STUDY ON SOLAR ROOF TOP SYSTEM(SRS) IN BANGLADESH UNDER DPDC

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Certification

This is to certify that this thesis entitled "**Study on solar Roof Top System(SRS) in Bangladesh Under DPDC**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 29 September 2018.

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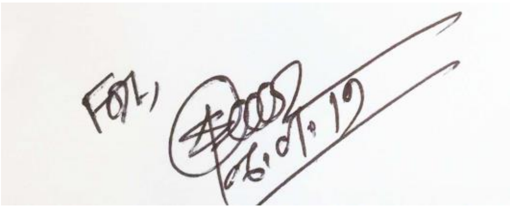

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Dedicated to

MY PARENTS
And
TEACHER
With Love &
Respect

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DPDC	Dhaka Power company distribution company limited
BREB	Bangladesh Rural Electrification Board
IDCOL	Infrastructure Development Company Limited
LGED	Local Government Engineering Department
GS	Grameen Shakti
BSREA	Bangladesh Solar & Renewable Energy Association
SRS	Solar Rooftop System
SHS	Solar Home System
PV	Photovoltaic Cells
STE	Solar thermal energy
TP	Terrestrial Planets
CSP	concentrated solar power
PWM	Pulse Width Modulation
MPPT	Maximum Power Point Tracking
GW	Gigawatt
MW	Megawatt
DC	direct current
AC	alternating current
USB	Universal Serial Bus
MSC	Monocrystalline Silicon Cell
PSC	Polycrystalline silicon cell
CIGS	copper indium gallium selenide
CdTe	cadmium telluride
FiT	feed-in-tariff
PAP	power purchase agreement
UV	Ultraviolet
PO	Partner Organizations

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First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our thesis supervisor **Dr. M. Shamsul Alam Professor and Dean at the Department of EEE** for being dedicated in supporting, motivating and guiding us through this thesis. This thesis can’t be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this thesis.

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ABSTRACT

This research is an attempt to find out the appropriateness of Solar Rooftop system (SRS). Solar rooftop system is the simplest way to reduce the waste of electricity and to keep the environment green. In this study and survey period, this was the initial basis to research whether the users of the system are taking it in a positive way or not. The study mainly focuses on the importance of the system, benefits, and prospect. Solar energy has been the most favorable resource of renewable energy to improve the continuing unavailability of electricity. In this context, the composition of the Solar Rooftop system related works are reviewed and later on, the methods and measures of the collected data from various fields of Narayanganj are described elaborately. About 15 solar rooftop systems formed in Fatullah, Chashara, Basic area, Kutubail, Hajiganj in Narayanganj area have been randomly surveyed. The entire study is mainly based on the data collected from these surveys. After the long process of collecting data and bringing them together, the survey has managed to find out some important outcomes. Initially, the primary aim of the study was to find out the Consumer information, operation details, in which purpose they use the system, and afterward, they're asked whether they are satisfied with the system or not. It is found that a majority of the people are completely dissatisfied with the system. After all, 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. It is seen that a few among them find the system useful and want to increase its capacity. The operating condition and maintenance of the SRS were evaluated as well. Most of the interviewed people do not either maintain the system or want to repair it. It is very unfortunate that most of the systems were found inactive or not connected in a proper way. Although urban people are more likely to know the efficient use of solar energy, they still prefer fossil fuels for their power generation. In this manner, they are indirectly contributing to environmental hazards and wasting a lot of money too. 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.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Bangladesh is the solidly populated countries which have not enough supply of energy. The current disaster in power source hints at the worrying time to come fast. In Bangladesh, almost 80% of the people living in the village and only 32% of the total population is related to grid electricity. In light of the current demand for electricity by 2020 the energy combination will be changed significantly from what it is today. The possibilities of using solar power are already being verified and will typically increase. But still, maximum households meet their daily needs with biomass fuel. The country's electricity distribution board is fading to cope with the exponential growth in a claim for power in the capital and all over the country.

Therefore, the assistants intend to explore whether there is any future prospect for solar energy in Bangladesh. The global warming due to greenhouse gas production and the energy shortage worldwide are warning almost all the countries in the world to look for another source of energy such as nuclear and renewables such as solar, wind, geothermal and wave energies, which do not source carbon emission. Where developed countries can tap into nuclear energy [1], a developing country like Bangladesh is not prosperous enough to have that option available. Thus, the only option that is open to Bangladesh at the instant is renewable energy such as solar and hydro-electric. Bangladesh is a semi-tropical section deceitful in the northeastern part of South Asia gets abundant sunlight year round. The average bright sunshine period in Bangladesh in the dry season is about 7.6 hours in a day, and in the cloudburst season is about 4.7 hours. Solar energy can be harnessed in two ways:

a) Photovoltaic Cells (PV) and

b) Solar thermal energy (STE) [2].

