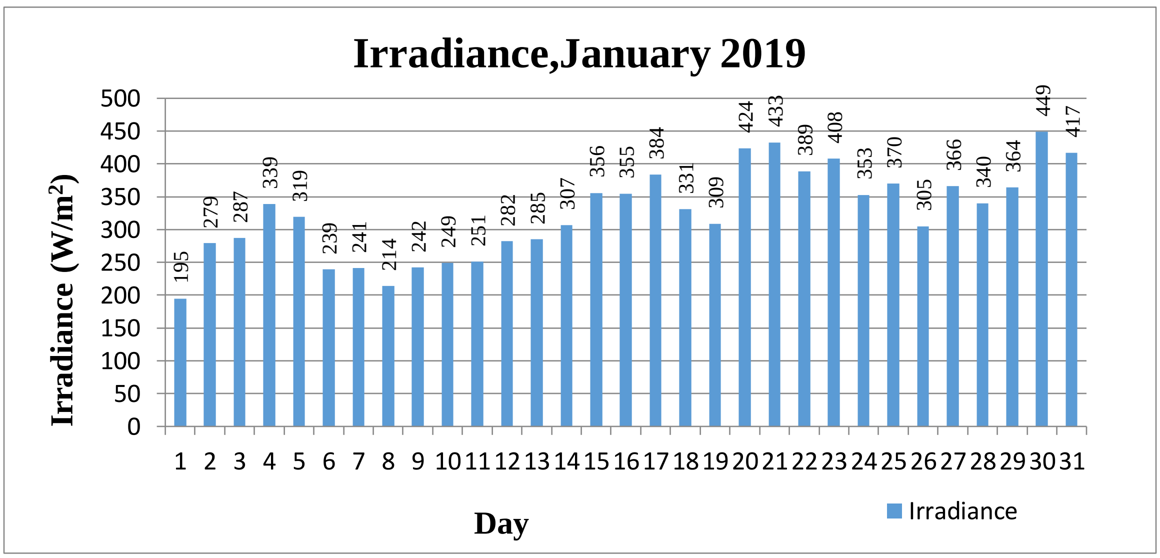

Figure4.1: Daily irradiance for January, 2019

In the figure-4.1 shows the data of solar irradiation of month of January 2019. On 3rd to 30th January 2019, the maximum irradiance was measured 449 W/m^2 the lowest value of the solar irradiance was 195 W/m^2 on 1st January. The main causes at the back of this circumstance were sunny & foggy weather. At some stage in the sunny day we had gotten the top value & because of winter season in foggy day we got the lowly value.

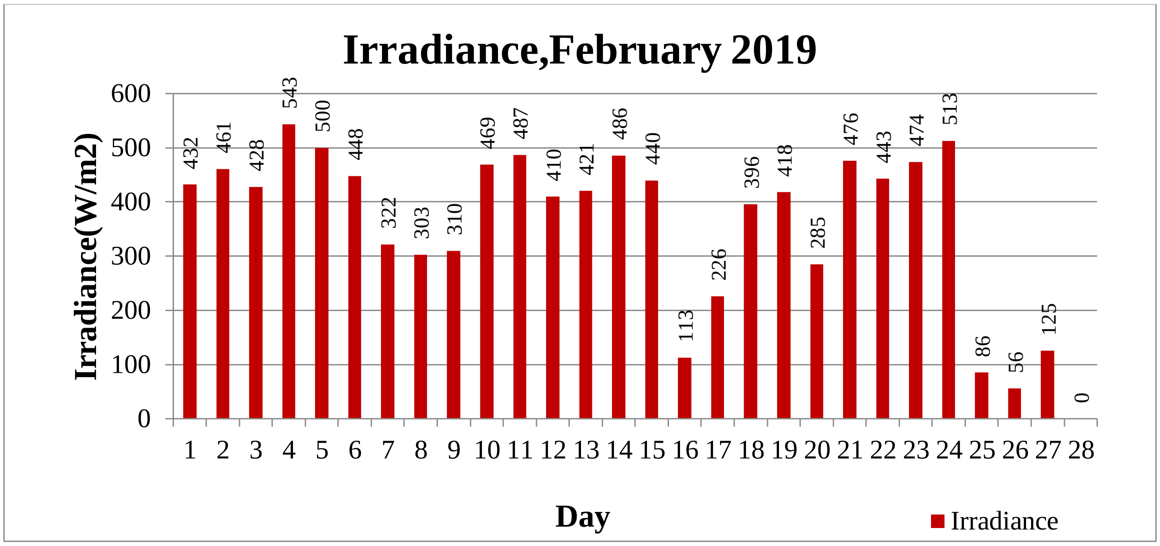

Figure 4.2: Daily irradiance for February 2019

Figure-4.2 shows the graph of solar irradiance of February 2019. From 1st to 28th February 2019, the peak value of solar irradiance was measured which was 543 W/m^2 and the lowest value of the solar irradiance was 0 W/m^2, the major reason behind this condition was sunny day and cloudy day. Throughout the sunny day we had gotten the maximum value and for wet day we got the lowest value. These are two months every day's image of irradiance which was directly reliant with sunlight's strictness.

Graph of two months maximum power generation shows below-

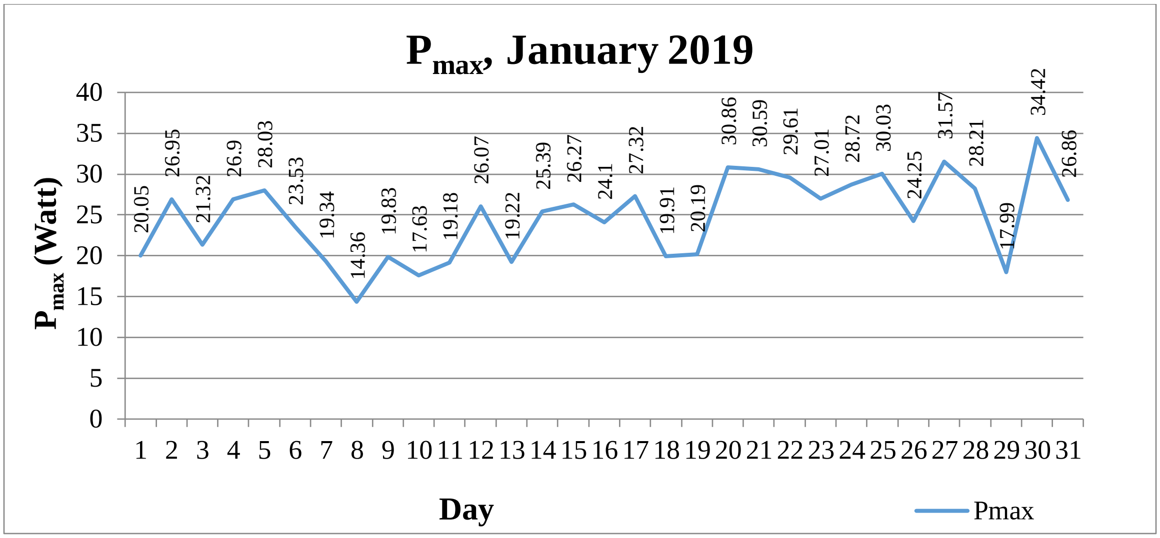

Figure 4.3: Daily P_{max} for January 2019

Now let's see the power generation graph of 100W solar panel in the month of January 2019. We had found the top value of maximum power (34.42W) and the lowest value of minimum power (14.36W) in January 2019.

