ESTIMATION AND ANALYSIS OF SOLAR ROOFTOP PHOTOVOLTAIC POWER SYSTEM IN BANGLADESH

This 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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December 2020

Certification

This is to certify provided that this thesis entitled **"Estimation and analysis of solar Rooftop PV power system in Bangladesh"** is done by the following students under my indirect supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering underneath 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 December 2020.

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This thesis paper entitled **"Estimation and analysis of Solar Rooftop PV power System in Bangladesh"** submitted by **ARIF MIAH,** ID NO: 172-33-470 and **IMRAN HOSSEN**, ID NO:172-33-491, Session: Summer 2017 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on December 2020.

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LIST OF ABBREVIATIONS

BPDP	Bangladesh Power Development Board
REB	Rural Electrification Board
NGO	Non-Government Organizations
IDCOL	Infrastructure Development Company Limited
DPDC	Dhaka Power Distribution Company
SHS	Solar Home System
SRS	Solar Rooftop System
PV	Photovoltaic
PWM	Pulse Width Modulation
MPPT	Maximum Power Point Tracking
MSP	Monocrystalline Solar Panel
PSP	Polycrystalline Solar Panel
CdTe	Cadmium Telluride
TV	Television
UV	Ultraviolet
GW	Gigawatt
MW	Megawatt
KW	Kilowatt
W	Watt
DC	Direct Current
AC	Alternating Current

ACKNOWLEDGEMENT

First of all, we give thanks to Allah. Then we would like to take this opportunity to express our appreciation and gratitude to our field study and thesis supervisor **DR.MD. ALAM HOSSAIN MONDAL, Professor of Department of EEE** for having dedicated to confirmatory, inspiring or guiding us even through this field study. This field study can't be done without his useful advice and helps. Also thank you very much for giving this opportunity to choose this field study.

We also want to convey our thankfulness to **Dr. Engr. Md. Shahid Ullah, Professor and Chairperson of the Department of EEE** for his help, support and constant encouragement.

Apart from in order that, we would like to thank our entire buddies for sharing knowledge, information or helping us in making this field study a success. Also thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for having very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

This research is an effort to find out the appropriateness of Solar Rooftop System (SRS). Provided that, Solar Rooftop System is the simplest way to alleviate the waste of electricity and to keep the environment green. Since, in this study and survey period, this was the elementary basis to research whether the users of the system are taking it in a positive way or not. Even if the study predominantly focuses on the importance of the system conveniences and expectation. So that, solar energy has been the most fortunate resource of renewable energy to improve the continuing unavailability of electricity. Here, in this context, the formation of Solar Rooftop System related works is reviewed and later on the process and dimensions of the collected data from various fields of Narayanganj are described elaborately. Therefore, about 25 solar rooftop systems formed in Fatullah, Amlapara, Panchabati, Mondolpara, Anayetnagar, Chashara in Narayanganj area has been randomly surveyed. Here, the whole study is predominantly based on the data collected from these surveys. After that, the long procedure of collecting data and fetching them together. However, the survey has managed to find out some important outcomes.

Although SRS processing has almost been successful in rural areas where most of the technologies are obtained based on Solar Home System (SHS). Even if, it has not yet been effective in urban areas after the attributed rule of meeting 3% of light fan load of a building. Therefore, we have observed the installed solar rooftop of 90 houses in Narayanganj. Where the solar system most of the houses was found inactive. Between them only 60 systems are active. However, in this thesis the overall analysis of urban solar anticipation has been done in three layers based on this investigation. In order that, compared discussion on cost efficiency of different solar panels has been given depending on amounts of loads being run. Once efficient batteries are modeled by SHS in context of Bangladesh to improvise PV systems.

Initially, the fundamental aim of the study was to find out the Consumers information, operation details, in which intention they use the system and in future. Since they are asked whether they are contented with the system or not. In order to, it is found that a multiplicity of the people are completely discontented with the system. Rather than, the effectiveness of the system was discussed in brief to influence them to come to know about the appropriateness of the system and the proper way to maintain the system. Even through, it is seen that a few among them find the system useful and want to increment its capacity. So the operating condition and maintenance of the SRS was appreciated as well.

Therefore, most of the interviewed people do not either keep up the system or want to repair it. Because of it is very accursed that most of the systems were found inactive or not connected in a proper way. Although urban people are more probably to know the efficient use of solar energy and they still prefer fossil fuels for their power generation. So in this manner, they are indirectly contributing to environmental hazards and wasting a lot of money too. Therefore, a cost analysis has been performed by SHS for different types of watt peak ranges and from the reading of an installed solar system, the cost per unit is calculated later as an example. However, the appropriateness of the system to the consumer is very limited due to having a lack of knowledge and training to operate the system productively. Apart from these, a regenerated design of the solar system has been accepted to make urban rooftop solar installation effective and successful

CHAPTER-1

INTRODUCTION OF THE EXPLANATION

1.1 Introduction

Bangladesh is one of the most populous countries where there is not enough supply of electricity as compared to other countries. In Bangladesh, the total population almost 80% lives in villages and 32% of the total population is connected to the electric grid. The role of solar in meeting the power deficit of Bangladesh is incomparable. So that use of the renewable energy is interesting for solar energy application in many developing countries. So that a solar panel is basically an electric device whose work is to convert the sun's light energy into electrical energy. Rather than a solar panel has many solar cells. Each cell is connected to each other. Solar cells work a lot like batteries, but ordinary batteries generate electricity from chemicals and solar cells produce electricity from light. Another name for solar for solar panel is photovoltaic(PV) panel. Since here photo means light and voltaic means electricity. So this panel is basically a two-tiered electric sandwich made of semiconductor material silicone. In order to get the maximum amount of electricity, and the panel has to be placed on the roof or high place in such a way that sunlight falls on it for most of the day. Once electricity is stored in solar panel batteries. The collected electricity can be used at night or on cloudy days. Now solar panels are usually more efficient at temperatures of 20 to 25 degrees. These panels can never produce more electricity than the energy received from the sun. Most panels can produce 10 to 20 percent of the energy from the sun. Another silicon Rooftop solar panel can produce a maximum of 30% electricity. Because sunlight contains photons of different waves. So that Rooftop solar panels can capture and work on certain waves. The rooftop solar panels are eco-friendly. It plays an effective role in avoiding extreme problems like global warming. Also this electricity is completely free. You don't have to pay the bill every month. And it doesn't cost much to set up. Since the rooftop solar radiation energy is converted into DC power or requires an inverter it into AC power. But there are still some problems provided that make it uncomfortable to us. Although its efficiency is so much low and its prices of the energy still so high. So that in this thesis paper we try to find way to make it comfortable. [1]

1.2 Representation of The Problem

Bangladesh has one of the world's largest domestic rooftop solar energy programs, which has changed the lives of 20 million people. In Bangladesh, the government planning for rooftop solar home system to generate 220 megawatts of electricity for around 4 million households and about 20 million people in rural areas, roughly one-eighth of the country's population. [2] Although the natural gas supply is not enough to meet the demand, and the power of producing current gas can't support the domestic requirement as well as the generating electricity for the country. So that it is five to eleven times more expensive to produce electricity from coal, hydro or nuclear sources. Once the first problem is with the cost of the technology. The rooftop solar panels use valuable semiconductor material to generate electricity directly from sunlight. Industry report watt silicone solar pants hotel price 48-58 taka. The price of 100 watt solar panels in the world is RS. Note that ordinary people who invest RS 4800-5600 for 100 watts of electricity are ultimately expensive. Silicon Metals like gallium, arsenic, indium, cadmium etc. are used besides silicon as components of solar panels; which, if released into the open at the end of the term, would be detrimental to biodiversity. There is still no planned infrastructure in Bangladesh to process these panels at the end of the term. According to 2012 UN figures, the world's population will be 1.4 billion in 2085, double the world's population 2011. According to Hobart's theory, petroleum production in 2085 will be equal to 1925. Therefore, the price of silicon solar panels will increase in the international market due to population growth and reduction in petroleum production in the future. [3]

1.3 Destination of the Research

The objectives of the study are as follows:

- To collect data about consumer opinions and grasp this state in SRS on Bangladesh additionally.
- To final point out of the output which gives a clear compare between the number of people having profited from the SRS system and many other people not being benefited.
- To verify that fans who use rooftop solar system are benefiting from using them properly.
- To percentage of the population of Bangladesh is able to manage with rooftop solar system and how many percentage of it flows to increase capacity.

- To calculate the per unit cost of solar electricity from the information of the rooftop solar system.

1.4 Significance of the study

Bangladesh is broadly known as a tropical country has a big amount of solar rooftop energy. But it is once and again asked provided that how much of the solar energy is being used properly. Although the openings with SHS around Bangladesh were in 1988 but it certainly appeared to be low antagonism for an extended time. So that, the initial step was to widen the scope of our investigation. No impenetrable study is strangely found for the expectation and extension of solar electricity for the economic development in rural areas of Bangladesh. Then it is found in order to the rural area has a fraction knowledge on the socioeconomic influence of solar electricity. So that, this report will obviously cover the knowledge about renewable energy solar system additionally with solar rooftop home system, operation of the system, on-grid and off-grid system, world solar energy installed capacity, Aptness of solar home system, Expectancy of solar rooftop system in Bangladesh, Solar panel, Batteries, Charge Controller Power Inverter, Backup Generator, Power Meter, Kilowatt Meter. In addition, it will also help with new technology transfer in rural areas. Since, this involves commercial technical manuals and engineering data concerning to their particular solar rooftop home system panel.

1.5 Thesis Outline

i) Chapter two describes the Literature Review Section.
ii) Chapter three describes the Research Methodology of the study.
iii) Chapter four describes the Thesis Result.
iv) Chapter five describes the Conclusion sector of the Thesis.

CHAPTER-2

LITARATURE REVIEW

Section-A

2.1 Introduction

In this chapter we've described History of solar energy, Renewable energy, solar panel, World solar energy such as China solar power, India solar power, also Bangladesh solar energy, working principle of PV system, Solar system equipment, Solar home system, Components of a solar PV system, Different types of solar panel, Types of solar system design, ON-Grid and OFF-Grid solar rooftop system, Advantage and Disadvantage of solar rooftop system.

2.2 History of Solar energy

Although the solar cell is one of the most studied subjects in modern physics, its history is quite old. In 1839, the French physicist Becquerel first accomplished the photovoltaic reaction. It was used by Charles Fritz in 1883 to make the first solar cell from a gold plated semiconductor selenium. So that, its efficiency was only 1%. then the first semiconductor-junction solar cell was created in 1948 by Russell oil. However, modern solar cell technology was born in 1958 at the Bell Laboratory in the United States. Invented by Daryl Chaplin, Kelvin Fuller and Gerald Pearson, the performance of this strand was close to 6%. Launched in 1956, Vanguard-1 was the first artificial satellite to use solar cells. So that, In the 1970's, Alfarve of the Soviet Union and his colleagues created high-performance hetero-structured solar cells. After that, in 1988, the American Applied Solar Energy Corporation (ASEC) exhibited a gallium-arsenide dual junction cell with an efficiency of about 17%. Since, over the next decade, ASEC improved the efficiency of their cells by 20%. These cells are extensively used in American spacecraft. By 2007, the technology had reached the tri-junction stage and achieved about 30% efficiency. Provided that, the 2000s saw the speedy development of solar cell technology and revolutionized the basic structure of cells. So that, the conventional solar cells can be divided into three generations based on difference in structure and composition.

There are three types of generation following below:

1st Generation:

The first generation solar cells are built of very high quality semiconductor junctions, large in size, but highly efficient. Theoretically, its maximum efficiency is 31% and the efficiency of such modern cells is close to this standard.

2nd Generation:

This generation of solar cells is cheap, but low performance (12-20%). So that, there are shaped in thin film technology. Then the most common components are cadmium telluride (CdTe), granular silicon and copper-indium-gallium-selenide (CIGS).

3rd Generation:

Third-generation cells are essentially improved versions of second-generation cells. Therefore, these include di-sensory cells, nanosilicon cells, etc. [4]

2.3 Renewable energy

Renewable energy often directed to as clean energy, these energy comes from natural sources that are permanently replenished. For example, sunlight or wind keep shining and blowing if their availability depends on time and weather. There are Five kinds of Renewable energy they are following below:

- Solar Energy
- Wind Energy
- Biomass Energy
- Hydropower
- Geothermal

Resources	Production	Percentage Share
Thermal Coal Gas Diesel	 76648 14716 1119 Total=92563	 52.8 10 0.8 Total=63.6
Nuclear	4120	2.8
Hydro	36033	24.8
Renewable energy sources (Excluding hydro)	12194	8.4
Total	144910	100

Table 2.1: Significance of renewable energy.

2.4 Global Scenery of Solar Energy

The amount of solar energy installed on the world's power grids jumped 50% year over year in 2016. According to the report, between 70 and 75 GW worth of solar panels came with close to half of those installation coming from China, where solar capacity more than doubled last year. IEA said renewables represented 24% of total electricity output, and it forecast the renewable power will grow by 36% by 2021, making it the fastest-growing source of electricity generation globally. So that, solar data on installed capacity (MW) and annual output (GWH) is sourced from IEA. Hence, the global installed capacity of solar electricity has seen an interpretative growth, reaching around of 227 GW. So it produced 1% of all electricity that is used globally. The global average solar radiation, per m2 and per year, has the ability to generate the same amount of energy as a barrel of oil, 200 kg of coal, or 140 m3 of natural gas. Solar installed capacity by region Africa installed capacity 0.9%. So that, the Middle East and North Africa have a capacity of 0.6%. Latin America and the Caribbean have 0.9%. North America installed capacity is 13.2%. Europe 43.7%. South and Central Asia 2.5%. East Asia 32.2%. South East Asia and Pacific have a capacity of 3.1%. Therefore, in 2020 the global use of renewable energy was 1.5% higher than in 2019. Then the increase was driven by a rise of about 3% in renewable electricity generation after more than 100 GW of solar PV system and about 60 GW of wind power projects were completed in 2019. Hence, the share of renewables in global electricity generation jumped to nearly 28% in 2020 from 26% in 2019. So the increase in renewables came principally at the cost of coal and gas, though those two sources still represent close to 60% of global electricity supply. [5]

2.4.1 Solar Energy in China

China is the extensive solar market around the world. Now a days, China is the world's maximum renewable capitalist.

So Chinese inverter manufacturer Sun grow, which supplied the inverters, said that the 2.2 GW solar plant was made in five phases. Then it related an investment of RMB 15.04 billion ($2.2 billion) and comprise 202.8 MW/MWH of storage capacity. Hence, the government commitment to consume $360 billion on clean energy projects by 2020. So china has installed capacity of around 130 GW and 47% of global demand this year. Provided that, the largest floating solar power plant around the world is located in the city of Huainan in the Anhui province in China, the system has a power output capacity of 40 MW. Therefore, sun grow supplied the plant's central inverter unit, which transforms DC from the solar panels into an AC for delivery to the local power grid. Show in Fig 2.1 China Largest Solar Plant. [5]

Fig 2.1: China Biggest Solar power plant

2.4.2 Solar Energy in India

India stands third in Asia and fourth in the world in terms of solar power production across its plants. So the total installed solar power plant capacity across India currently and up to about 30 GW by the time 30 April 2020. Provided that, this currently accounts for about 38% of its total capacity of renewable energy. Hence, the country also claims to own the world's largest solar park, located in Rajasthan. So that India national Solar Mission launched in 2010 a time when just 10 MW of solar power was installed with a target of 20 GW set for the end of the decade. However, due to significant activity within the solar power sector over the following years, India has raised its target by several notches and now aims to achieve 100 GW of solar power capacity by 2022.Show in Fig 2.2 Indian biggest solar plant. [6]

Top five solar power plants in India Capacity Generate

- **Bhadla Solar Park (2250 MW)**
- **Shakti Sthala Solar Power Project (2050 MW)**

- **Ultra Mega Solar Park (1000 MW)**
- **Rewa Solar Power Project (750 MW)**
- **Kamuthi Solar Power Plant (648 MW)**

Fig 2.2: Indian Biggest Solar Power Plant

2.4.3 Solar Energy in Bangladesh

The government of Bangladesh has committed a total of 19 solar power projects of total 1070 MW capacity which taken the prime minister's evidence in principle as part of its plan to Generate 10% electricity from renewable energy source by 2020. After that, the solar power plant is the first footstep towards the government's target of producing 2000 MW of solar power plant in BD by 2021. So, the Bangladesh incompletely small segment of energy demand filled by solar PV system. Once the Bangladesh positional view in aspects of solar radiation 241 0' 0" N latitude and 901 0' 0" E longitude.