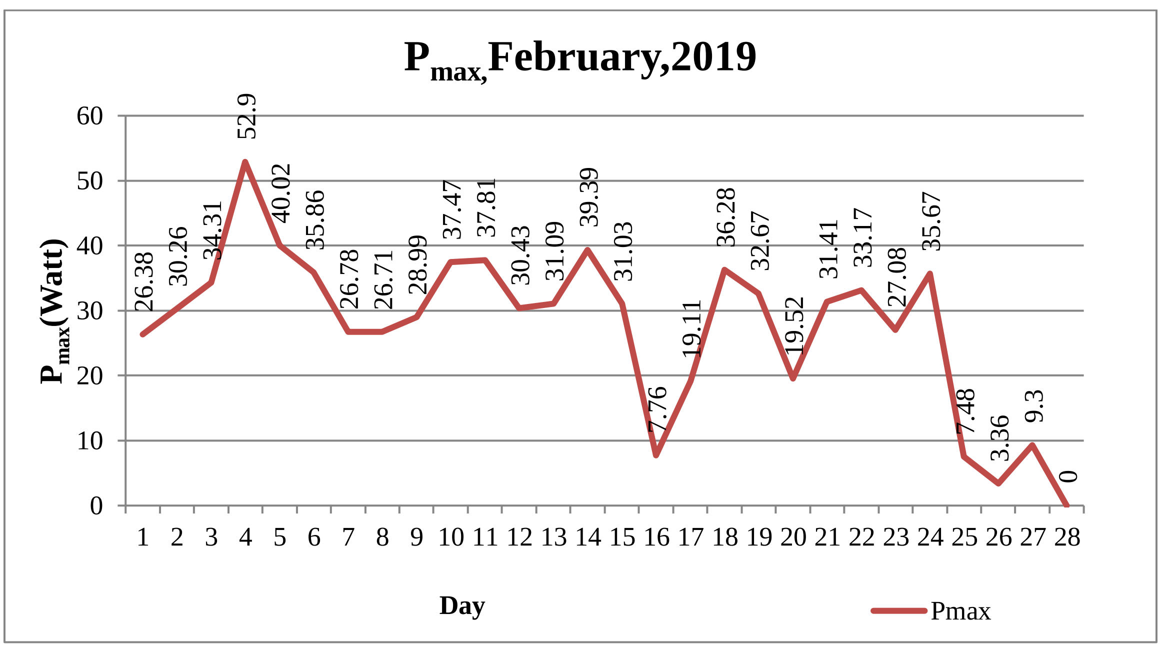

Figure 4.4: Daily P_{max} for February 2019

The figure-4.4 represents the power generation graph of 100W solar panel in February 2019. On 1st to 28th February 2019, we found the highest value of maximum power (52.9 W) and the lowest value of minimum power (0W).

Now we'll discuss the two months highest, lowest and average irradiation-

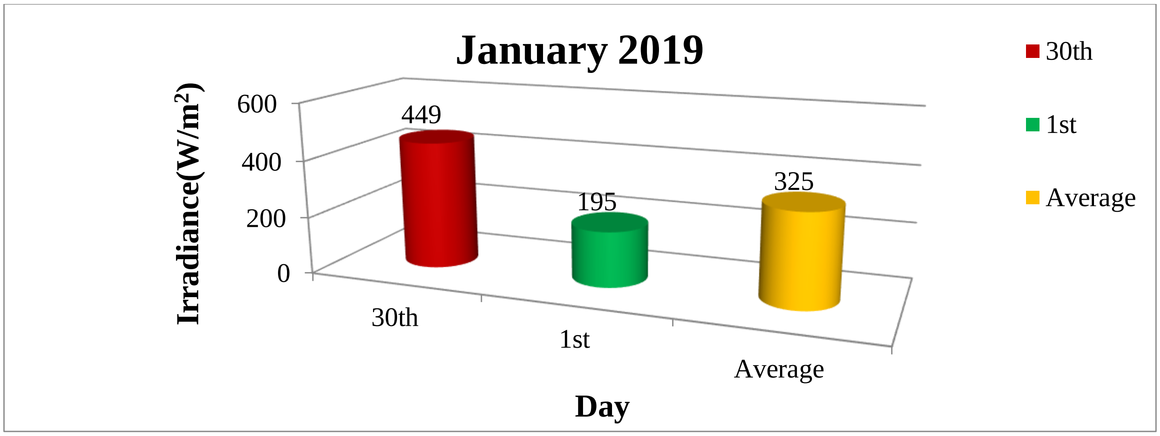

Figure 4.5: Irradiation graph for January 2019 (highest, lowest & average)

Look at the figure-4.5 which shows the calculated data of solar irradiation of January 2019. On 30th January 2019, the maximum value of solar irradiance was measured 449 W/m^2 and ion 1st January, the lowest value of irradiance was initiate which 195 W/m^2 was and the key reason following this circumstance was mostly sunny day and foggy day. All through the sunny day we got the maximum value and for wet day we go the lowest value. Additionally, monthly average irradiation we calculate 325 W/m^2.

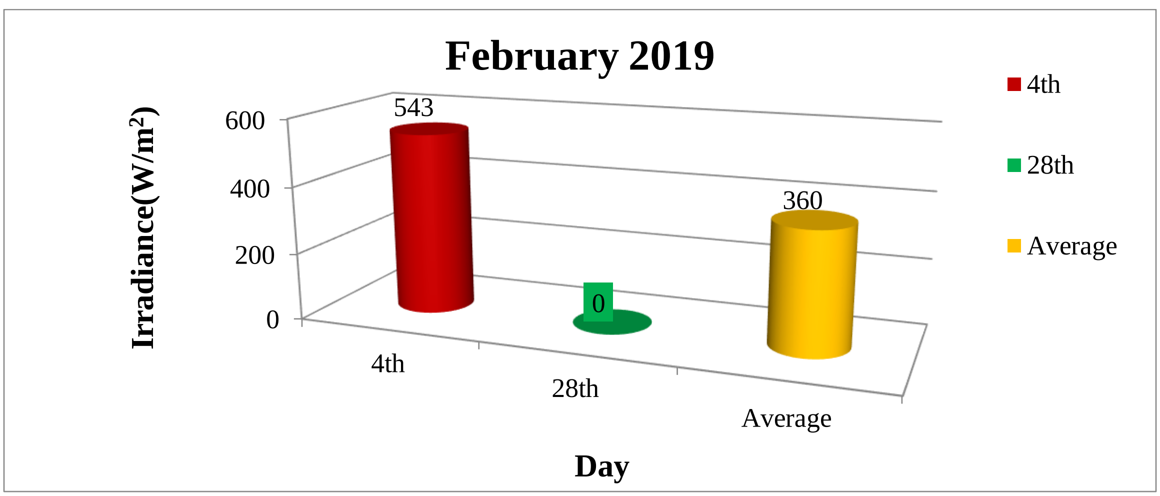

Figure 4.6: Graph Irradiation for February (high, low & average)

At the same time in figure-4.6 we can see also the data of solar irradiation of February 2019. On 4th February, 2019 the maximum data of solar irradiance was measured which was 543W/m^2 and on 28th February we measured the lowest value of irradiance was found 0W/m^2.During the sunny day we have gotten the top value and for cloudy day we got the lowest value. In addition, February's monthly average irradiation was 360W/m^2 per day.

Now let's see the high-low & average maximum power generation of these two months-

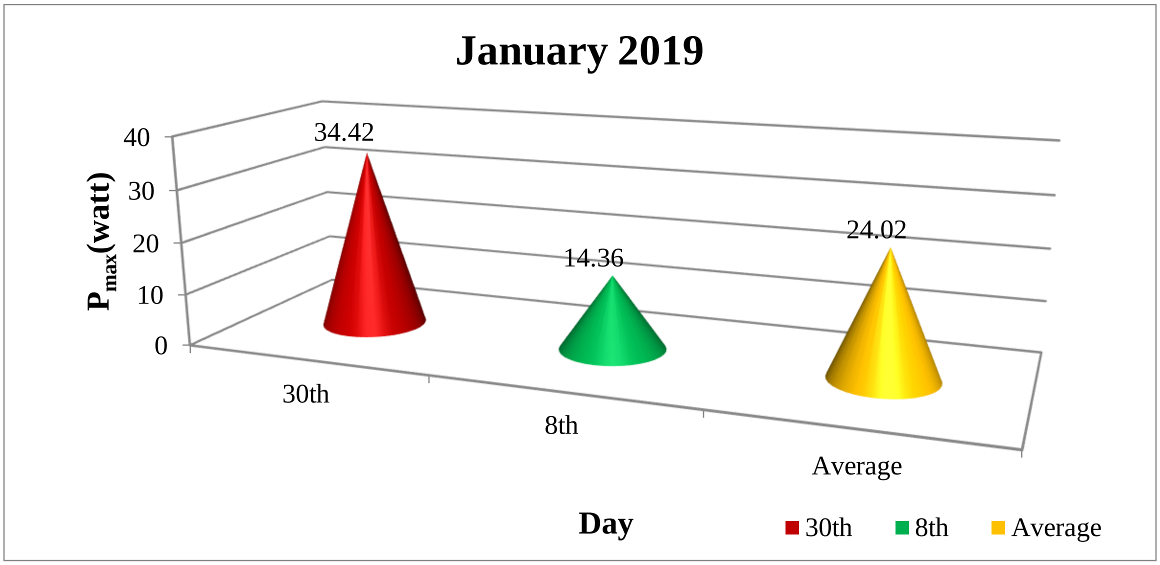

Figure 4.7: P_{max} graph for January 2019 (high, low & average)

Figure-4.7 symbolize the maximum power generation curve of 100W solar panel in January, 2019. On 30th January 2019, we measured the peak value of maximum power 34.42W and the lowest value of maximum power production 14.36W in 8th January. Monthly average power we calculate 24.02 W.

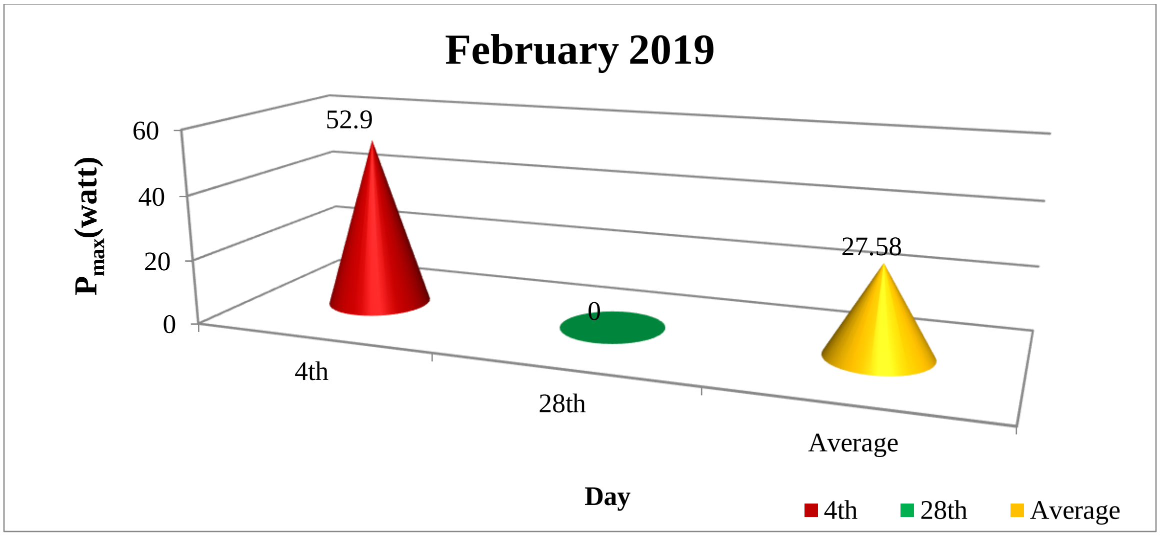

Figure 4.8: Graph P_{max} in February 2019 (highest, lowest & average)

We also calculate in figure-4.8 which signifies the maximum power generation curve of 100W solar panel in February 2019. On 4th February 2019, we have found the top value of maximum power 52.9W and the lowest value of maximum power 0W in 28th of the month. The monthly average power was 27.58W.