However, the total generation of solar energy in Bangladesh 500 MW and the total of share of renewable energy 39.5%. Although, Bangladesh has already installed 3 million solar home systems (SHS) by providing clean energy over 13 million of the rural population. So that, Bangladesh receives an average daily solar energy radiation in the range of 4-5KWh/m. Provided that, Bangladesh installed over 50,000 SHS and the fastest growing nation around the world. Figure 2.3 below show the Bangladesh largest solar power plant. [7]

Fig 2.3: Bangladesh Largest Solar Power Plant

- **Solar Power Project in Bangladesh**

The names of solar power projects in Bangladesh are presented in a listed manner:

SL No	Project Name	Location	Sponsor	Power MW
01	200 MW (AC) Solar Park	Teknaf, Cox's Bazar	SunEdison energy Holding (Singapore Pvt Ltd)	200

02	50 MW (AC) Solar Park	Sutiakhali, Mymensingh	Hetatditrolic IFDC solar	50
03	32 MW (AC) Solar Park	Dharmapasha, Sunamganj	Edisun power Point & Haor Bangla-Korea Green energy LTD	32
04	30 MW (AC) Solar Park	Gangachara, Rangpur	Intraco CNG Ltd & juli New Energy Co. Ltd	30
05	20 MW (AC) Solar park	Cox's Bazar	Joules Power Limited (JPL)	20
06	200 MW (AC) Solar Park	Gaibandha	Beximco Power Co. Ltd& TBEA XinJiang Sunoasis CO. Ltd	200
07	10 MWp Grid Tied Solar Power Project	Goainghat, Sylhet	Eiki Shoji Co Ltd, Japan & Sun Solar Power plant Ltd	5
08	10 MW (AC) Solar Park	Moulvibazar	Symbior Solar Siam & Holland Construction	10
09	30 MW (AC) Solar Park	Panchagarh	Beximco power Company Ltd & Jiangsu Zhongtian Technology Co Ltd China	30
10		5 MW (AC) Solar Park	Patgram	Green Housing & Energy Ltd	5

11		10 MW (AC) Solar Park	Goainghat, Sylhet	Golden Harvest and DREPL Consortium	10
12		100 MW (AC) Solar Park	Baradi, Narayanganj	Blue Mounatain Ltd	100
13		100 MW (AC) Solar Park	Bagerhat	Energon Technologies FZE, UAE & China Sunergy Co.Ltd (CSUN)	100
14		35 MW (AC) Solar park	Manikganj	Consortium of Spectra Engineers Limited & Shunfeng Investment Ltd	35
15		70 MW (AC) Solar Park	Panchagarh	BGB Power Company Limited	70
16		50 MW (AC) Solar Park	Bhola	Greenwitch Elcon BD Ltd	50
17		60 MW (AC) Solar Park	Porabari, Tangail	Consortium of Hanwha 63 City Co. Ltd, BJ Power CO. Ltd Solar City BD Ltd	60
18		100 MW (AC) Solar Park	Teesta Barrage, Lalmonirhat	Zhejiang DunAn New Energy CO. Ltd, China National Machinery Mport & Export Corporation, STP Ltd, Amity Solar Ltd	100
19		11 MW (AC) Solar Park	Panchagarh	JV of Paragon Poultry Ltd. & Parasol Energy Ltd AND Symbior Solar Siam Ltd	11
				Total =	1118 MW

Table 2.2: List of Solar Power Project in Bangladesh [7]

2.5 Solar Home System

The use of electricity by people in rural areas through Solar Home System (SHS) is becoming more and more popular in Bangladesh. So that, solar home systems produce electricity using PV panels, replacing the use of kerosene for lamps and the use of diesel to charge batteries. Since, Solar home system program has been started to ensure the use of clean energy in the rural areas of Bangladesh where there is no electricity. Once this program complements the government's vision to generate for all by 2021. In order that, about 4.5 million solar home systems have already been installed in the off-grid rural areas of Bangladesh under the IDCOL program and about 13 million beneficiaries are getting solar power. Although, under this program, more than 65,000 solar home systems are being installed every month, which is growing at an average rate of 58% per year. Provided that, the program is replacing 180,000 tons of Kerosene worth 225 million annually. However, about 70,000 people are directly and indirectly involved in this program. So the program has earned a worldwide reputation as one of the largest and fastest growing off-gird renewable programs.

2.6 Solar Home System Working Method

Solar panels work by drying sunlight with photovoltaic (PV) cells, generating direct current (DC) energy and then converting it to usable alternating current (AC) energy with the help of inverter technology. Then AC energy flowing through the home's electrical panel and is distributed consequently.

ON-Grid System: As long as there is sunlight without batteries, the whole system is called ON-Grid. There are some equipment required for ON-Gird system:

- **Solar Panels**
- **ON-Gird Inverter**
- **Energy Meter**

OFF-Gird System: OFF-Gird is a method of protecting solar power through batteries and using it at night or during load shedding.

There are some equipment required for OFF-Gird solar system:

- **Solar panels**
- **Charge Controller**
- **Inverter and**
- **Battery Bank**

Now we see the Fig 2.5 working method of Solar Home System [9]

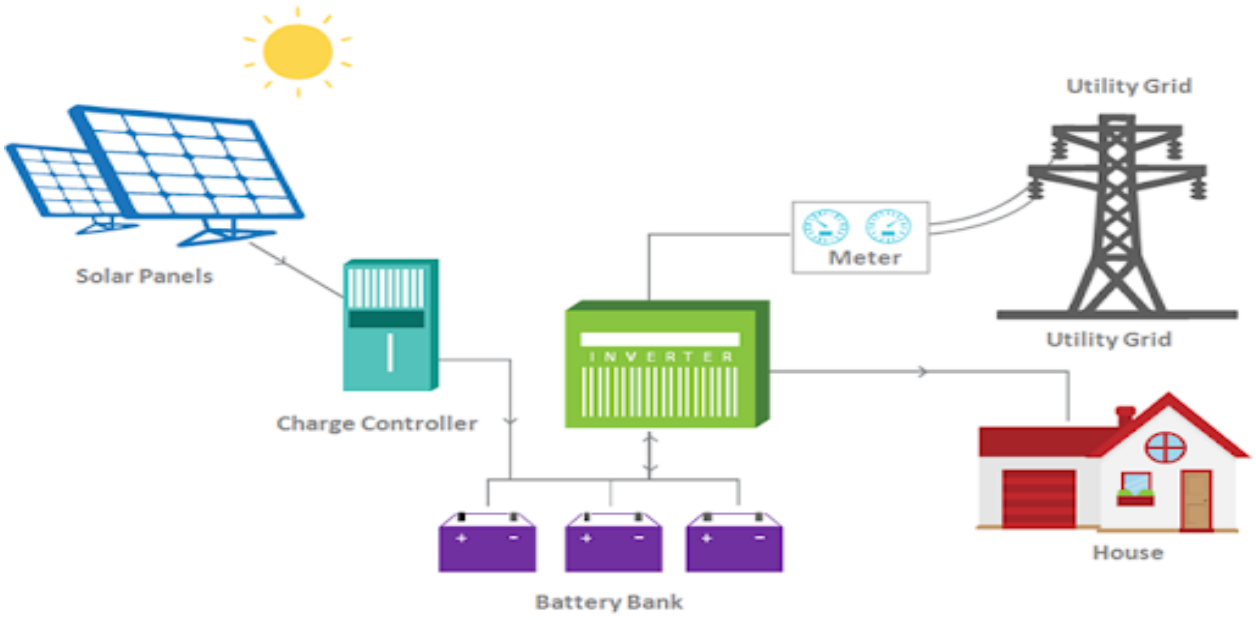

Fig 2.4: Solar Home System Working Method

However, the sun shines on the solar panels generating DC electricity that convert it to 240V, 50Hz of AC electricity. So the 240V AC electricity is used to power applications in our solar home system.

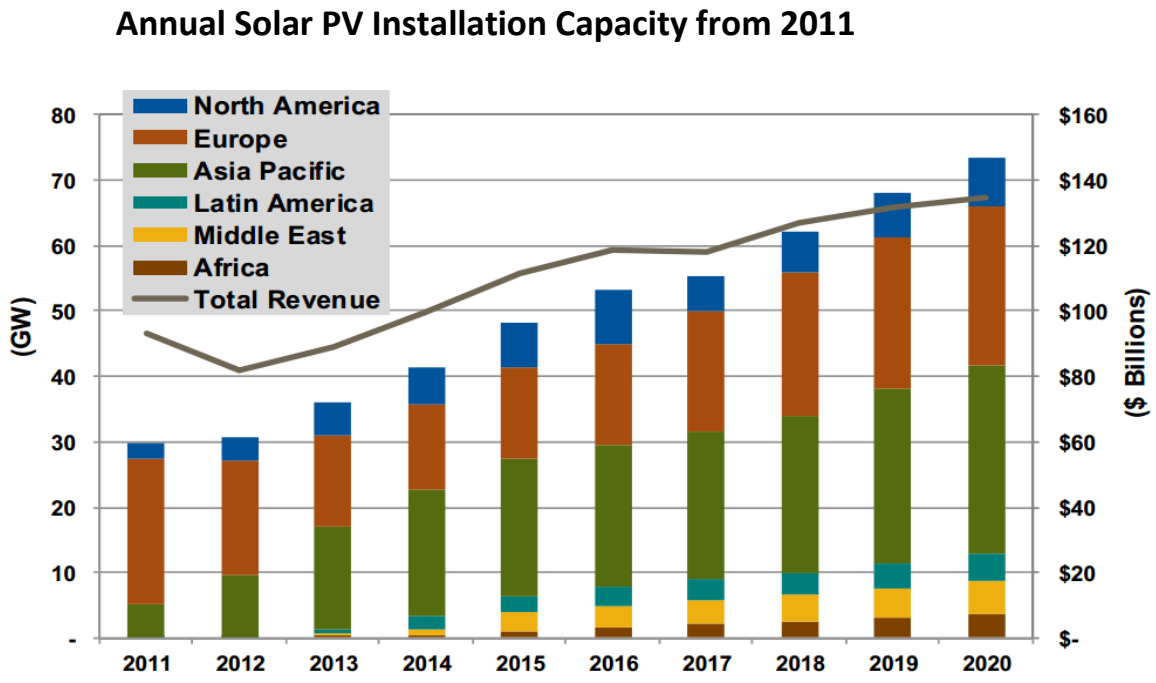

Fig 2.5: Installation Chart

2.7 Solar system equipment

Solar system equipment is an essential component of a solar energy. Component residential Solar electric system component, Solar Panels, Solar array mounting racks, Array DC disconnect, Battery Pack, Inverter, Power Meter, Utility Meter, Kilowatt Meter, Backup Generator, Charge Controller.

The Basics Four Pieces of Solar Energy Equipment

- **Solar Panels**
- **Batteries**
- **Charge Controller**
- **Power Inverter**

Section-B

2.8 Components of a Solar PV system

The OFF-Grid Solar system means you propagate this energy on your own home and use this system energy/electricity only home. So that it does not need to supply on the grid system. Than the off-grid solar system there are four basic components:

- **Solar Panel**
- **Battery**
- **Charge Controller**
- **Power Inverter**

2.8.1 Solar Panel

A solar panel is a type of photovoltaic (photoelectric) cell that generates DC direct current through the action of light. So Many do not have a clear idea about this issue. Let's see how DC is made in solar. So that, the solar panel has a layer of silicone under the thin glass plate which looks very dark on the outside. This silicone layer contains two types of silicone, positive and negative. Proton come from sunlight and excite negative silicon. Then the newton of this negative silicon is attracted to the positive silicon and this whole process takes place and a magnetic flux is created. With silicon it attracts this newton and if the circuit is completed, DC current flows. This DC current is converted to AC or directional current through an inverter. This directional; flow can be used at home or office using either a system ON-Grid or OFF-Grid.

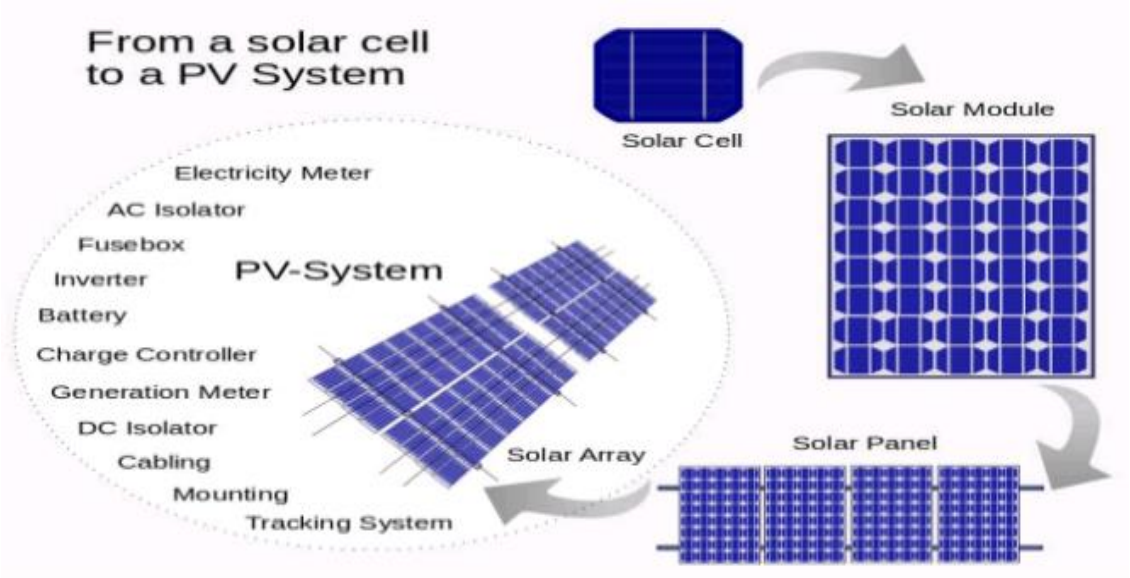

Fig 2.6: Solar Panel

2.8.2 Battery

A battery is materially an electronics device consisting of one or more electrochemical cells. So It is used as a source of energy in a diversity of electrical and electronics components. So than the battery bank is the sum of many batteries. Therefore, these batteries can be connected in series or in parallel. Even If you want to increment the voltage, you have to connect the batteries in series and if you want to raise the current, you have to connect the batteries in parallel.

Fig 2.7: Battery

2.8.3 Charge Controller

It controls the battery charge. When the battery is fully charged, it stops charging and disconnects the load from the battery when the charge is over. This protects the battery. It is generally used in battery system.

Types of Solar Charge Controller:

- **PWM Controller**
- **MPPT Controller**

PWM Controller: It is a controller that is used at low cost for small systems when the temperature of the solar cell is much higher (between 45 degrees to 75 degrees). This is a very old technology so it goes without saying.

Fig 2.8: Solar PWM Charge controller.

MPPT Controller: It is a controller that is used to charge low voltage batteries by converting high voltage DC outputs from solar panels. This is modern technology. It gives 30% more output than the PWM controller. It costs a lot more but it is less of a problem even if the temperature of the solar cell is low (between -20 degrees to 55 degrees). So its current use is much more.

Fig 2.9: MPPT Solar Charge Controller

2.8.4 Power Inverter

An inverter is a type of electronics device that converts direct current (DC) to alternating current (AC). Inverters are used to supply AC power from DC sources such as solar panels or electric batteries.

Electrical inverters are essentially high power electronic oscillators. Inverters usually perform the opposite of rectifiers. So Inverters can generally change the frequency and voltage. So we know that the electricity generated from the sun through solar panels is usually DC. This DC power continues to be deposited in the battery bank through the charge controller. But we commonly use AC load in the house so we need to convert this DC current to AC which we can do with the help of inverter.

Fig 2.10: Solar Power Inverter.

2.9 Working Principle of PV System

Solar PV system use cell to convert sunlight into electricity. So the PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers causing electricity to flow. After that the greater the intensity of the light, the greater the flow of electricity. Solar cell (crystalline Silicon) consists of a n-type

semiconductor (emitter) layer and p-type semiconductor layer (base). The two layers are sandwiched and hence there is formation of p-n junction.

The surface is coated with anti-reflection coating to avoid the loss of incident light energy due to reflection.