Irradiation from sunrise to sunset of the mostly sunny day of the month-

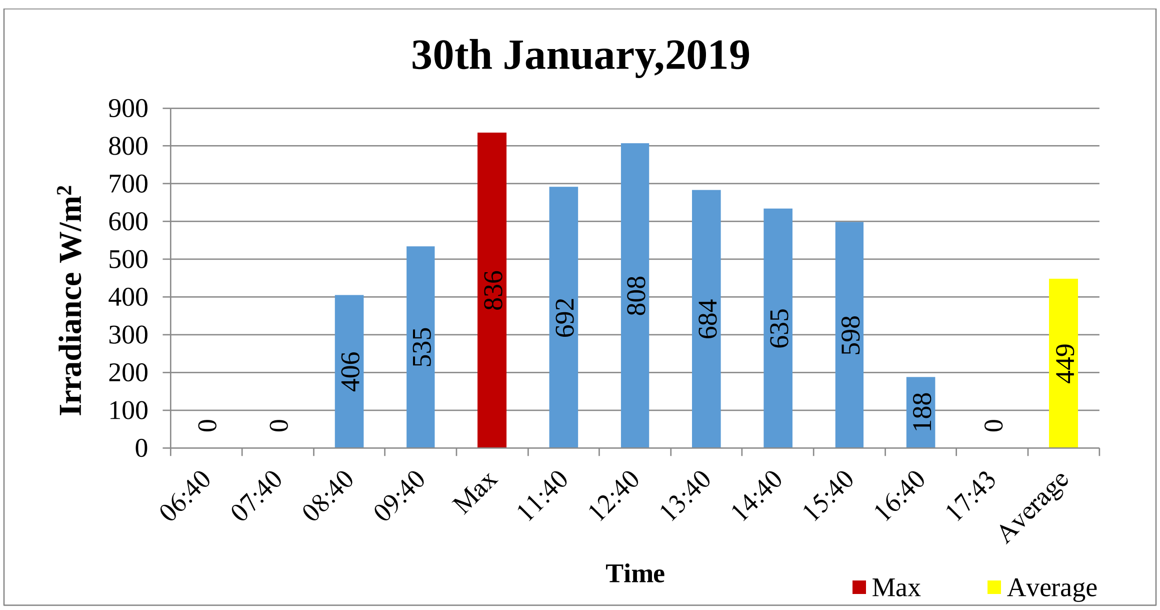

Figure 4.9: Irradiation of Sunny day in January 2019

Figure-4.9 illustrate the data as regards the irradiance of sunny day in January, 2019.Throughout sunny day, we got the highest irradiance 836 W/m^2. Because of sunny day, we could measure solar data every hour. The average irradiance of sunny day we get 449 W/m^2.

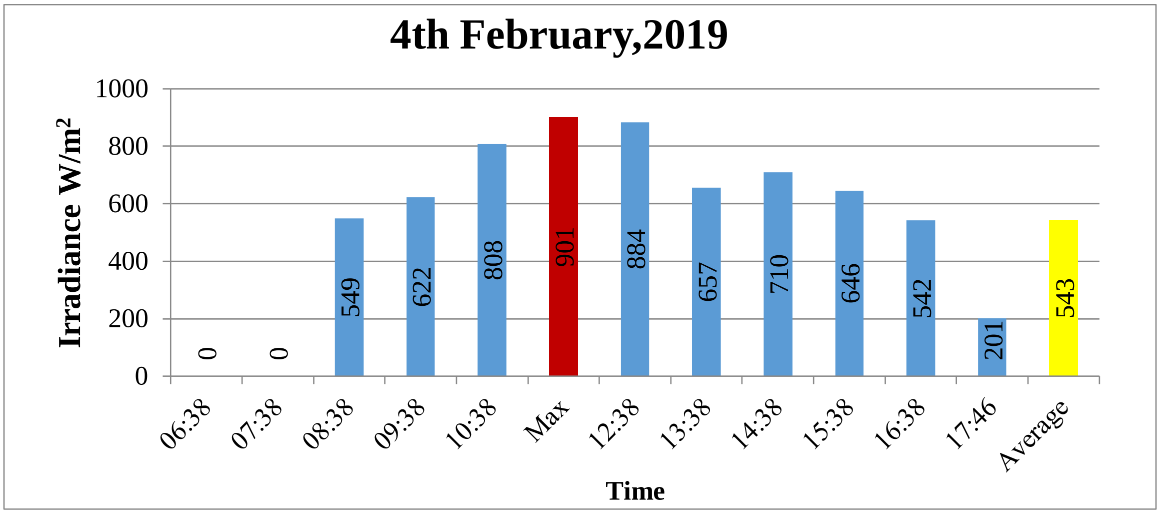

Figure 4.10: Sunny day irradiation for February 2019

At the same time in figure-4.10 shows the records of the irradiance of sunny day in February 2019. In sunny day, we search out the utmost irradiance 901W/m^2. In sunny days, we measured data every hour. The average irradiance of sunny day is 543W/m^2.

Now let's compare two different day's irradiance with their generated maximum power-

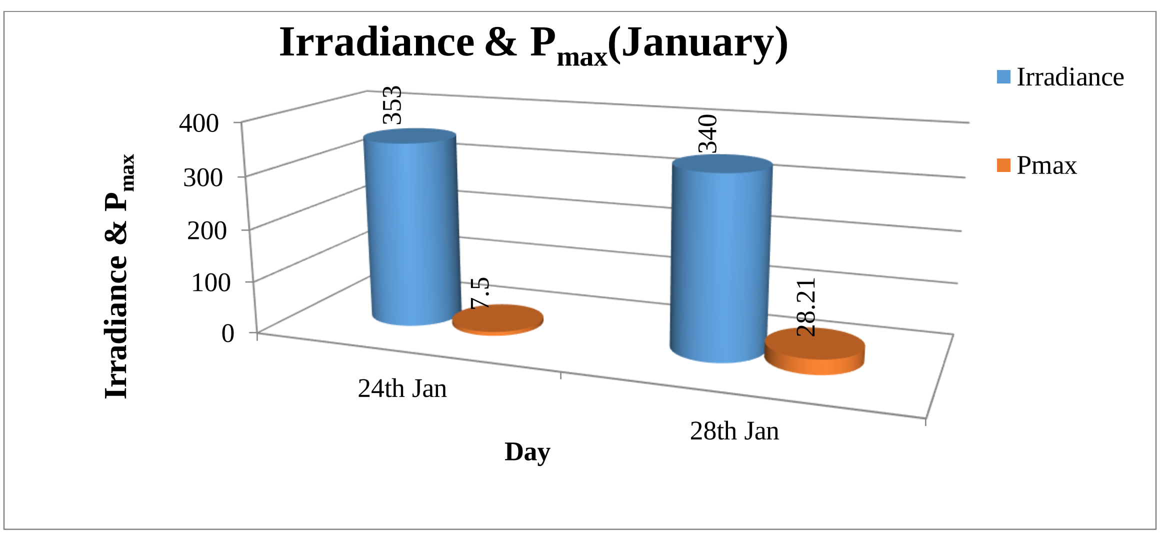

Figure 4.11: Comparison of Irradiance and P_{max} in January 2019

On 24 Jan 2019, the calculated irradiance was 353W/m^2 and the resultant power produced by that panel was 7.5W (figure 4.11).However, the subject of concern that, on 28th January, the deliberate irradiance was 340 W/m^2 but the power formed by the panel was 28.21W which was upper than the preceding one. This is a different discovery of this study. Usually, we can see that the production of power is proportional to the irradiation of the sunlight. But in this case the condition is not alike because we search out more power generation in less irradiation and acquire a smaller amount power in higher irradiation. At this point in this research we uncover this main reason following this problem. This is happened for the reason that the irradiation dimension tool did not measure the power production of the panel in that split of second. We got the total produced power from the solar panel and irradiation from the other tool box. Since we know sun irradiation is not same in all places. So, as we measured the less power (7.5W) at that instant the drop irradiation of the sunlight on that panel was less than the irradiation measured. So, we get less power in more irradiation. We took data by I-V 400W Photovoltaic Panel Analyzer. Our main function is to find out how much dc power we get from a solar panel or how much efficient a solar panel is. We took 10-12 different time's data in a day. The objective of taking data from solar panel is to find out how much dc output can deliver a solar panel in a day. So as much time we can take data in a day then the calculation will be more fairly accurate.