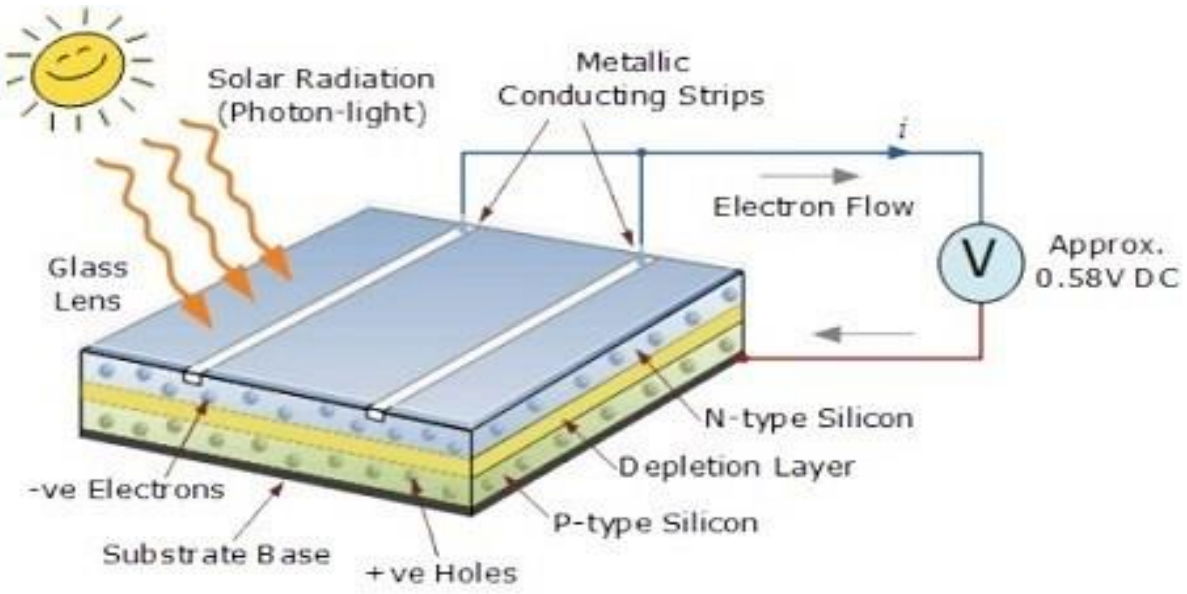

Fig 2.11: Working principle of solar PV system

The solar panel exposed to sunlight, the light energy absorbed by semi conduction materials. Due to this absorbed energy, the electrons are liberated and produce the external DC current. The DC current is converted into 240-volt AC current using an inverter for different applications. Thus when this p and n layers are connected to external circuit, electrons flow from n-layer to p-layer, hence current is generated the electron that leave the solar cell as current give up their energy to whatever is connected to the solar cell, then re-enter the solar cell. Once back in the solar cell, the process begins again. [8]

2.10 Connection of Solar PV System

There are two different types of Solar PV System

- Gross-Metered Solar Rooftop PV System
- Net-Metered Solar Rooftop PV System

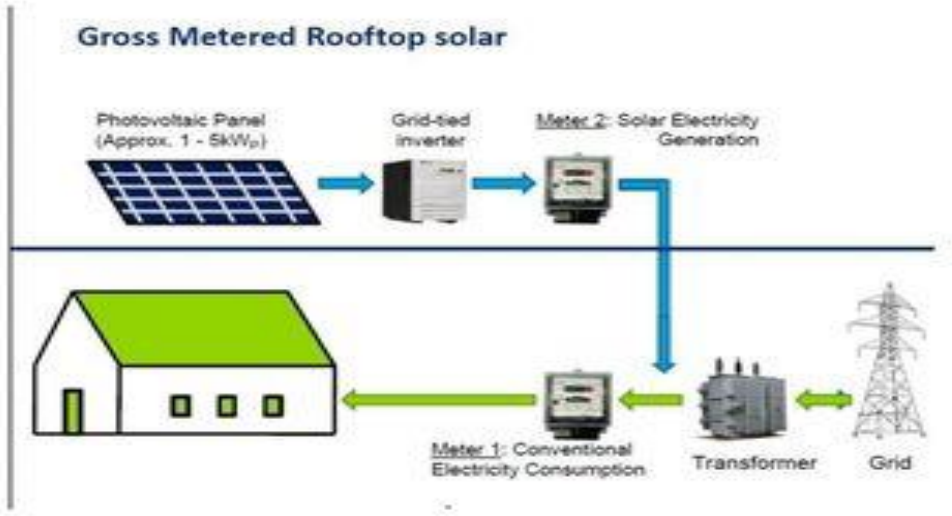

Fig 2.12: Gross-Metered Solar Rooftop PV System.

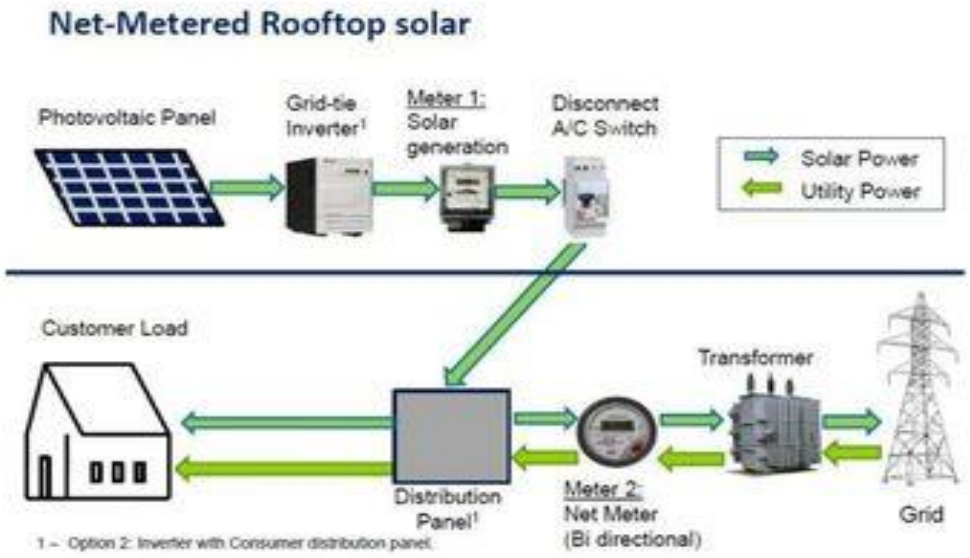

Fig 2.13: Net-Metered Solar Rooftop PV System.

2.11 Parallel Connection of Solar Panels

When all (+) ends of multiple Solar panels are joined together and all (-) ends are joined together, it is called parallel connection. So In a parallel connection the voltage remains the same but the amount of current increases. That is, watts increase.

Calculation of Parallel Connection:

- If the 2 panels of 17V 3A (50W) are connected in parallel, 17V will be fine but current will be 3A*2=6A, then solar system will be 17V 3A*2=102W or, 17V 6A (100W).
- If the 3 panels of 17V 3A (50W) are connected in parallel, 17V will be fine but current will be 3A*2=9A, then solar system will be 17V 3A*3=153W or, 17V 9A (150W).
- If the 4 panels of 17V 3A (50W) are connected in parallel, 17V will be fine but current will be #A*4=12A, then solar system will be 17V 3A*4=204W or, 17V 12A (200W).
- If the panels are not of the same watt, such as 3 panels 17V 3A (50W), 17V 3A (50W), 17V 6A (100W) in this case the total amperes by adding amperes and the total watts by adding watts. 17V (3A+3a+6A) = (50W+50W+100W) or, 17V 12A (200W).

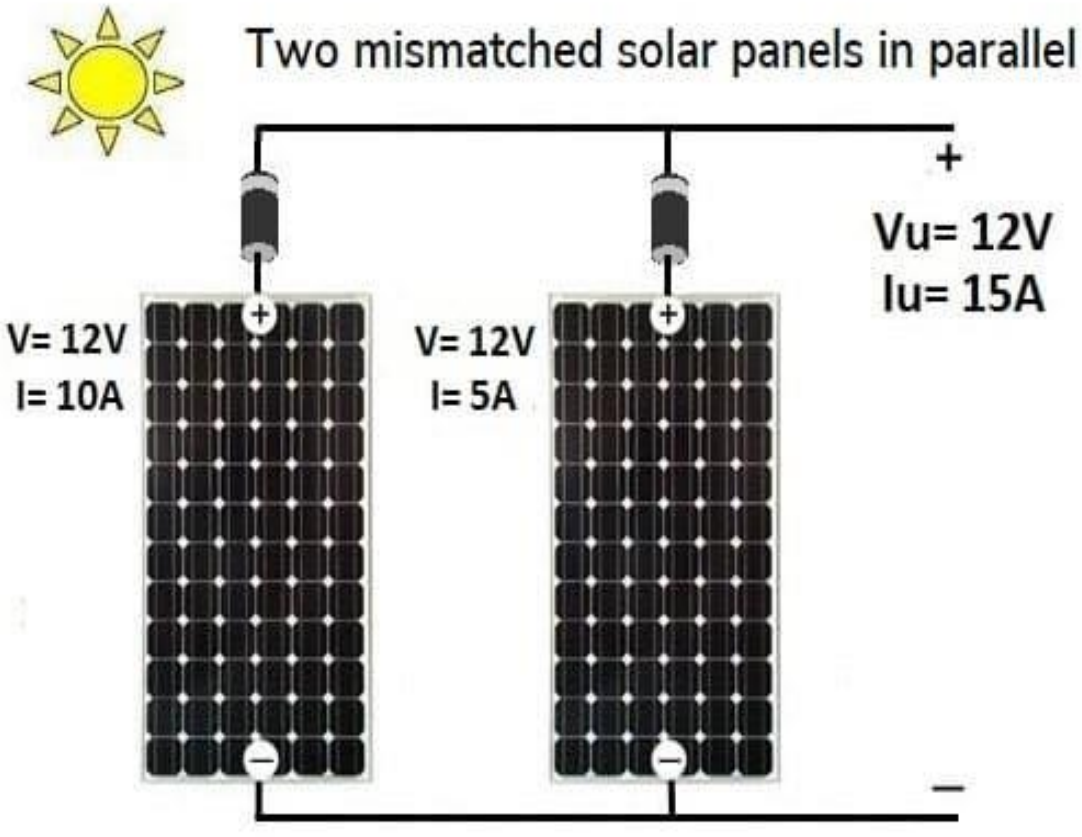

Fig 2.14: Parallel connection of solar panels.

2.12 Series connection of solar panels

When one (+) end of one of the multiple Solar panels connects the other (-) end of the other in this way, it is called series connection. The current flow in a series connection system remains the same (pointedly) but the total watts have to be calculated by adding the voltages the total watts.

Calculation of Series connection:

- If the 2 panels of 17V 3A (50W) are connected in series, the current flow will be 3A but the voltage will be 17V +17V= 34V, then the solar system will be 34V 3A (100W). Then the Maximum output of the system is not available if connected to a series of different solar panels. So for Maximum best result the same watt panel connection should be given in case of series connection. Now we see the Fig 2.8.

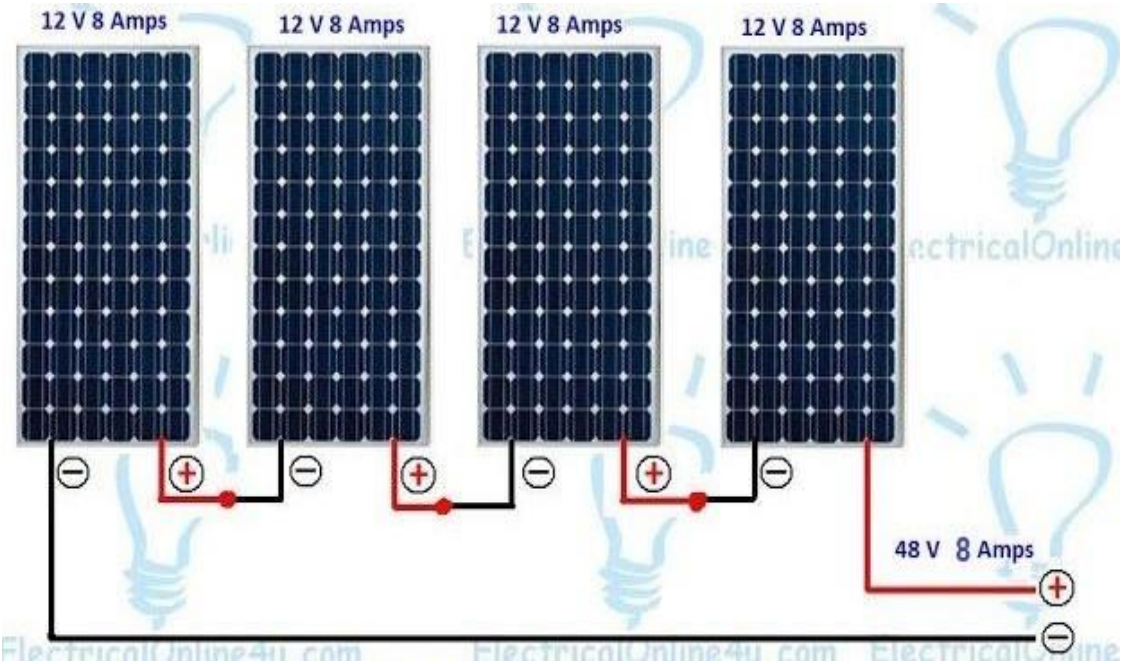

Fig 2.15: Series connection of solar panels.

2.13 Series Parallel Combination Connection of Solar Panels

When a series and parallel connection are connected, it is called a mixed connection. (Although in electronics there is no fixed number of series parallel in mixed circuits). So Abundant series panels are connected in parallel with the same number of panels as there are in a series in a solar system.

So that the solar system will be 34V 3A (100W) if two panels of 17V 3A(50W) are connected in series. Even If two such series of system are connected in parallel, the solar system will be 34V 6A (200W). If 3 such series system connected in parallel, the solar system will be 34V 9A (300W). As can be seen, the voltage increased with the connection in series and the ampere with the connection in parallel. Have to pay. If you need a 24V system, you need to connect 2 solar panels in series. Even If 48V system is requisite, $ solar panels should be connected in series. If a higher voltage system is needed, then the number of more solar panels in the series will have to be increased.

Again, even if more amperes are needed with higher voltage, the same number of series panels will need to be connected in parallel and mixed. In series, parallel and mixed connection, keep in mind that each 17V solar panel will be used as 12V, although it is seen that if 4 solar panels 17V connected, the voltage is 17V * 4=68V, basically for voltage drop it is 12V*4=48V episodic.

- Amperes are constant in series, volts increase, watts increase. In parallel the voltage remain constant, the amperes increase, the watts increase. In mixed connection voltage, amperes, watts are increased. [10]

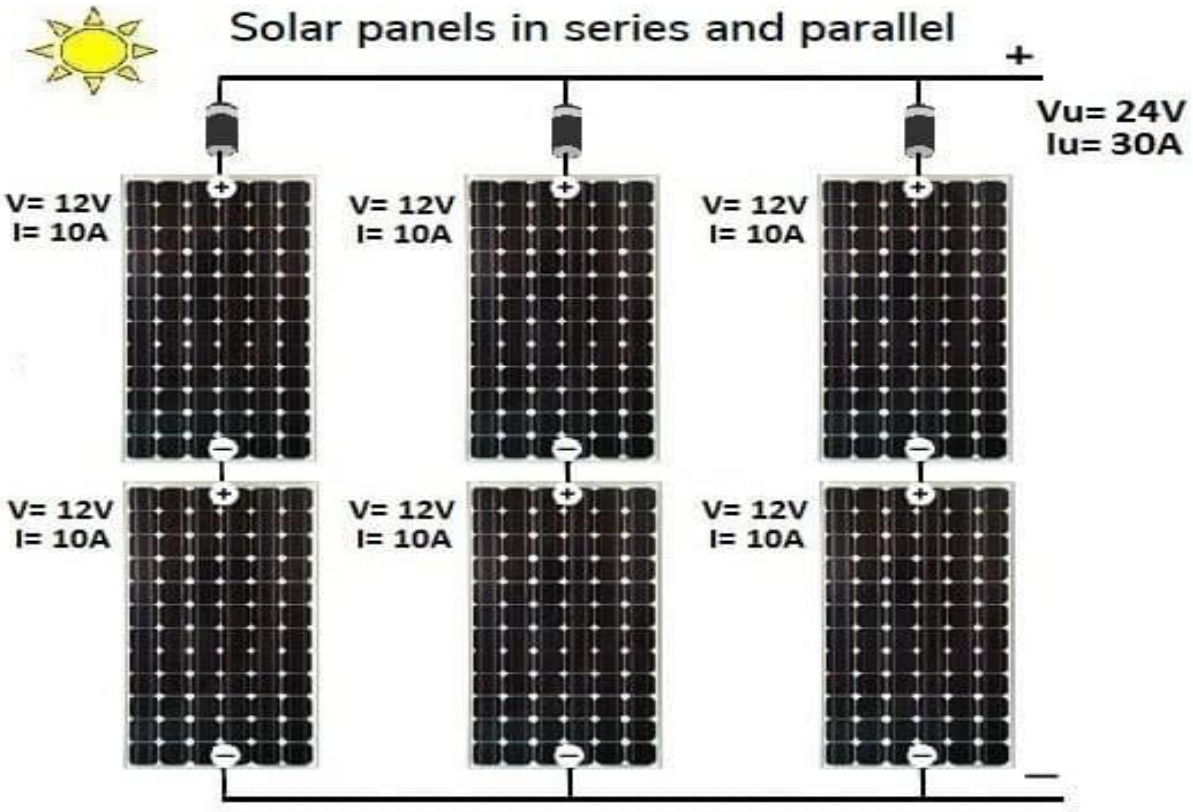

Fig 2.16: Series parallel combination connection.

2.14 Specification of Solar Panel

The specifications of the solar panel are shown in the form of a table below:

Technical Details			
Model			SP20 125*125/4*36
Cell Material			Monocrystalline
Maximum Power		Watts	20 Watts
Cell Grade		A,B,C,D	A
Nominal Voltage		Volts	12 V
Maximum Voltage (Vmp)		Volts	17.6 V
Open Circuit Voltage (Voc)		Volts	21.8 V
Maximum Current (Imp)		Amp	1.14 A
Short Circuit Current (Isc)		Amp	1.25 A
Maximum System Voltage		Volts	600 V
Cell Efficiency		%	17%
	Length	Inch	24 1/2"
Dimensions	Width	Inch	10 3/4"
	Thickness	Inch	1 1/8”
Weight		Lbs	5 Lbs
Cell Size			125*125/4 mm
Cell Quantity			36
Frame Structure (Material)			Extruded Anodized Heavy Duty Aluminum
Encapsulation			EVA
Rear Side			DuPont Tedlar (TPT)
Glass Thickness		Inch	1/8” 3.2mm
Maximum Wind Resistance			65 m/s - 145 MPH
Maximum Hail Diameter Size/ Speed			1+ Inch @ 50 mph
Maximum Load Capacity			200 kg/m^2

Table 2.3: Specification of solar panel.

2.15 Different types of Solar Panel

A Solar panel is essentially an electronic device that converts solar energy into electrical energy. So a solar panel contains many solar cells. Then every cell is connected to each other. Hence, Solar cells work a lot like batteries, but common batteries produce electricity from chemicals and solar cells generate electricity from light. So that, second name for solar panels is photovoltaic panels or (PV). There are three common types of the panel available on the market and they are following below:

- **Monocrystalline Panels**
- **Polycrystalline Panels**
- **Amorphous Thin Film Panels**

2.15.1 Monocrystalline Solar Panels

Solar panels propagate from mono or single cells are called monocrystalline solar panels. So this process was invented in 1975. Hence, its price is comparatively high and its popularity is high. Once the volume of mono panels is less than that of the same watt poly panel. However, it performs well in extreme heat. Show in Fig 2.17 Monocrystalline Solar Panel following below:

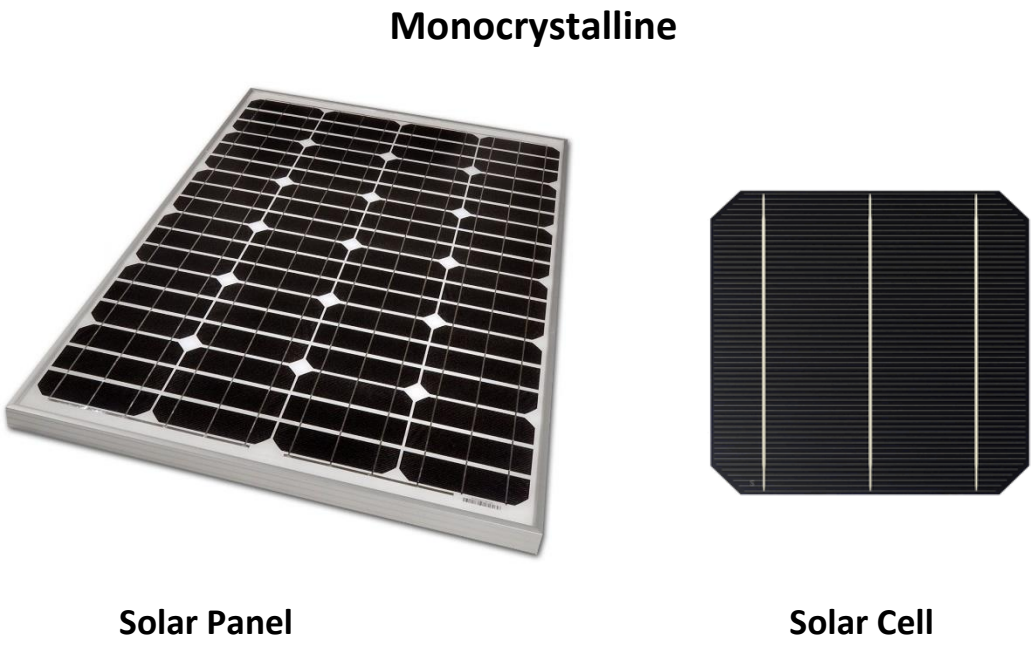

Fig 2.17: Monocrystalline Solar Panel.

2.15.2 Polycrystalline Solar Panels

Polycrystalline solar panels are also composed of silicon. However, Polycrystalline solar panels were invented in 1985. In order to, solar panels are shaped by forming a crystal shape of multiple cells. So that, it is comparatively cheap. Since, it is larger in size and its efficiency is lower than Monocrystalline. Although, polycrystalline solar panels are also mention to as multi-crystalline or many crystal silicon. Because of there are many crystals in every cell, this is to less liberty for the electrons to move. As a result, polycrystalline solar panels have lower efficiency ratings than Monocrystalline panels. Show in Fig 2.18 Polycrystalline solar panels

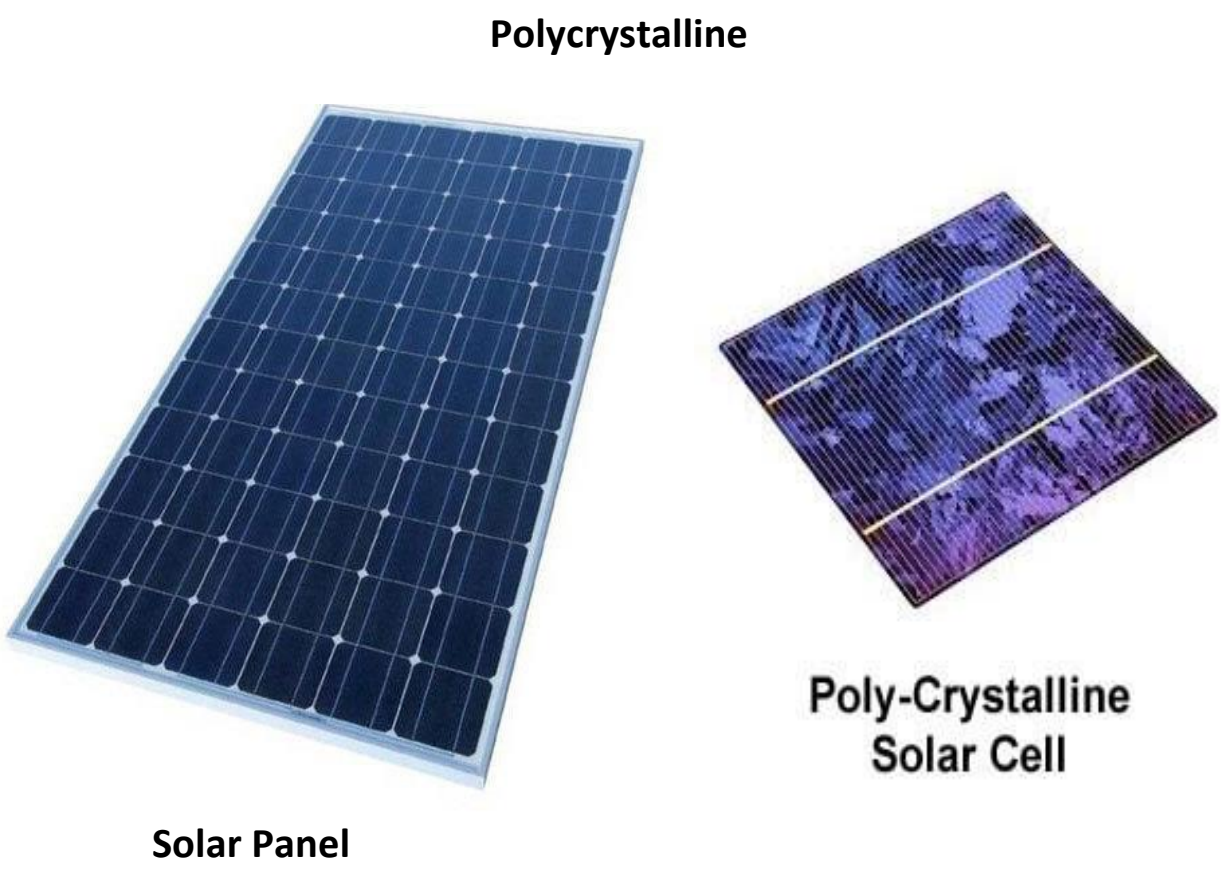

Fig 2.18: Polycrystalline Solar Panels

2.15.3 Amorphous Thin Film Solar Panels

Amorphous Thin Film Solar panels are built with electricity-producing large hundreds of times thinner than those in traditional silicon panels. These lightweight, durable solar modules can be made in several different ways, and with many concentrated materials. So there are four type of Amorphous Thin Film Solar panels: [11]

- Amorphous
- Cadmium Telluride (CdTe)
- Copper Gallium Indium selenide (CIGS)
- Organic Solar Panels

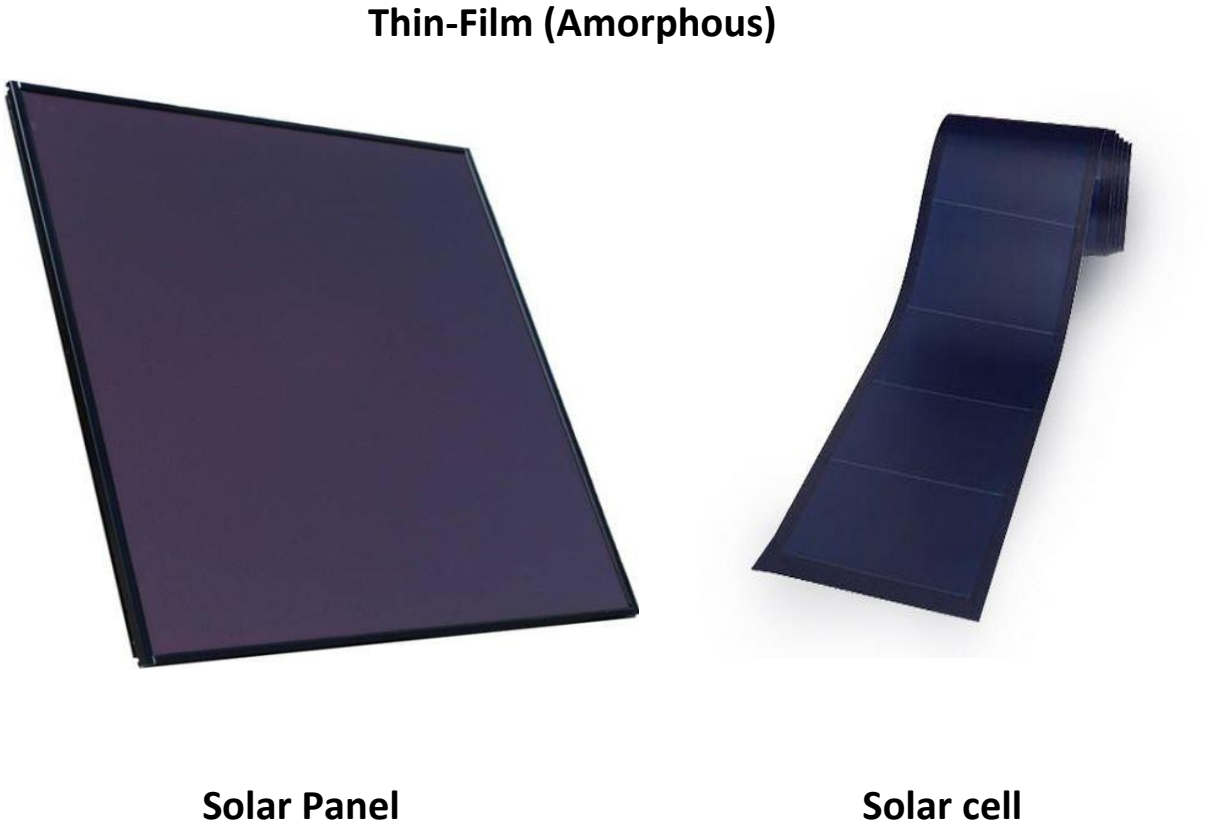

Fig 2.19: Amorphous Thin Film Solar Panel.

2.16 Types of Solar System Design

There Can be various types of solar system design. So there are three basic design consideration, they are following below:

1. Grid Tie

2. Off-Grid

3. Standalone

2.17 ON – Grid Solar Rooftop System

An on-grid solar system is a system that propagates solar panel electricity from being connected to the grid and transmits it to the customer via an inverter. It does not give any back up, but reduces the pressure on the power.

It is capitally used for two reason:

1st Reasons: The customer's electricity bill comes low so customers use it.

2nd Reasons: The government has laid down rules for installing on-grid solar systems on the loads of new power connections to decrease the pressure on electricity. So that the customers use it to connect to new electricity. [12]

Fig 2.20: ON-Grid Solar Rooftop System.

2.17.1 Advantage and Disadvantage of ON-Grid SRS

Advantage	Disadvantage
1. On-Grid Solar systems are very cost effective and easy to install.	These provide less incentive to conserve.
2. It is comparatively easier to install since there is no require a battery system.	These are battery less system, which provide you with no backup.
3. It is a 100% efficiency battery, which has the potential to absorb all the additional energy.	Since you don't have a battery bank, you can't store electricity.
4. Businesses can recoup cost of their investment by offsetting electricity bills in just 3-8 years. If a private, commercial or industrial building sets up a solar PV rooftop system	If during the night, your grid is down, you will not have any electricity.
5. Residential users and business owners can earn a passive income for the surplus energy generated by the system.	Utility companies charge monthly fees that you'll need to pay. [13]

Table 2.4: Advantage and Disadvantage of ON-Grid SRS

2.18 OFF-Grid Solar Rooftop System

An off-gird rooftop solar system is exceeding popular and comes with a power backup. So it works free of the gird. Although most of the home appliances such as Fans, TV, Cooler, AC, Water pump

etc. in order that, off-gird is a system of conserving solar rooftop power through batteries and using it at night or during load shedding. Hence, it is most of the common type of solar rooftop power system with backup. Whenever, it works in day and night both, during the day, solar panel charges the battery and runs the home devices such as the Air Conditioners, Cooler, Television

and the Submersible pump. Therefore, at night, when the sun is not available, Inverter runs your home gears using the battery power. Now show in Fig 2.21 Off-gird solar rooftop system following below: [14]

Fig 2.21: OFF-Grid Solar Rooftop System

2.18.1 Merit and Demerit of OFF-Gird SRS

Merit	Demerit
Freedom - Go with an off-gird system, and you're no longer subject to the terms and policies of the utility company. Getting away from the ongoing rate increase may be reason enough to cut ties.	Higher Initial Cost – If you disconnect fully from the power company, you'll need a source of backup power for when the sun isn't shining. Adding a battery bank or generator bumps up your solar costs.
No Blackouts - When the power is out and everyone else has no electricity, your home will still have full power. This can be particularly important for people with health conditions that require electronic devices or refrigerated medicine.	Limited Solar Energy Storage – Even with backup power, energy storage is limited. Given a few days of cloudy weather, you may run out of stored electricity.
No Electricity Bills - You'll never again have to give the utility company a slice of your monthly paycheck after you go off-gird with solar rooftop power.	Energy Efficiency is a Must – When you live off-gird, you have to be careful about your household energy use or you run the risk of not having enough power for your home.