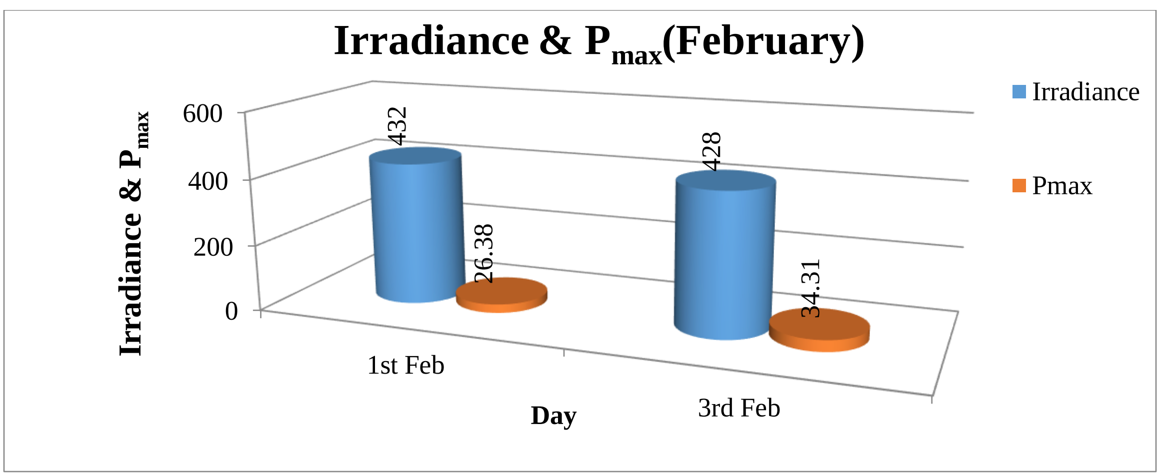

Figure 4.12: Irradiance and P_{max} in February, 2019

Similarly the figure-4.12 shows on 1st February, the calculated irradiance was 432W/m^2 and the equivalent power formed by that panel was 26.37W. However, the issue of concern that, on 3rd February, the exact irradiance was 428W/m^2 but the power produced by the panel was 34.31W which was higher than the earlier one.

Let's see now a cloudy day's irradiance & max power generation for both months-

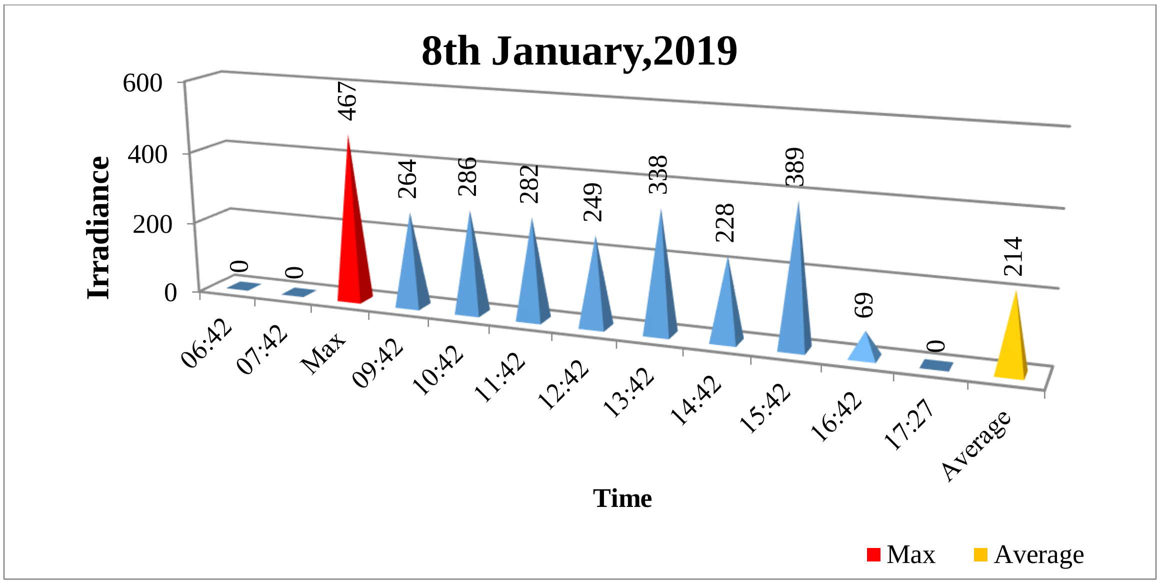

Figure 4.13: A cloudy day Irradiance of January, 2019

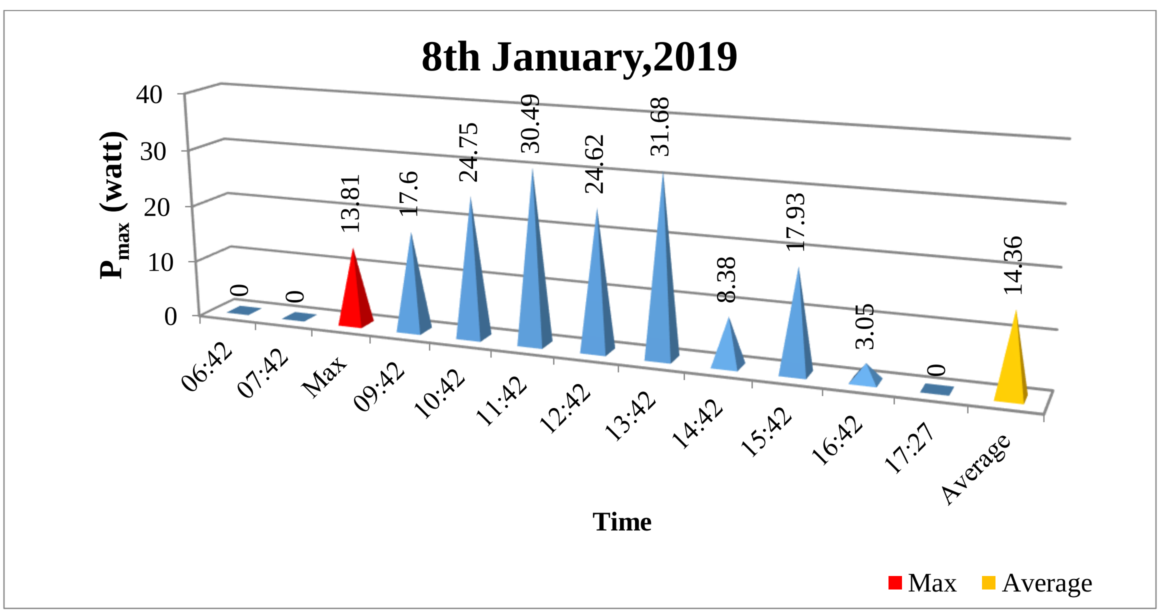

Figure 4.14: P_{max} for a cloudy day of January, 2019

Figure-4.13 & 4.14 demonstrates only cloudy-day's irradiance & maximum power in January 2019. In a cloudy day, average irradiance was 214 W/m^2.We got the highest & lowest irradiance 467 W/m^2 & 0 W/m^2 correspondingly. During cloudy day, maximum time we couldn't measure necessary data in time.