Table 2.5: Merit and Demerit of OFF-Gird SRS

2.19 Solar Energy Attractive in Bangladesh

Bangladesh is a south Asian country situated in between latitudes 20◦34' and 26◦39' north and longitudes 80◦00' and 90◦41' east. Therefore, it is an ideal location for solar energy utilization. In order that, it is a subtropical country, 70% of the year sunlight is abundant. Also, this makes the use of solar panels very feasible in Bangladesh. However, Diurnal solar radiation is 4-6.5 KWh/m^2 and maximum radiation is usually received in the months of March-April and minimum in December-January. So that, solar energy can be a durable solution for the power crisis in Bangladesh. [15]

Now Exhibition in Fig 2.22 Future Prospect of Solar Energy following below:

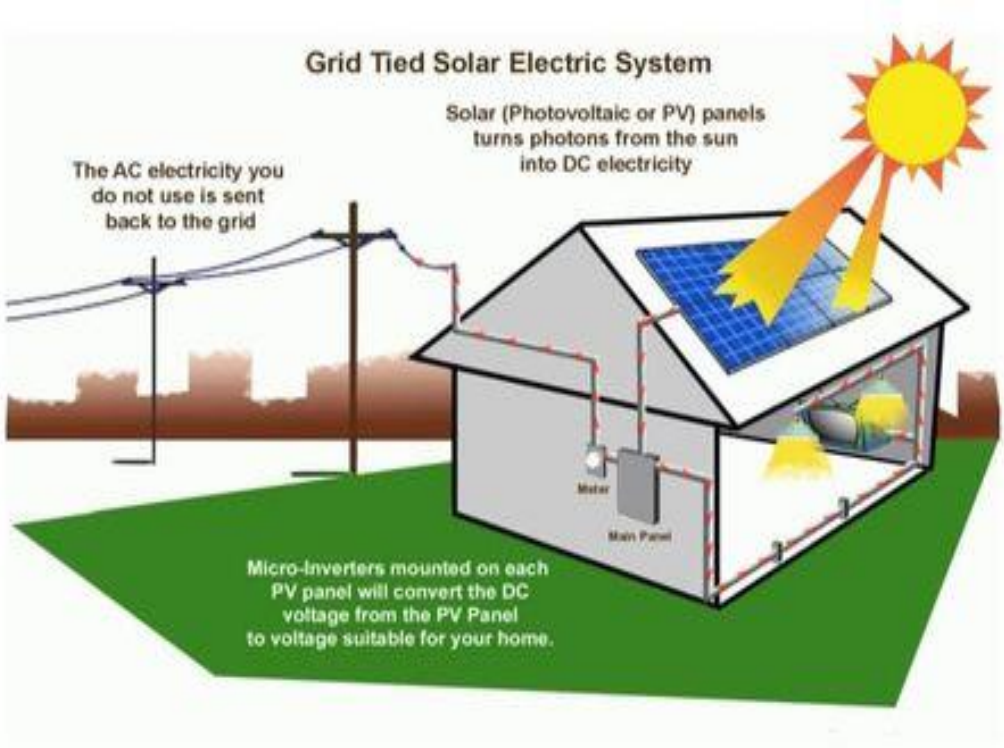

Fig 2.22: Future Prospect of Solar Energy

2.20 Top ten countries using Solar Panel

Over the next few years, the global solar energy leader board is set to change significantly. Therefore, we can find that top 10 countries in the solar electricity generation all over the world in 2020. However, we take a look at what the global top 10 energy rankings are considered to look like in terms of installed capacity. So here are the top 10 solar producing countries: **China, United States, Japan, Germany, India, Italy, Australia, Spain, United Kingdom, South Korea.**

Now show the Fig 2.23: Top 10 countries using solar panel:

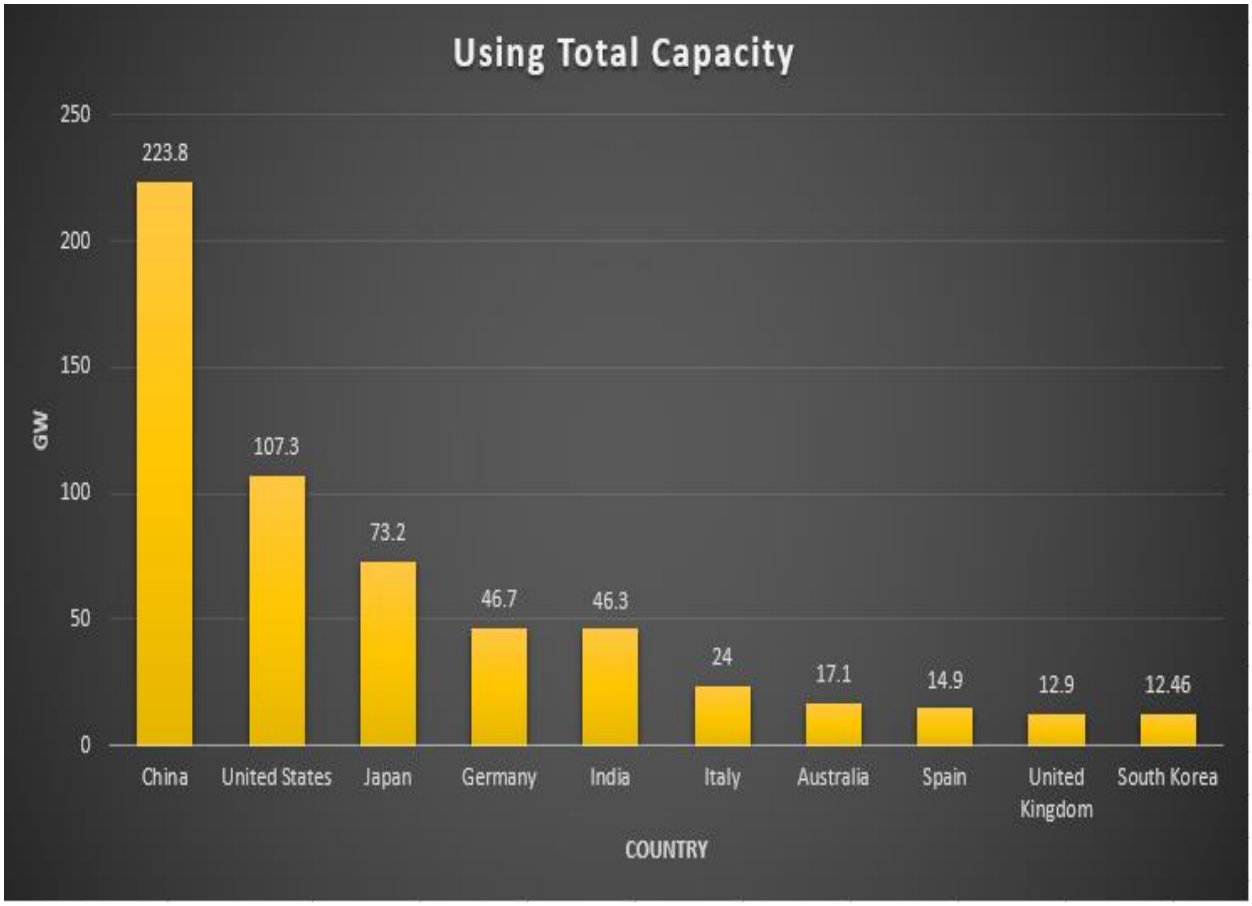

Fig 2.23: – Chart for Top Ten Countries using Solar Panel.

CHAPTER-3

METHODOLOGY

3.1 Introduction

This chapter eventually constitutes the analysis methodology of the survey. So the NOCS Narayanganj (East) DPDC was occasionally visited for this survey. In additional details, during this section, the exploration methodology, the resolution approach, the progenitor outlines the analysis strategy and the techniques of information repository, the analysis method, the moral issues, the choice of the sample, the sort of information and therefore the exploration narrowness of the thesis. Hence, this study is applied to the business and industrial areas of Bangladesh. So that, this observation was desired to research the socio-economic effects of the solar rooftop system and find the answers about what do the users think about its appropriateness. As a result, some of the characteristic and quantitative methodological approaches are applied and the survey initially based on social analysis. However, the survey also pointed out that solar panel failed to apprehend public interest as the distributing agencies (DPDC). Therefore, some of the houses were listed under DPDC and others were not. Necessary data from panel, battery was collected. User feedback was also collected from every possible individual consumer.

3.2 Survey Study

- First of all we go to Narayanganj DPDC office.
- We were visited some Solar system, grid system and some home off - grid system.
- Most of the people don’t want to take solar system but it has taken by the government policy and very big problem initial cost is high.
- Surveys on solar system here, most of the Solar system users know how to maintain the solar system.
- Some people doesn’t know about on-grid and off-grid system.

3.3 Site Selection

We are survey for solar rooftop system (SRS) inwardly (DPDC) site selection of Narayanganj circle. So that, we are two group separated for audit Narayanganj west and east. Then me and my group member visit some home and industry. Hence, we tell about solar user consumer and collect data. In order that, we do some questions solar rooftop system for consumer.

In this part of the design, the location where the system can be founded, the presence of sunlight, these issues are well reviewed. Because of the whole value of the system will recline on sunlight. However, depending on the size of the panel, how much space it will need is decided. Therefore, the performance of the system is always good for the solar PV panel.

3.4 Site Selection Map

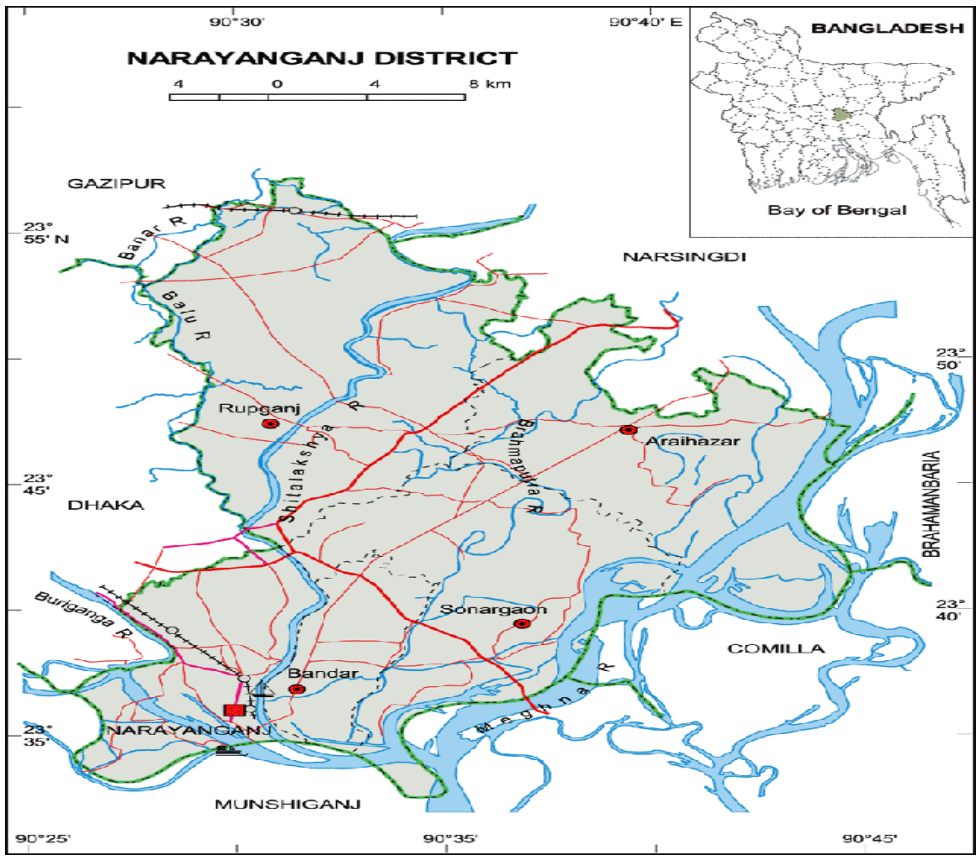

Fig 3.1: Site Selection Narayanganj

3.5 Flow chart of the working Procedure

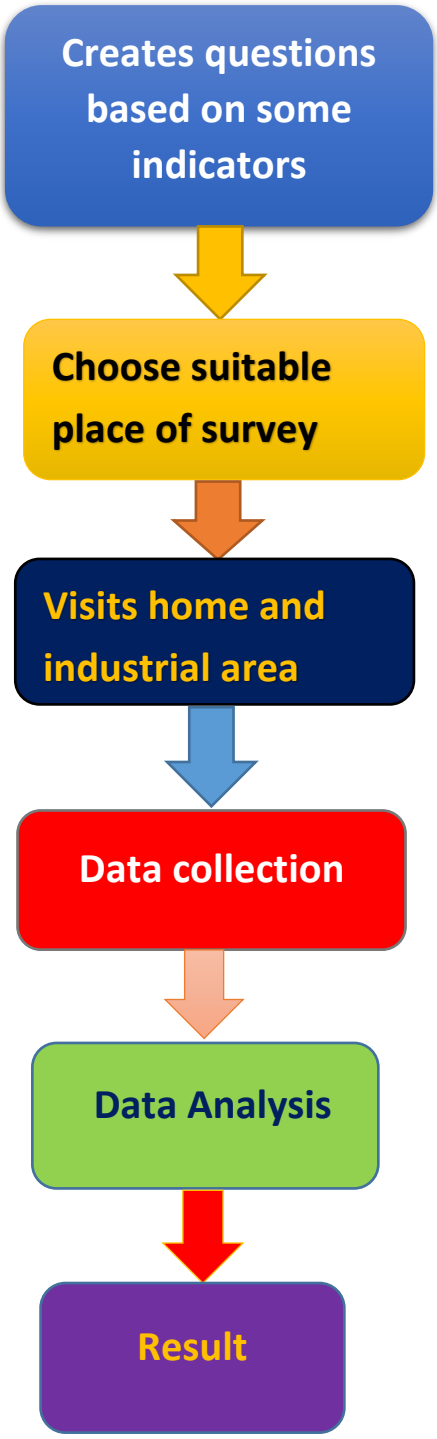

Fig 3.2: Flow chart of the working procedure.

3.6 Survey questionnaires for solar rooftop system

SL NO	Indicator	Question	Description
01	Consumer Information	Owner Name: Mobile No: Address: Capacity: Date of Installation:	Consumer information and correlated data for several systems are collected in this method.
02	Installation Information	1. Why do you install this SRS? 2. What Kind of solar rooftop system SRS are you using? 3. How many days ago you install this SRS? 4. Are you fed your Solar Electricity to the grid?	Installation information as like the reason behind installing the system, durability, and type of the system has been asked in this step.
03	Maintenance	1. Is your SRS in operation? 2. Do you test it regular basis? 3. What is the main reason of system disorder? 4. Do you want to repair it? 5. Do you get any training for SRS operation? 6. Do you clean your SRS?	In this step, we tried to find out the activity of the system whether it is in operation or not. Sequentially, the information about the maintenance of the system and training way was also here.

04	Consumer Satisfaction	1. Do you think this SRS are useful? 2. Do you want to increase capacity of your SRS? 3. Do you think it is a waste of money? 4. Do you satisfied to use SRS? 5. Do you face any kind of survey?	In this step, the main discussion was about to note down their satisfaction with the system. It was intended to find out that how many of them take it as a way of wasting money. Moreover, people who were found pretty satisfied with the system were questioned whether they want to increase the capacity or not.
05	Cost Analysis	1. Is the meter reading of the solar electricity taken? 2. What is the total cost of SRS? 3. Do you have record on solar electricity? 4. How much electricity do you get SRS?	In this section, the electricity generation per unit and its cost are calculated.

Table 3.1: Survey questionnaires.

CHAPTER-4

RESULT AND DISCUSSIONS

4.1 Introduction

This chapter contains the pronouncement of the study where the analysis of the thesis result is prominently narrated. However, it accepts a look over the consumer information about how many consumers use the SRS and the chart is also exhibited in this treatise. In order to, it also provides maintenance result, consumer gratification, cost analysis consequent to the consumer answer and additionally with all the correlative charts.

4.2 List of Total Consumers

We visited Narayanganj to analysis the performance of solar rooftop system (under DPDC). For this occasion, we condiment the survey at the west zone of Narayanganj. Here we found 5 consumers at basic industrial area, 7 consumers at mandolpara area, 6 consumers at panchabati area and we found 4 consumers at fatulla area. So that, we almost collected all of the data. Therefore, after completing the west zone we conduct the survey at East Zone. So here are we found 10 consumers at chasara area, 3 consumers at anayetnagar area, 12 consumers at fatulla area, 7 consumers at amlapara area and we almost collect all of the data.

It is mentioned earlier; the survey area and the list of the consumers were provided by DPDC.

The following chart has been made from approximately 54 consumer information.

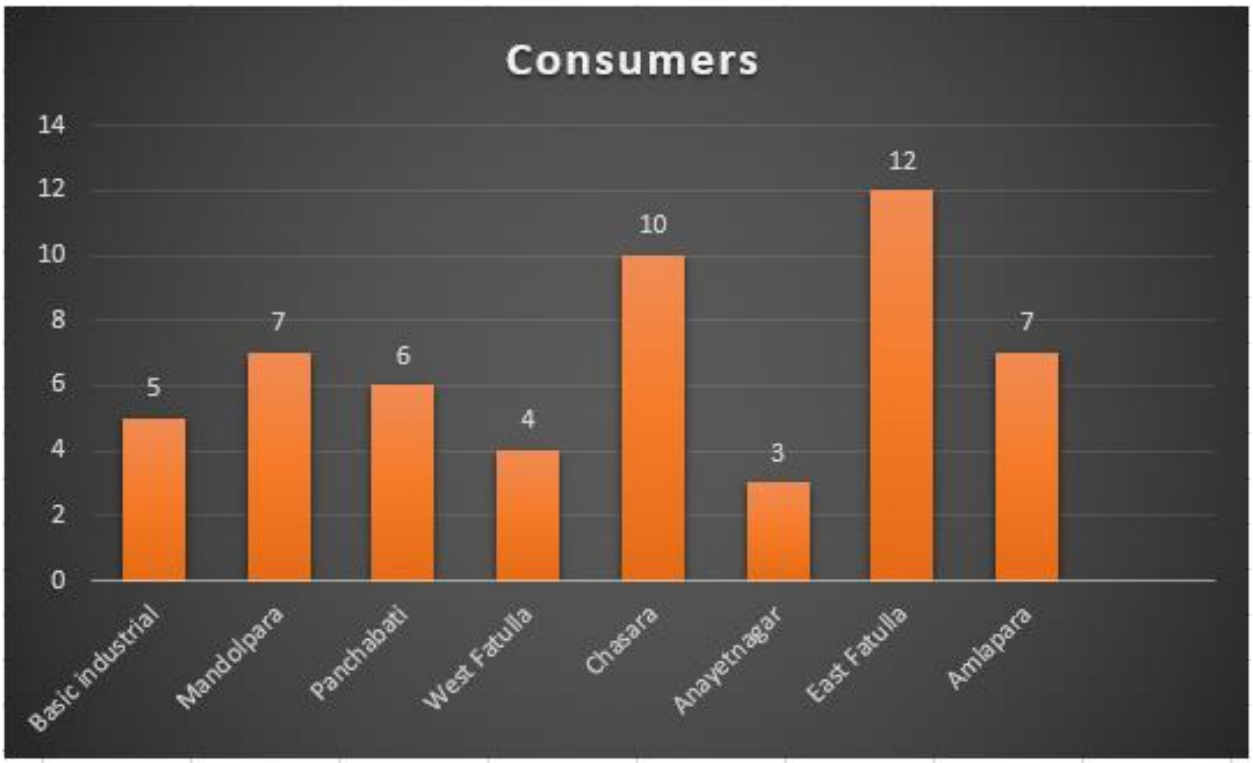

Fig 4.1: Chart of Total Consumers

4.3 Information of Installation

Most of the consumer acquainted that the SRS was indeed installed by policy responsibility of electricity connection. Provided that, they said if they want to connect power line in their own home at first they need to install solar otherwise the policy doesn't give permission to make a connection with electricity. Therefore, some of the people said that bought this system on their own choice from the market and some people installed it from policy obligation.

4.3.1 Source of Installation

This survey report found that there is 40 consumer installed solar system from the policy obligation and only 14 consumer installed it by their own choice overall 54 consumers.

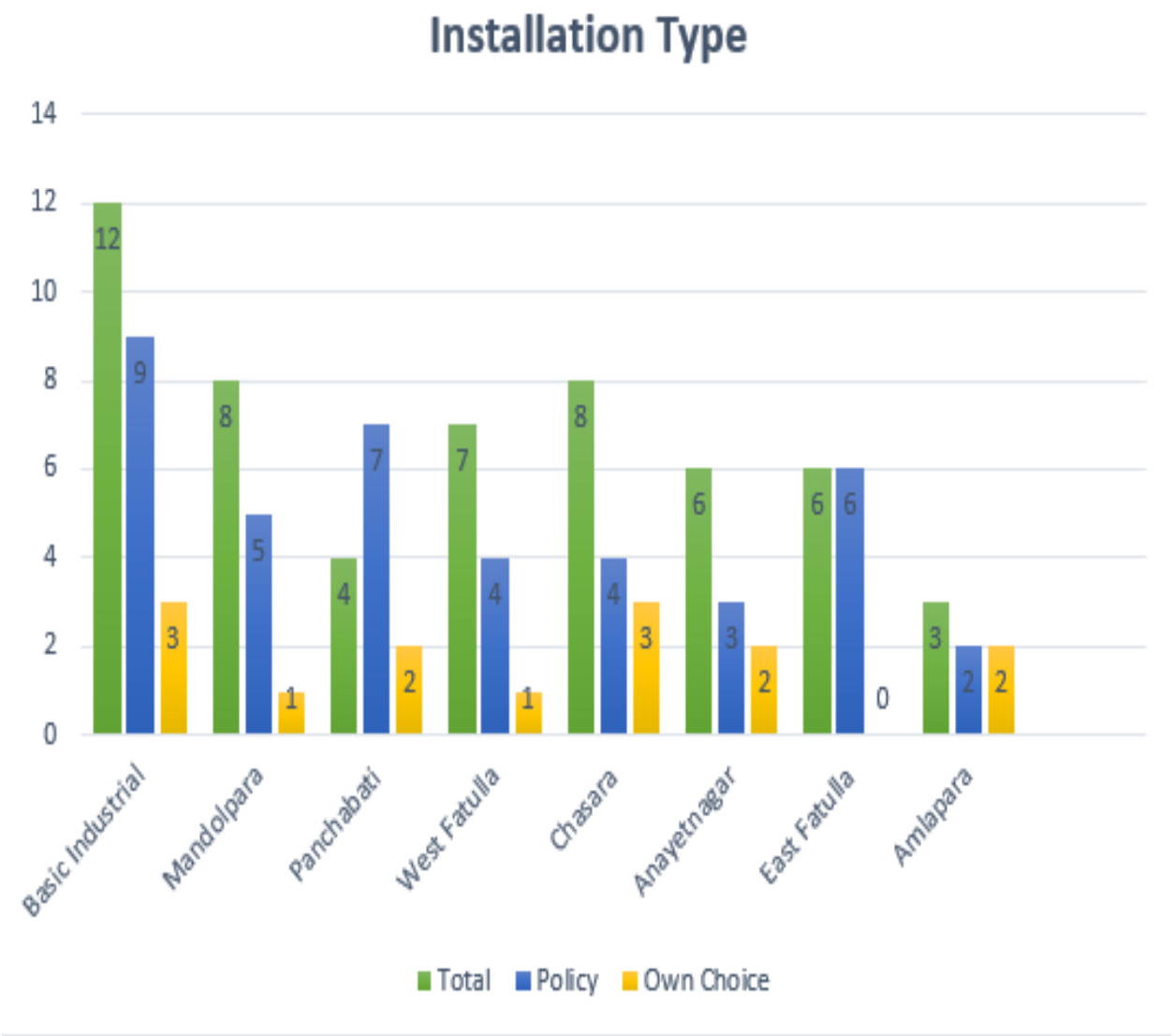

Fig 4.2: Type of Install Chart.

4.3.2 Buying System

This Survey report found that only 25% of the Solar system is bought from the market, 75% has been taken from the solar system agency because they are not aware of the solar system.

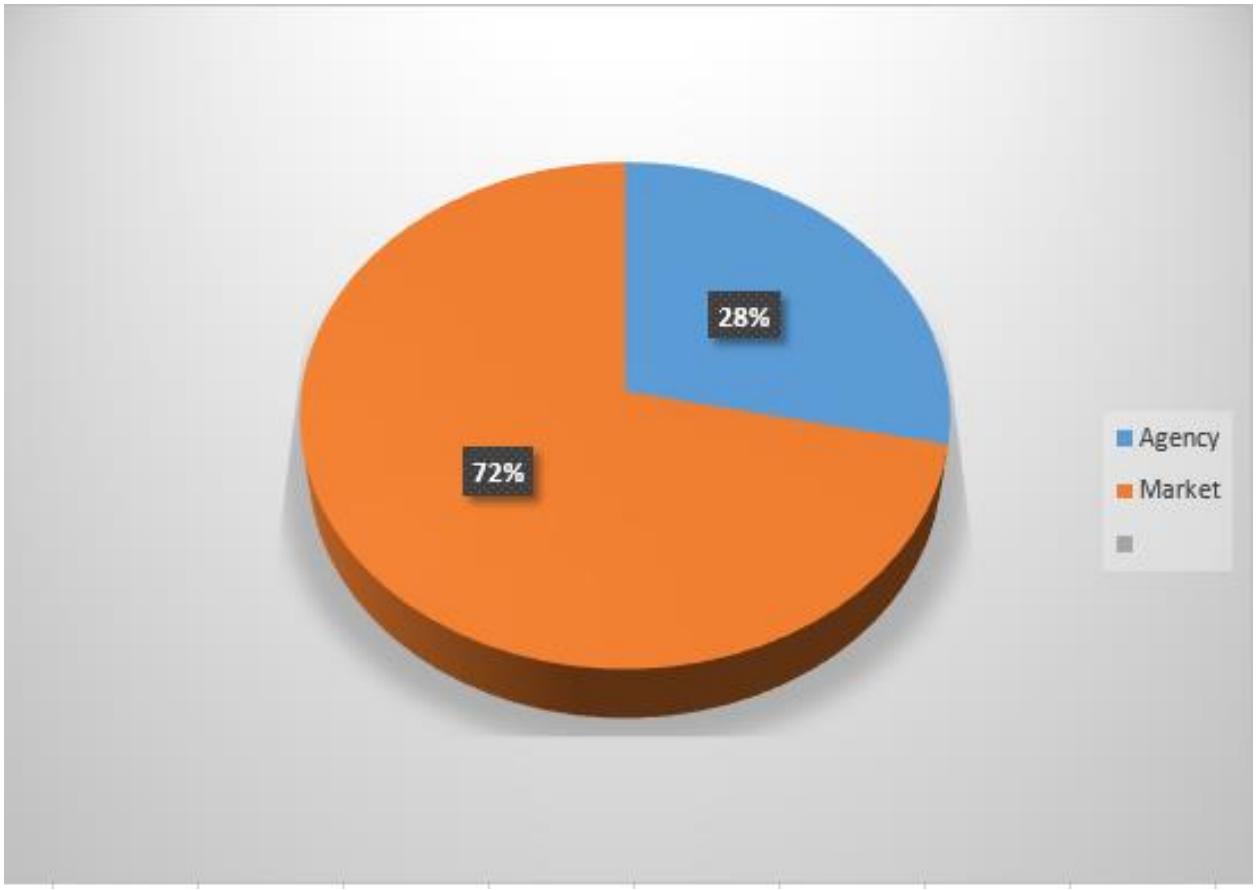

Fig 4.3: Buying System Chart.

4.3.3 Installation year

The maximum Installation of SRS was in 2017 and the minimum installation of SRS was in 2020.

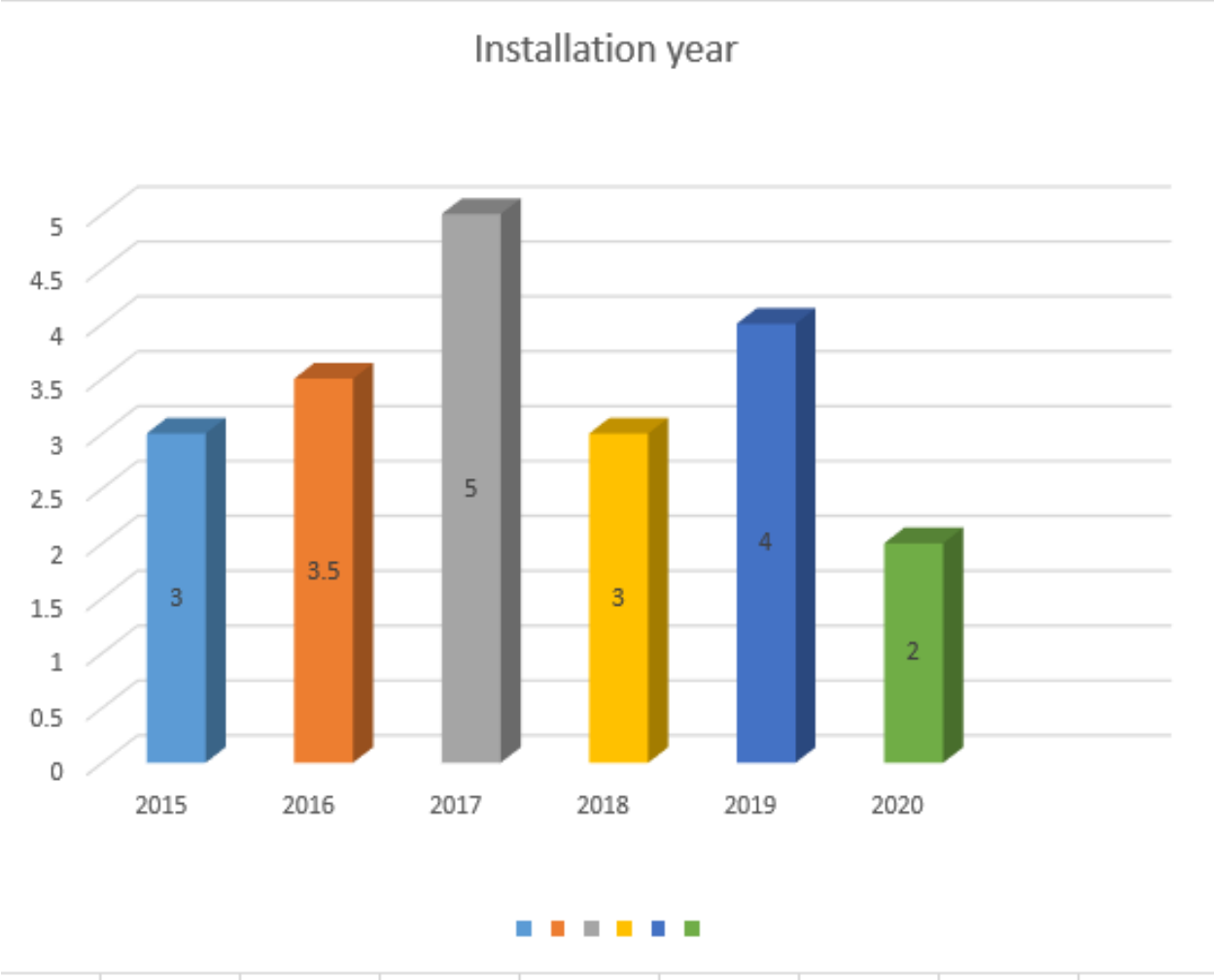

Fig 4.4: Installation Chart.

4.3.4 Grid types of Solar

In our Survey time we found that 15 consumers are used this system for their own use and 7 consumers use it for own home and export the power in the grid.