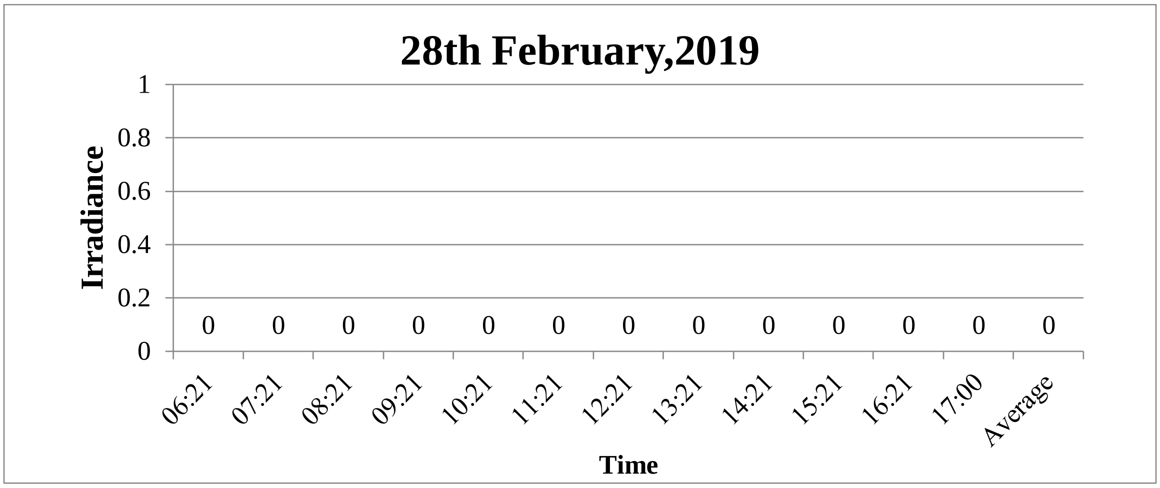

Figure 4.15: Irradiance for a cloudy day in February 2019

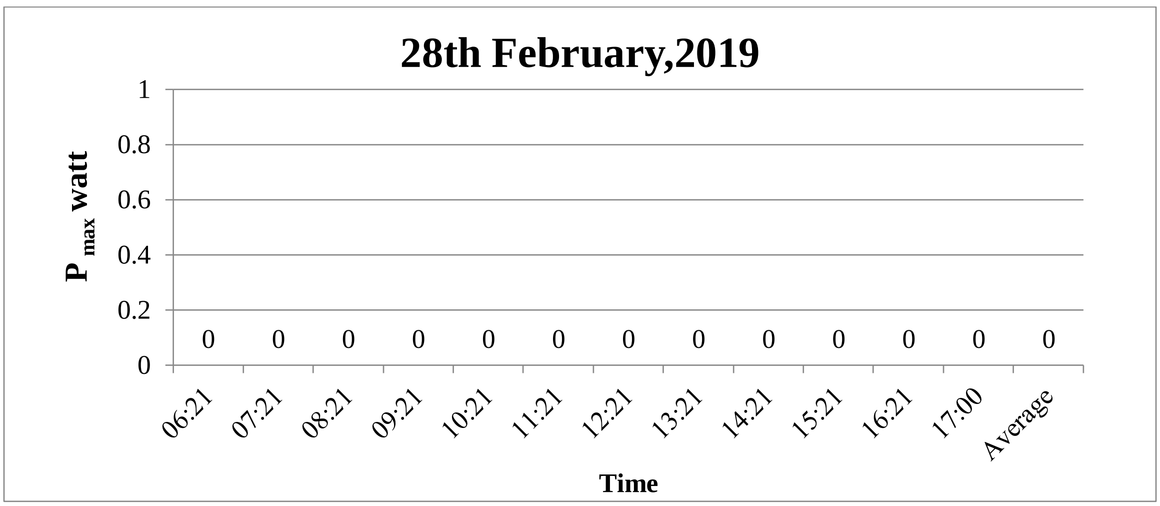

Figure 4.16: P_{max} for a cloudy day in February 2019

In the figure-4.15 & 4.16 we can see that this day was totally a cloudy day that's why irradiance is 0W/m2.We average got no highest or lowest value of irradiance and maximum power.

Table 4.1: 100W panel's two months irradiation and P_{max} (January & February)

Date	January-2019		February-2019	
	Irradiance	P_{max}	**Irradiance**	P_{max}
1	195	20.05	432	26.38
2	279	26.95	461	30.26
3	287	21.32	428	34.31
4	339	26.9	543	52.9
5	319	28.03	500	40.02
6	239	23.53	448	35.86
7	241	19.34	322	26.78
8	214	14.36	303	26.71
9	242	19.83	310	28.99
10	249	17.63	469	37.47
11	251	19.18	487	37.81
12	282	26.07	410	30.43
13	285	19.22	421	31.09
14	307	25.39	486	39.39
15	356	26.27	440	31.03
16	355	24.1	113	7.76
17	384	27.32	226	19.11
18	331	19.91	396	26.28
19	309	20.19	418	32.67
20	424	30.86	285	19.52
21	433	30.59	476	31.41
22	389	29.61	443	33.17
23	408	27.01	474	27.08
24	353	28.72	513	35.67
25	370	30.03	86	7.48
26	305	24.25	56	3.36
27	366	31.57	125	9.3
28	340	28.21	0	0
29	364	17.99		
30	449	34.42		
31	417	26.86		

Now let's put the value of the table in the curve and compare them-

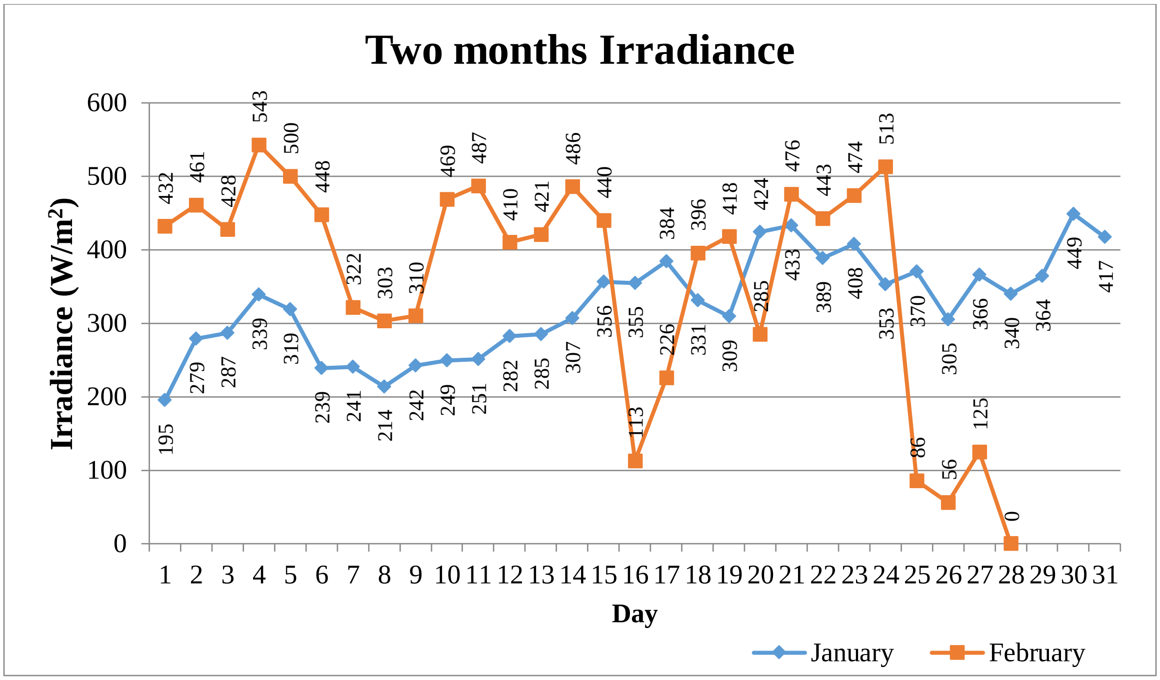

Figure 4.17: Two months irradiation (January & February)

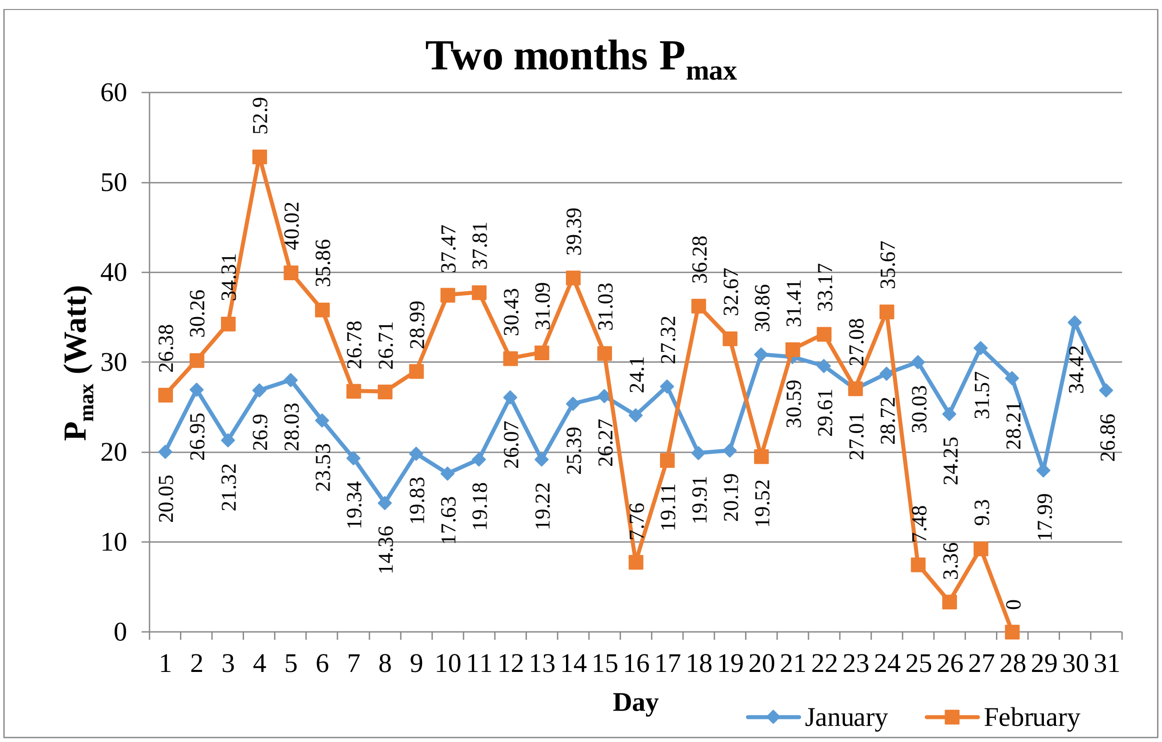

Figure 4.18: Two months P_{max} (January & February)

By measuring irradiation for both month January & February we see in figure 4.17 that the irradiation of February is comparatively higher than January. Since getting power is depend on irradiation of sunlight so the irradiation of February get more power than January. So we can say February is better for generation of solar power among both months. In figure 4.18 illustrate that P_{max} of the full months both January & February. The P_{max} of February is enhanced than P_{max} of January.

4.3 Solar Irradiation Data of Different Years

Table 4.2: Data of Monthly Average Solar Irradiance in 2008, 2009 & 2010 [18].

Months	**Solar Irradiance(W/m^2) (2008)**	**Solar Irradiance(W/m^2) (2009)**	**Solar Irradiance(W/m^2) (2010)**
January	164.9	165.6	151.5
February	209.8	219.1	186.7
March	225.7	228.3	238.2
April	283.3	273.1	236.7
May	261.1	235.1	225.8
June	212.4	210.3	176
July	176.2	197	201.6
August	174.1	177.5	166.3
September	189.6	166.8	165.5
October	179.7	189.1	175.2
November	208.1	164	168
December	123.7	142.5	159.2
Annual average Irradiance(W/m^2)	209.05	197.36	187.55
Annual Average ($kWh/m^2/day$)	5.01	4.73	4.50

In the table we can notice that in 2008, yearly average solar irradiation was 5.01 $kWh/m^2/day$ and the value of irradiation in 2009 was decreased and that was 4.73

kWh/m^2/day. There was also a diminishing drift in solar irradiation value in among 2009 and 2010 because in 2010, only 4.50 kWh/m^2/day irradiation was measured. Solar irradiance data were composed from Renewable Energy Research Center of Dhaka University, National Renewable Energy Laboratory and Development and Research is given in bellow table. Most of these solar irradiation data were collected from Dhaka University with different cities in Bangladesh.

Table 4.3: Collected Solar Irradiance Data of Bangladesh from 1985-2006 were Presented below [19].

Month	NREL (1985-91)	RERC (1987-89	RERC (1992)	DLR (2000-2003)	RERC (2003-2005)	RERC (2006)
January	4.18	4.29	3.34	4.58	3.16	3.4
February	4.68	4.86	4.05	4.81	4.46	3.79
March	5.55	5.53	5.24	5.31	4.88	5.04
April	5.65	5.23	6.02	5.84	5.28	5.06
May	5.58	5.67	5.76	5.21	5.46	5.09
June	4.48	5.13	5.39	3.85	4.22	4.8
July	3.9	3.87	4.2	3.76	4.48	3.84
August	4.12	3.92	4.87	4.11	4.12	4.73
September	3.96	4.5	5.38	3.76	3.78	5.15
October	4.7	4.61	4.93	4.19	3.57	3.18
November	4.25	4.22	3.72	4.47	3.92	3.35
December	4.06	3.89	3.39	4.34	3.19	2.84
Annual Average	4.59	4.64	4.69	4.52	4.21	4.45

From the table we can observe that in the year 1985-1991, annual average solar radiation was 4.59 kWh/m^2/day and it was increased into 4.64 kWh/m^2/day in 1987-89.However in 2000-03, annual average irradiation was 4.52 kWh/m^2/day which was decreased into 4.2 kWh/m^2/day in 2003-05.In 2006, irradiation was increasing, and the value was 4.45 kWh/m^2/day.