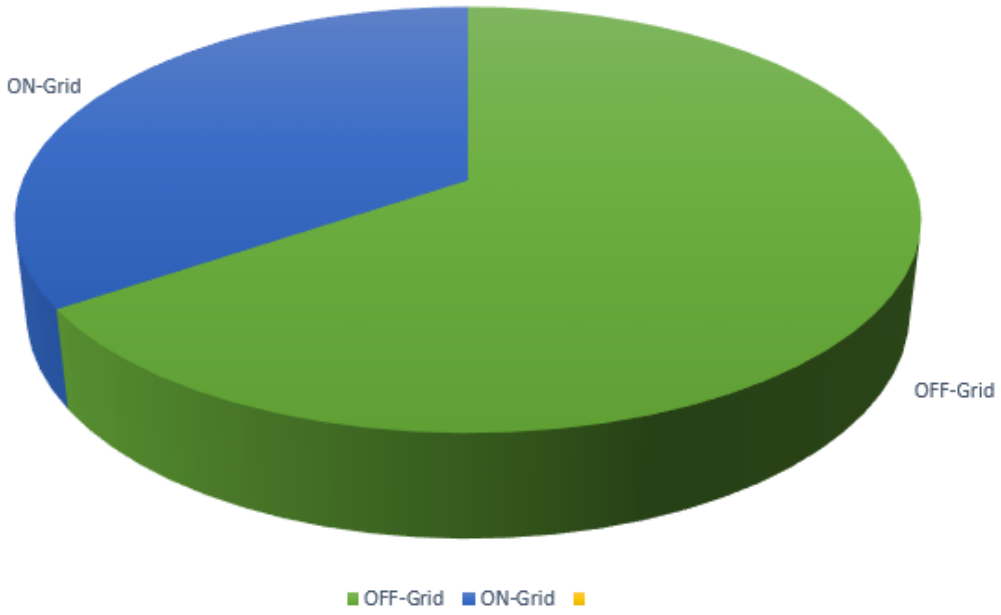

Fig 4.5: Kind of Solar Rooftop System

4.4 Operation of SRS

First of all we can observe that, in House, there are total 20 consumers in which 16 are active and 4 are deactivated. Therefore, most of the SRS are in operating condition. Now we can observe that, in Industry, there are total 8 consumers in which 5 are on and 3 are damaged. Therefore, most SRS are in operating condition. We can observe that, in Academic, there are total 5 consumers in which 3 are on and 2 are off. Therefore, most SRS are in operating condition. Now we can observe that, in Hospital, there are total 7 consumers in which 6 are active and 1 are deactivated. Therefore, most of the SRS are in operating condition. However, again we can

observe that, in Market, there are total 4 consumers in which 3 are on and 2 are damaged. Therefore, most SRS are in operating condition. From this analysis we can say that, in Industry and Market 30% SRS are damaged. Now show in Fig 4.6 following below:

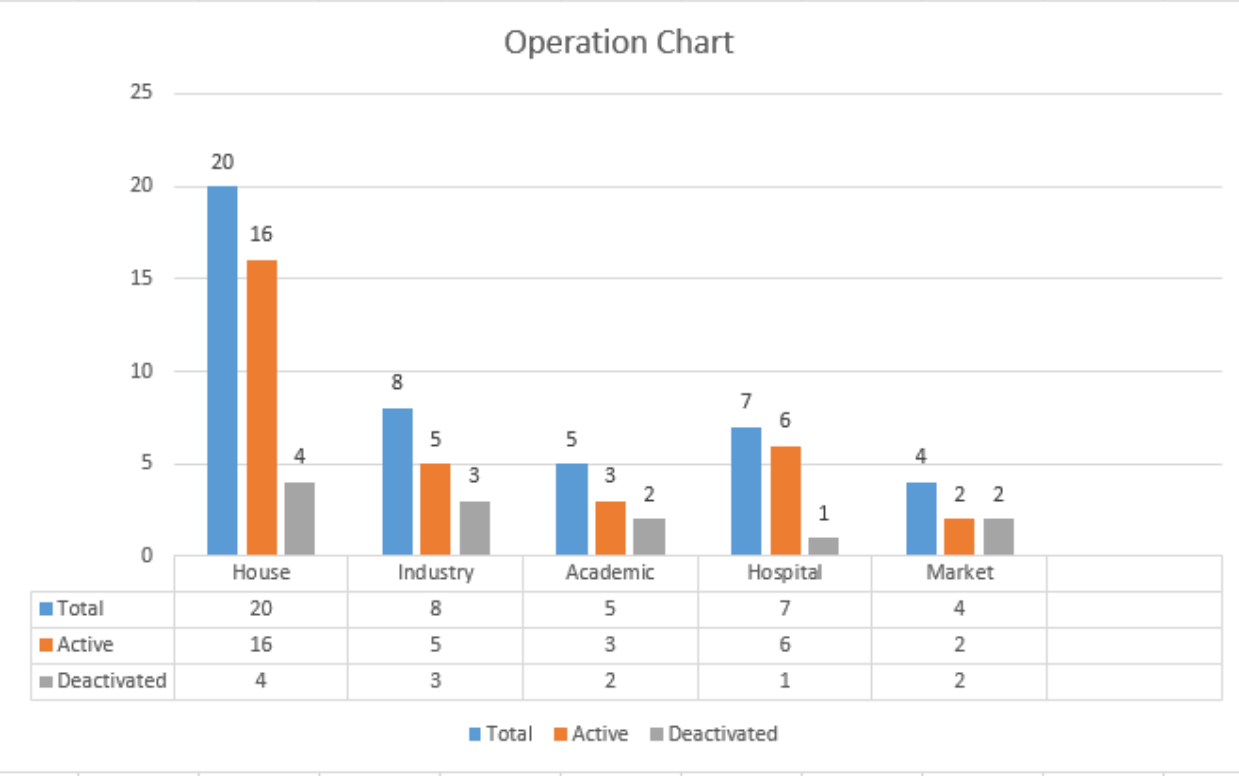

Fig 4.6: Operation Chart of SRS.

4.5 Maintenance Information of SRS

The chart shows the proper maintenance condition of all the SRS. From this chart, it is seen that among 25 consumers, only 5 consumers have got the record of the electricity from SRS, and 20 consumers have been testing the system on a regular basis, only 7 consumers have got the record of the electricity from SRS, and 18 consumers haven't got the record right, only 3 consumers clean the panel where 22 consumers do not either feel the necessity to clean the panel at all. In additional only 6 consumers are interested to repair and 19 consumers are no interested to repair. Now show in Fig 4.7 following below:

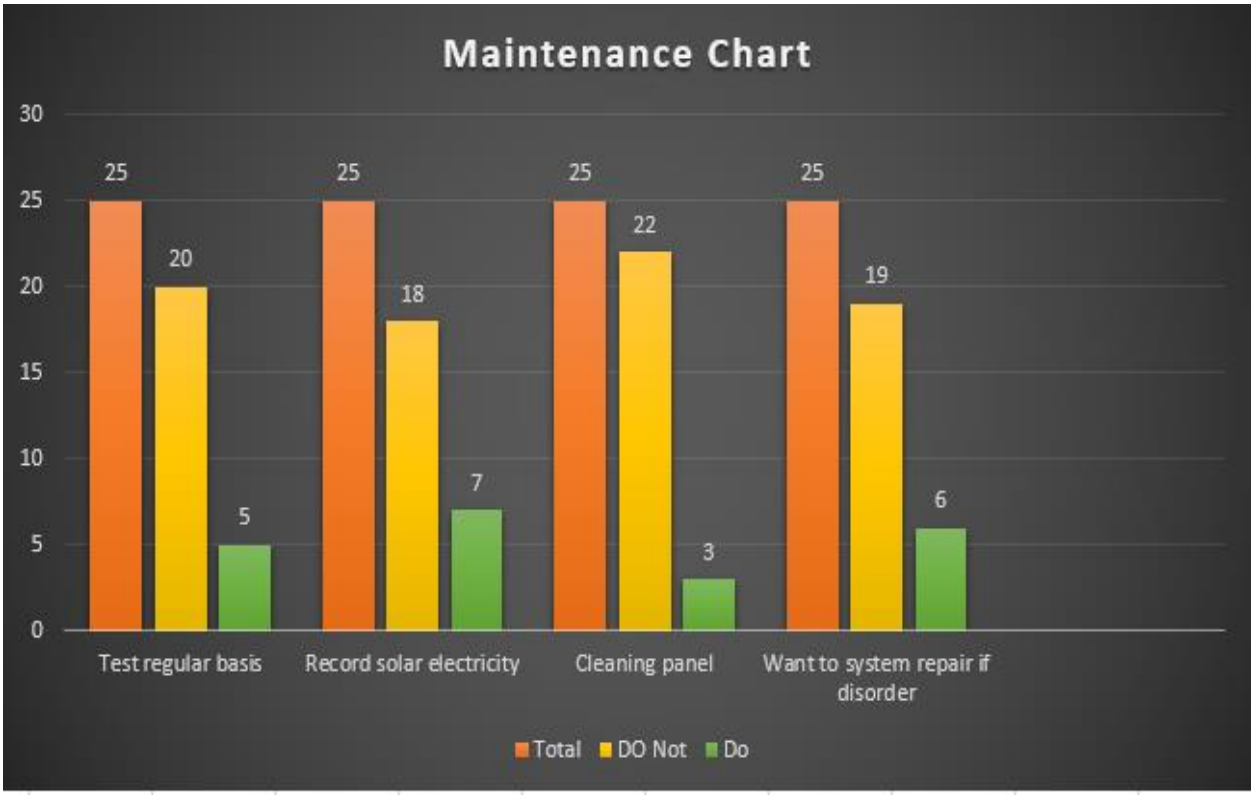

Fig 4.7: Maintenance Chart of SRS.

4.6 Repair of SRS

There are two types in repair of Solar Rooftop System.

i) Choice of Repair
ii) Face any kind of survey

1.Choice of Repair:

We asked the consumers about the repair of SRS. Solar Rooftop System uses consumer want to know about repair it. Therefore, they want to repair their solar rooftop system. However, the consumer in which 85% are not repair and 15% are repair of solar rooftop system. Therefore, most of the consumer is no repair of SRS system. Now show the Fig 4.8.1:

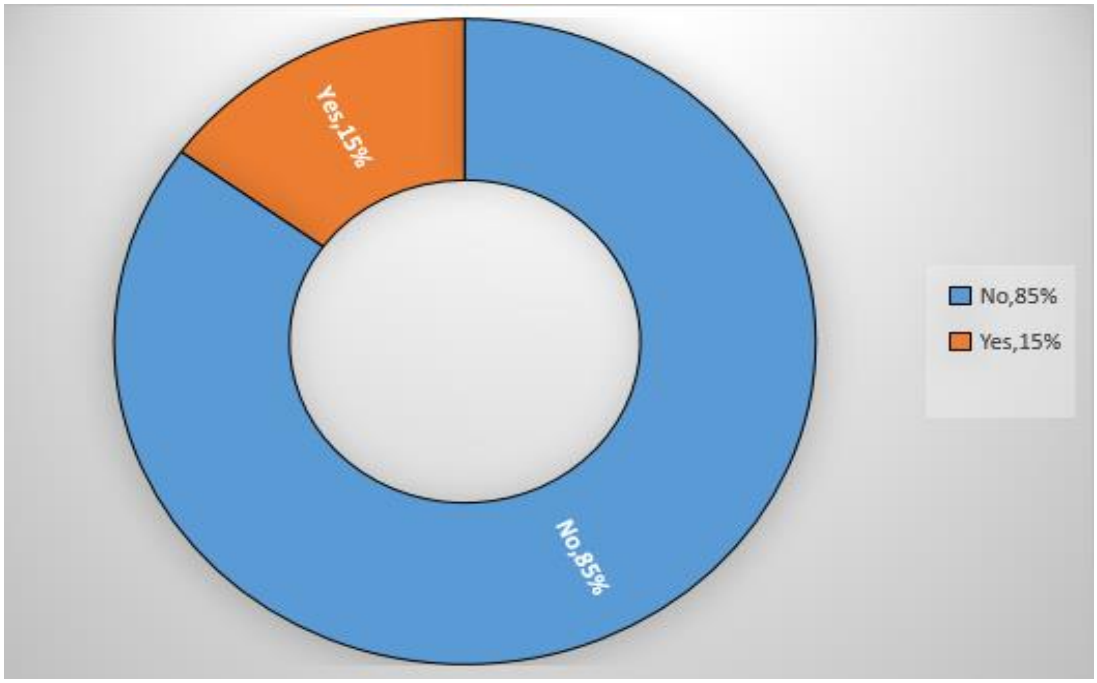

Fig 4.8.1: Choice of Repair.

2. Face any Kind of survey:

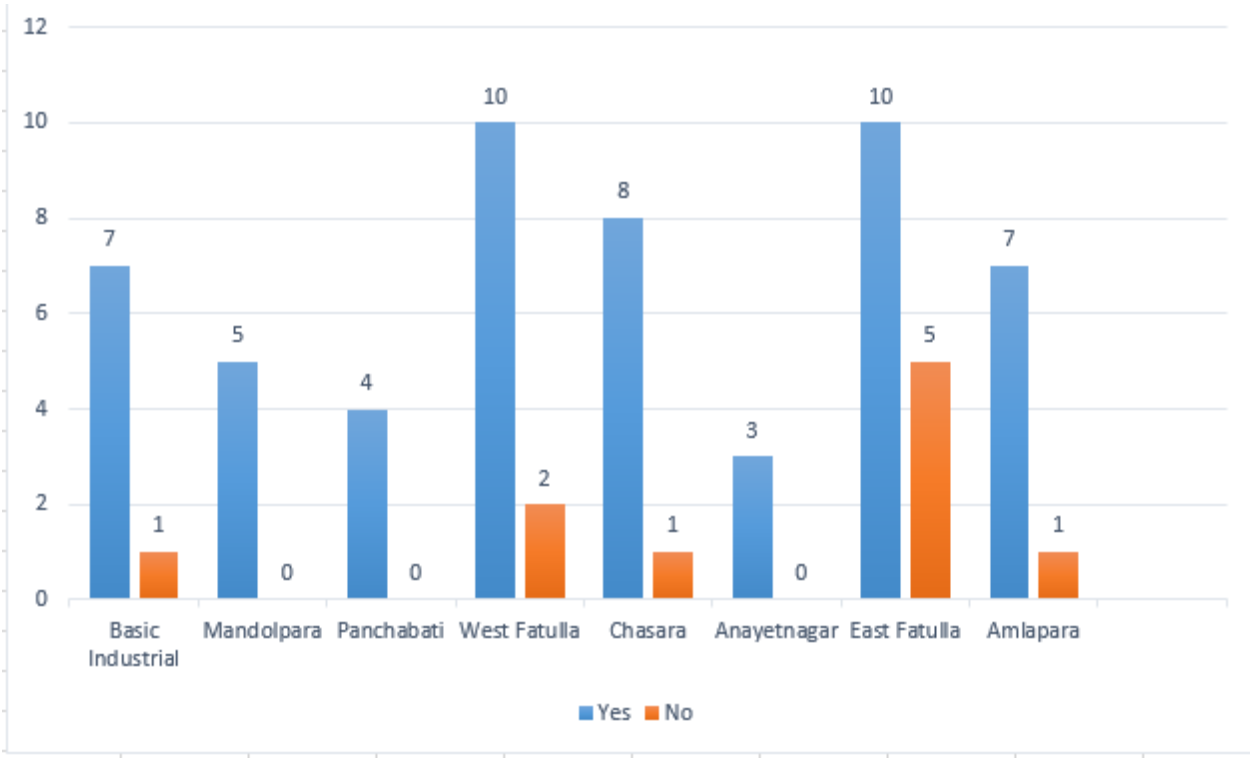

Fig 4.8.2: Face any Kind of survey Chart.

In this graph represents eight areas. In the area of Basis industrial there are total $ consumers in which 4 are no any survey. Therefor most of the consumers are no survey. Now in the area of Mandolpara there are total 5 consumers in which 5 are no any survey. Therefor most of the consumers are no survey. Again in the area of Panchabati there are total 6 consumers in which 6 area any survey. Therefor most of the consumers are survey. In the area of West Fatulla there are total 5 consumers in which 5 area any survey. Therefore, most of the consumers arena survey. In the area of Chasara there are total 9 consumers in which 9 arena any survey. Therefor most of the consumers are no survey.

4.7 Consumer of Satisfaction

Some of consumer are satisfied and some of them are not. Almost 50% of the consumers do think that this SRS is just a waste of money. Some consumers said that the SRS is not appropriate according to their point of view. Most of the consumers are not influenced to increase the SRS capacity. Maximum consumers do not have any knowledge about the net metering system as well. When they were introduced to the net metering system by this survey, they were found to be quite interested. He following chart is made from the consumer satisfaction on the basis of the interviewed consumer and their answers.

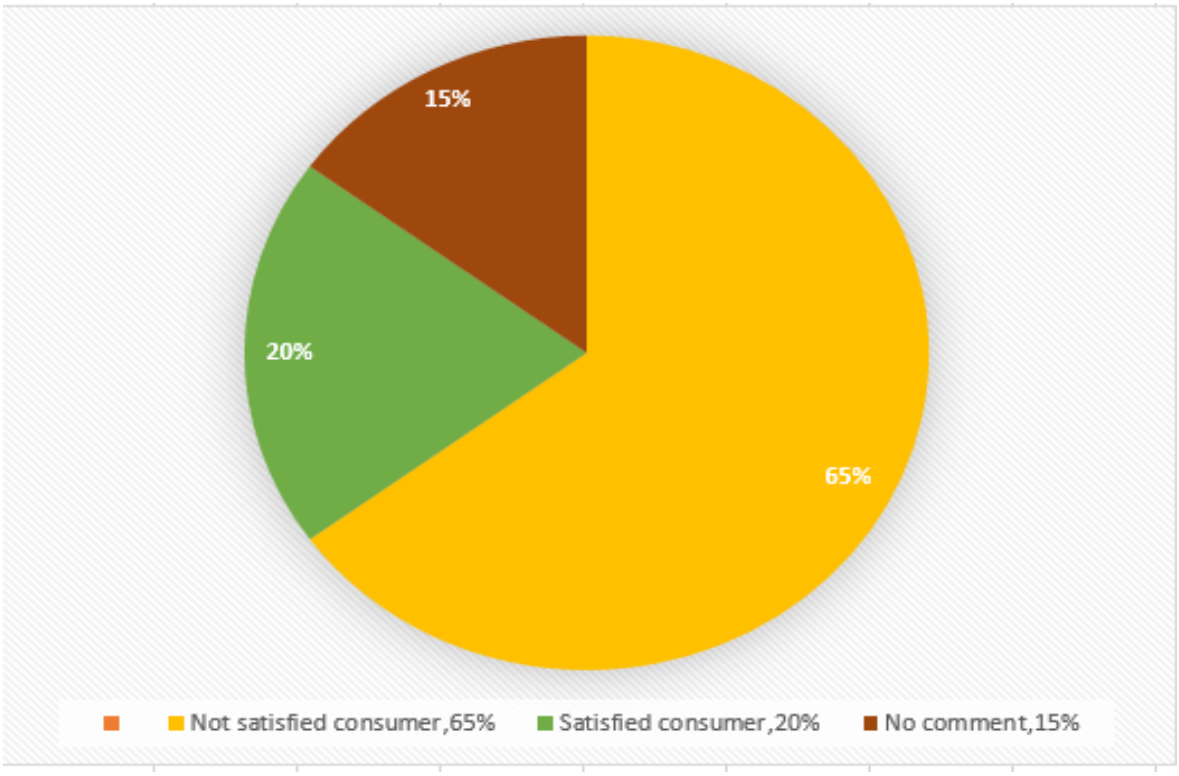

Fig 4.9: Consumer Satisfaction Chart.