Table 4.4: Collected Data from 1985 to 2018 and Compare Irradiance Among them were Presented Below:

Year	Month	Irradiance kWh/m^2/day
1985-1991	January	4.18
	February	4.68
1987-89	January	4.29
	February	4.86
1992	January	3.34
	February	4.05
2000-2003	January	4.58
	February	4.81
2003-2005	January	3.16
	February	4.46
2006	January	3.4
	February	3.79
2009	January	3.97
	February	5.26
2010	January	3.64
	February	4.48
2018	January	7.8
	February	8.64

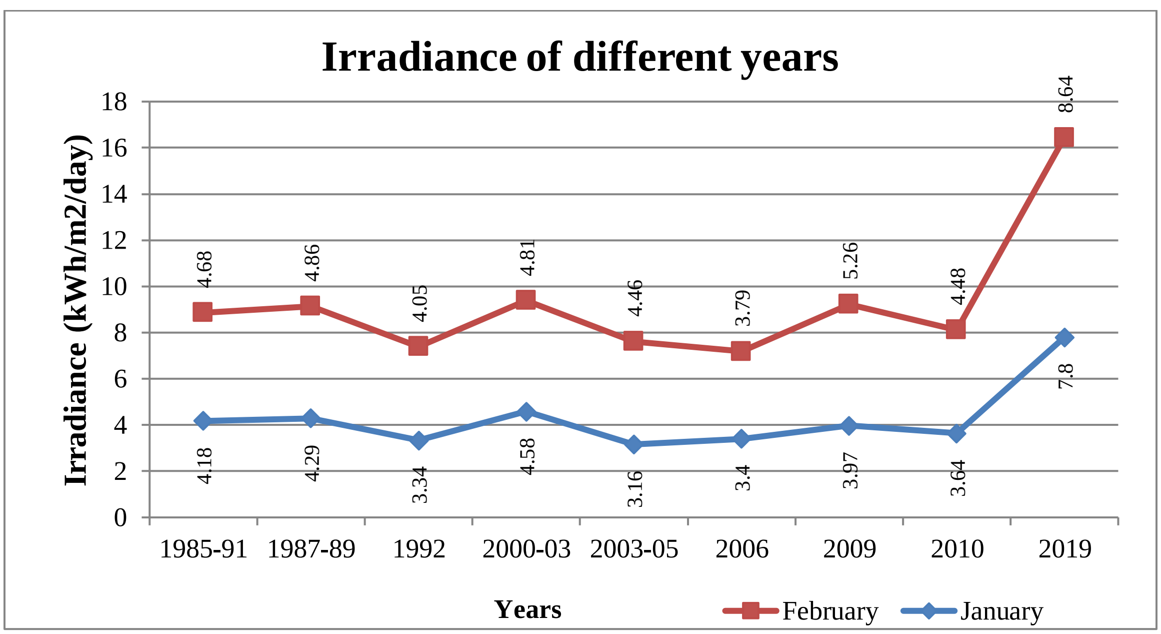

Figure 4.19: Different Years Irradiance

Finally in the figure-4.19 after analyzing several years' data we can state that in the month of January & February, we got the maximum amount of Irradiance in February. During the year 1985-1991, January & February average solar irradiation was 4.18 & 4.68kWh/m^2/day and it was greater than before to 4.29 & 4.86 kWh/m^2/day in 1989.Although in 2000-03, January & February average irradiation was 4.58 & 4.81 kWh/m^2/day. Within 2009 irradiation was increasing and the value was 3.97 & 5.26 kWh/m^2/day. Again in 2010, irradiation was decreasing, and the value was 3.64 & 4.48 kWh/m^2/day. Furthermore, in 2019, irradiation increased and the value was 7.8 & 8.64 kWh/m^2/day. Additionally, in 2019, irradiance was higher than another year. For that reason, we can definitely state that global warming is increasing day by day. For that reason research on solar energy and technology should be carry on.

4.4 Summary

In data analysis section we explain about our work. We worked on 100W solar panel in Dhanmondi area. Here we measured daily irradiation and maximum power for January & February. We obtained monthly average irradiance for January was 325 w/m^2 and 360 w/m^2 for February. And also got monthly average P_{max} for January which was 24.02W and 27.58 W for February. We measured separately average irradiation and P_{max} for sunny day and foggy day for both month. At last we have also compared several years' data with our study data in our university's rooftop.

Chapter 5
Conclusion

5.1 Conclusion

Solar power is an enormous source of straight useable power and eventually produces other energy resources: hydro, biomass, wind power. Most of the Earth's surface receives adequate solar energy to permit low-grade heating of water and buildings, even though there are large distinction with autonomy and season. At low latitudes, simple mirror devices can concentrate solar energy sufficiently for cooking and even for driving steam turbines. The energy of light moves electrons in some semiconducting materials [20]. This photovoltaic effect is capable of large-scale electricity generation. However, the present low efficiency of solar PV cells demands very large areas to supply electricity demands. At present days the impetus, progressive and sustainability of a civilization depend on energy. For operating the solar power more efficiently, it is very important to measure the irradiation of that country time to time because the sun radiation is changed over time. In this thesis, our main aim was to find out the irradiation of sun in Dhaka city in the month of January and February. So that the power production by the solar panel can be estimated and by using this data we can easily understand the electricity production by SHS and create a standard form of power production of SHS in 2019. Here we find that the average irradiation of January was 325Wh/m^2/day and February was 360 Wh/m^2/day and corresponding power produced by 100W solar panel was 24.02 W and 27.58 W in that order.

Though the use of SHS energy execute is more restricted, lifestyle has notably developed due to the accessibility of solar energy. Family members except households work position develops due to electric lighting and ignore of kerosene-related work. Solar energy lighting augments evening hours of family activity. Watching TV, creative activities and the studying of school going children are common activities compensation from the improved evening time [21].SHS electricity also develops family situation for education as it supply clear light and fresh air as well as longer studying hours for kids. In case of health benefit, it is also found that SHS owned households get developed indoor air, availability of information on health issues as well as reduced accidents related to kerosene use. We get many of information, education and leisure for using TV, Radio and mobile phone. Advance economic growth, quality education, health benefit and access to information can significantly rise the productivity, skill and livelihood of the rural people. In combination with other wide rural improvement programs, SHS will ensure sustainable socio-economic development in the long run. Our life directly depends on electricity. In Bangladesh electricity production is mostly reliant on diesel fuel and gas. These resources are limited that's why solar energy will be the main source of electricity [22].Massive prospect of solar electricity in rural area of Bangladesh Researchers are accredited that. Now Researchers are trying to use this technology for rural development and trying how to find more solar energy from this technology and we get more and more benefits from solar energy. Now it is high time to amalgamate structural set up for using this unexploited resource [33][34].

5.2 Upcoming prospect of the Work

Generation of solar energy has tremendous opportunity in Bangladesh. The environmental location of the country position to its handiness for generating solar energy. The reason being Bangladesh is a tropical country and it obtains solar radiation almost all over the year [23].In this study, we attempt to explain that how much power can be produced in the month of January and February of 2019 from a SHS. We have investigated only for two months but in future we can quantify power and irradiation throughout the year along with the scrutiny of panel effectiveness. This work is long time procedure. It needs minimum one year & maximum two or three years. The future extents this work is very intense [24].We work the solar irradiation and power. In future this work is to fix up consistency of solar energy, effect of dirt on panel and to fortitude of the battery losses also.

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