In this chart, the comparison result is made from the information given by 20 consumers where the result says that only 6 consumers are satisfied with the system and 13 consumers are not satisfied, 3 of them did not even comment on this question. So the higher percentage of the consumers find inappropriate due to lack of knowledge of the net metering system and proper training of different uses.

4.7.1 Opinion of Consumer

In the following chart The comparison gives the result of how many consumers accept the system as a waste of money and how many of them find it appropriate. To find out the result, 25 consumers are judged totally where the result shows that 15 consumers think that the installed system has just been a waste of their money, 8 consumers find the system appropriate, and rest of the consumers did not either make any comments on this question.

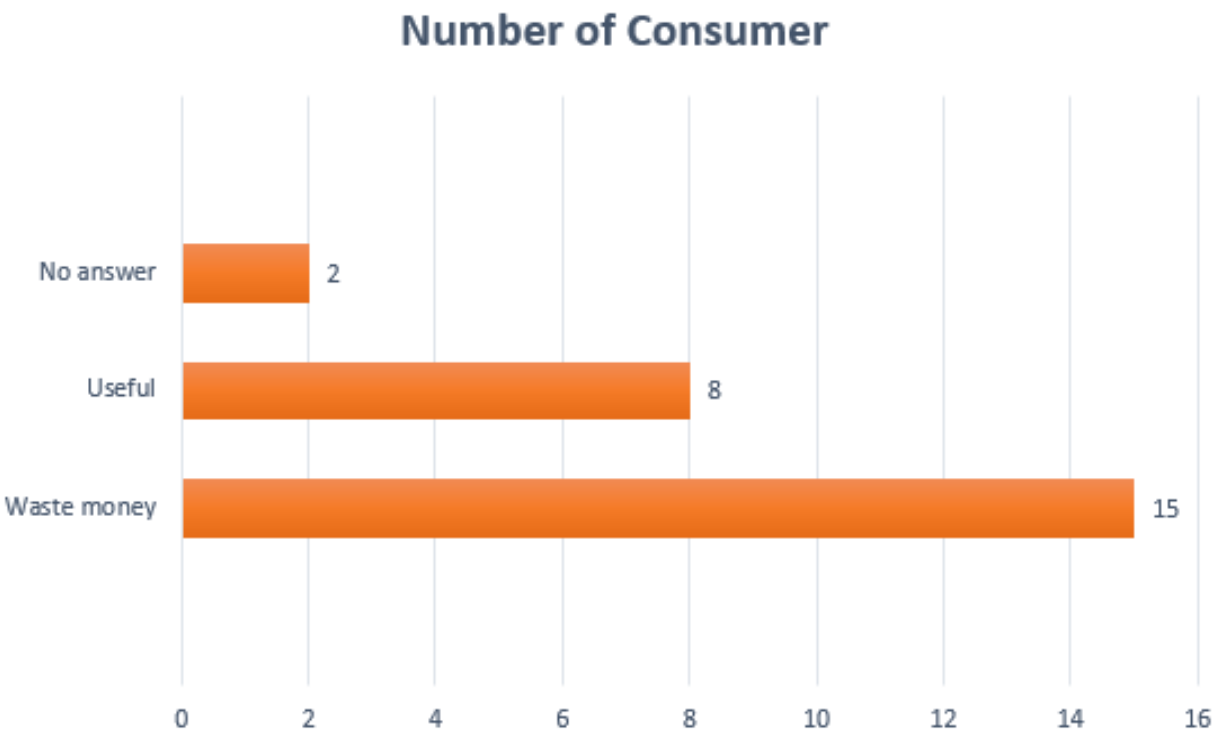

Fig 4.10.1: Opinion of Consumer.

From the judgement of 25 consumer opinions, it can be clarified that the less percentage of the consumers find it useful which is only by 35%. On the contrary, 65% of the consumers take it as just a waste of money. In fine, most of the consumers think that the system does not provide any noticeable benefits to them. In addition, many of them have totally lost their interest to run the system anymore.

4.7.2 Capacity Increase

The following chart is as usually made from the same number of consumers. The collected data from the consumers is identified below.

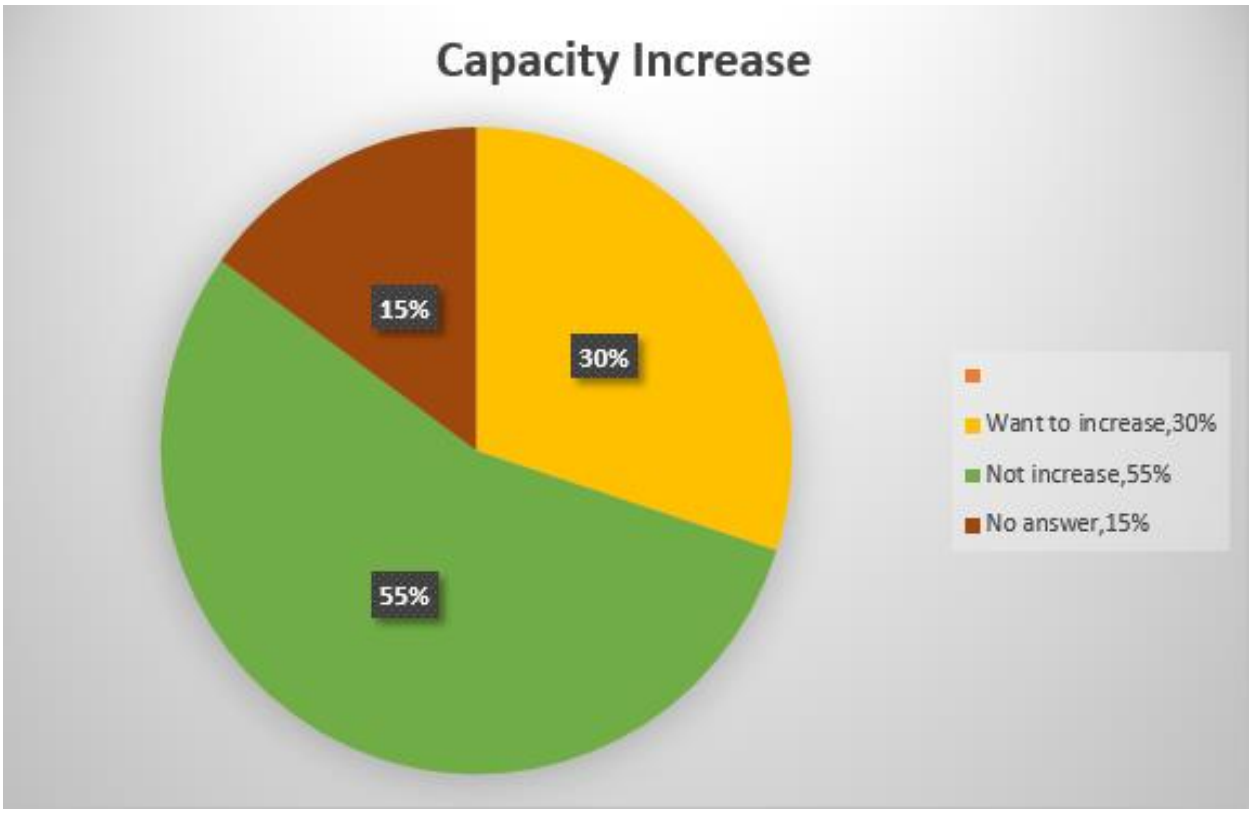

Fig 4.10.2: Capacity Increase Chart.

From the survey, it is found that 8 consumers are interested and want to increase the capacity of the SRS. 15 consumers are no way interested and do not want to waste their money to increase the capacity of the system, and no answers are found from the rest of the consumers. So, it can be clarified from the Pi-chart that 55% of the consumers do not want to increase its capacity as they are not being benefited from the system. Only 30% of the consumers are found to be influenced to increase the capacity of the system.

4.8 Cost Analysis

Anwar Fashion Lit (5 No North Hajiganj, Fatullah, Narayanganj) brought a SRS by 2,32,320 TK in January 2020. Installation capacity is 3.2 KWh. The system was installed 6 months ago. Present reading of the system is 2135.04 KWh. Life time of SRS is 25 years. What is the unit cost of this SRS per KWh?

Solution:

Date of Installation = 2020

Total cost of SRS = 2,32,320 TK

Present Reading = 2135.04 KWh

Installed capacity = 3.2 KWh

In 6 months, the SRS produces = 2135.04 KWh

In 1 months, the SRS produces = 355.84 KWh

In 1 years, the SRS produces = 4270.08 KWh

In 15 years, the SRS produces = 4270.08 × 15

= 64051.2 KWh

In 20 years, the SRS produces = 4270.08 × 20

= 85401.6 KWh

In 25 years, the SRS produces = 4270.08 × 25

= 106752 KWh

$$\textit{So, the cost of SRS Per KWh} = \frac{232320}{106752} = \textit{2.18 TK/KWh}$$

(Ans).

We collected data from Anwar Fashion Lit. Therefore, They are brought a SRS by 232320 Taka. So that, Here is a Installation capacity is 3.2 KWh. After that, we find out the per unit cost for SRS. So that, we use life time of SRS is 25 years. First of all we find 15 years cost of SRS is 3.62 Taka\KWh. Then 20 years cost of SRS is 2.72 Taka\KWh. Finally, Life Time of SRS 25 years cost per unit of energy is 2.18 Taka\KWh.

The table below shows the Total Cost, Installation Capacity, Electric Demand of the Solar Rooftop System of the Companies we visited and the list of 25 years per unit cost.

A table is given below regarding all the cost-calculation.

SL NO:	Name of Consumer	Total cost of SRS	Installation Capacity	Electricity Produce from Installation	Life Time	Per Watt Cost
01	Anwar Fashion Lit. 5 No North Hajiganj, Fatullah Narayanganj	2,32,329 TK	3.2 KWh	6 months- 2135.04 KWh	25 years	2.18 TK/KWh
02	K.Khan Classic Tower 55/58 S.M. Malleh Road, Narayanganj	1,81,250 TK	2.5 KWh	15 months- 3127.5 KWh	25 years	2.90 TK/KWh
03	Rajiya Tower 32/41 Esha Kha Road Shitalakshyam, Narayanganj	3,38,400 TK	4.8 KWh	1 year 6364.8 KWh	25 years	2.13 TK/KWh
04	Pace View 39 Khapur, Fatullah, Narayanganj	1,63,206 TK	2.5 KWh	14 months- 3904.6 KWh	25 years	1.96 TK/KWh
05	Prime Jeans Culture 32 Esha Kha Road, Naraynaganj	2,17,500 TK	3 KWh	1 year 4042.8 KWh	25 years	2.15 TK/KWh
06	Zaman Tower 155 B.B Road, Narayanganj	1,06,200 TK	1.5 KWh	7 months- 1180.2 KWh	25 years	2.10 TK/KWh
07	City Poddo Plaza 155 A.M Malleh Road,Narayanganj	Data not Collected	Data not Collected	Data not Collected	25 years	Data not Collected

08	Topon Shah 5 No Adorsho, Chashara, Narayanganj	70,200 TK	1 KWh	1 year 1344 KWh	25 years	2.09 TK/KWh
09	Jhanara Garden 40/1 New Khanpur Bank Colony, Narayanganj	1,97,400 TK	2.8 KWh	8 months- 2490.88 KWh	25 years	2.12 TK/KWh
10	Mersas Amzad Dying Kutubail Fatullah, Narayanganj	75,000 TK	1 KWh	6 months- 673.2 KWh	25 years	2.23 TK/KWh

Table 4.1: Consumer Information and Correlated Data

4.9 Result Analysis

This thesis reports that most of the people do not check how much the solar rooftop system works or not, then the SRS doesn't coherent it orderly. Therefore, SRS are used to get the whole building solar rooftop system for Government policy. Hence, most of the people buy the SRS and do not buy it from the market and the agency is at a higher price. In order that, most of the people using SRS system do not keep meter readings because of the use of electricity. Although, SRS system users, it is a good solar system but nobody wants to increment the SRS because of the primary cost is much more. So that, the SRS is very small and grid connected to most of the off-grids.

4.10 Thesis Findings

We have to find a new issue while we are on the field survey on consumer door to door.

Some are technical some are theoretical.

4.10.1 Lack of Knowledge

We have to find a new exposure while we are on the field survey on consumer door to door that most of the case most of the consumer don't have any increment to clean the rooftop solar panel on adjustable basis. Because of when we ask them why you don't have any interested to make your expensive solar panel neat and clean. After that, most of the consumers replies the same answer that first time they hear that SRS panel need to ordinary maintenance. Here are other problem is that at present Bangladesh is importing almost all types of solar panel. However, due to policy responsibility consumers don't want consumption more money to buy attribute product instead to buy a low exorcism solar panel at low price.

4.10.2 Technical Issues

When few days soon after they are genuinely looking at a number of tech agreements. So that, in this extraordinary operation they are really giving up one's own concernment in improving solar. Therefore, on top of that tips in judgment to expenditure of solar not even early and late obtainable in the market. However, Bangladesh kingdom should really have critical process to help you challenge the market place consumers in collation to distant many people.

4.10.3 Government Initiative

Most of the event when we ask the consumer did they get any economic or technical support like how to manage the SRS in accurate way. In order to, then another part is maintenance which is very import part in SRS. Even if consumer don't get any short-training support from occupational they will have face many difficulties. Since, they said they don't get any support from government influence (in that case authority is DPDC). Therefore, we know that growth monetary support is not possible from government domination(DPDC) for all consumer but if they wish they can freely dispose one or two days long Workshop about "How to handle and protection of Solar Rooftop System" at their local office or society.

4.11 Summary

This chapter is shaped by the result of the survey. However, it is structured by the consumer answer which is shown in the chart. So this chapter is most of the important one in this book.

CHAPTER-5

CONCLUSIONS

5.1 Conclusions

Bangladesh is obviously the morally all deeply populated not to mention poorest cities across the world. So that, insufficiency of the ways to entrance leading energy source assistance are possibly the low income not to indication affordable personal economic expansion. Since, there is an indispensable shortage of the right system not to allusion market recreation towards popularize typically the panel structure through the Bangladesh. Therefore, solar energy is expressly a free environment-friendly approach of obtaining ability and should take up a big character through limiting active creak. However, the government makes typically the sun power panels permitted socially effectively numerous attempt which could deal with the issues spoken about through this learn. Although, considering that market place for panel is entirely not greatly competitive, further industry groups should for sure check out advertisement options available in the market. In order that, managers need to learn this unique uncontested economy spot rigorously not to mention create strategies to penetrate safely and practically. Even if unitedly treat not to mention short out the problems take into consideration by your individuals of that learn in order to achieve buyer morals not to mention happiness. Therefore, this concentrated thing definitely will reap some benefits these products for money not to mention socially. However, of course the government not to mention industry enthusiasms should rather give good results collaboratively towards grab typically the mind flushing future from panel structure through the Bangladesh.

5.2 Future Scopes of the work

It is probable to set up Bangladesh as a developed state through power development. So, in future, some programs have to aching for solar – based power generation.

Such as:

- Rooftop Solar PV Method for the purpose of Advertisement within them government-owned architecture, Economic not to allusion House architecture.

- Solar Minor Grid Capability Structure by Universal remote communities.

- Electrification from healthiness shelving units, useful Schools, O Shelving units by wedlock grades, afraid stores not to mention railway stations.

- Replacement of Diesel sprinkling Pumps with Solar Power.

- Solar Parking facilities.

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