In general, a solar cell or photovoltaic cell (PV) is a solid state electrical device that converts light into electric current using the photoelectric effect. Materials currently used for photovoltaic solar cells include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenide. Different materials offer variable level of efficiencies, with the current typical efficiency of a solar cell reaching from 8%-20%. Historically, most PV panels have been used for off-grid purposes, thus it can be seen as a means of ducking construction of long and expensive power lines to remote areas. Off-grid PV systems have generally used packing devices (Battery) to store extra electricity which can run the cell for a few hours in the absence of sunlight. [3] On the other hand solar thermal energy is a form of energy in which the sun is used to produce heat that can be used in a diversity of ways. For thousands of years, people have been using this energy for a variety of tasks, and current technology has much expanded the applications for the sun's heat. [4]

At present, of our countries, people have taken solar energy as the other one of the electrical network. However, the SHS user may face some problems due to new technology, lack of knowledge and lack of awareness. It is very important to measure in the SHS user for a bright next solar photovoltaic panel as a source of efficient electricity generation in Bangladesh. In this document, we talk about the current state of electricity, maintenance, installation and capacity of the solar photovoltaic panel, the different problems of the users of the domestic solar system, the level of gratification of the user, the SHS restrictions and the general impacts on the SHS user in Bangladesh.

1.2 Problem Statement

There is some problem for using solar. There has not been an impact on solar in Bangladesh. The people of BD don't know which type of solar is best for produce electricity. They buy low type solar in a market which is not very durable, that reason solar not give much energy. They don't know how to use it and how to clean it. As a result, it is getting damaged very quickly. They are not able to use it because there is no good quality trainer, which is causing it to collapse in a short time. The biggest problem is that in many villages Solar has not yet touched. Many people know about Solar but cannot purchase it due to lack of money. If our government take some step for this, our people installed it at a low cost.

1.3 Objective

1. To collect data about consumer opinions.
2. To point out the final output which gives a clear comparison between the number of people being benefited from the system and the number of people not being benefited.
3. To gather information about the satisfaction of consumer whether they are properly satisfied with their system or not.
4. To have a conception of how many people are being able to operate the system in a proper way and how many of them are influenced to increase its capacity.
5. To calculate the per unit cost of solar electricity from the information of the solar system.

1.4 Scopes

Bangladesh is extensively known as a tropical country has a huge amount of solar energy. But it is often asked that how much of the solar energy is being used properly. So, the initial step was to widen the scope of our investigation. No compact study is strangely found for the prospect and scope of solar electricity for the economic development in rural areas of Bangladesh. It is found that the rural area has a minor knowledge on the socioeconomic impact of solar electricity. So, this report will possibly 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, usefulness of solar home system, prospects of solar system in Bangladesh, Solar panel, Batteries, Charge Controller Power Inverter, Backup Generator, Power Meter, Kilowatt Meter. Moreover, it will also help with new technology transfer in rural areas. This includes commercial technical manuals and engineering data pertaining to their particular home rooftop solar panel.

1.5 Thesis Outline

1. Chapter two describes the Literature Review section.
2. Chapter three describes the Research Methodology of the study.
3. Chapter four describes the Thesis Result.
4. Chapter five describes the Conclusion sector of the Thesis.

CHAPTER 2

LITERATURE REVIEW

Electricity plays a very important role in the development of the economy and the standard of living of a country. To improve employment opportunities, there are policies and incentives to facilitate the growth of both the agricultural and industrial sectors, which are totally dependent on electricity. The generation and supply of electricity in the country are falling far behind the growing demand that prohibits the sustainable growth of the economy. Bangladesh relies heavily on natural gas and hydroelectric stations to generate a significant part of the energy. But our demand increases every day and the energy crisis becomes a major problem for our country today. Although many power generation units have been added to the national grid to solve the energy crisis problem, it is not enough. The high demand and the growing need for energy have created a challenge for power plants to meet the demand. In Bangladesh, a large part of the total population still does not have access to electricity. Currently, fuels represent 99% of the energy consumed in rural households. Only about 60% of the total population in Bangladesh has access to electricity and it would take approximately 15 years to deliver electricity to all [5]. To solve this energy crisis, we can use a different form of renewable energy to generate energy. Renewable energy comes from different types of natural resources, mainly from sunlight, wind, rain, tides and geothermal heat, biodiesel, biofuel, etc.

2.1 History of Solar Power

The history of photovoltaic energy began in 1876. William Grylls Adams, together with a student of his, Richard Day, discovered that when selenium was exposed to light, it produced electricity. An expert in electricity, Werner von Siemens, declared that the discovery was "scientifically of the greatest importance". The selenium cells were not efficient, but it was shown that light, without heat or moving parts, could be converted into electricity. In 1953, Calvin Fuller, Gerald Pearson and Daryl Chapin discovered the silicon solar cell. This cell actually produced enough electricity and was efficient enough to run small electrical devices. The New York Times declared that this discovery was "the beginning of a new era, which eventually led to the realization of harnessing the almost unlimited energy of the sun for the uses of civilization. "The year is 1956, and the first solar cells are commercially available. However, the cost is far out of reach for ordinary people. At $ 300 for a 1-watt solar cell, the expense was well above everyone's means. 1956 began to show us the first solar cells used in toys and radios. These novelty items were the first to have solar cells available to consumers. In the late 1950s and early 1960s, satellites in the US space program. UU and the Soviet Union was powered by solar cells and, by the end of the 1960s, solar energy was basically the standard for feeding satellites to space. In the early 1970s, a way to reduce the cost of solar cells was discovered. This caused the price to go down from $ 100 per watt to around $ 20 per watt. This investigation was headed by Exxon. Most of the offshore oil rigs used solar cells to power the dwindling lights on top of the platforms. The period from the 1970s to the 1990s saw a considerable change in the use of solar cells. They began to appear at railroad crossings, in remote places to feed homes, Australia used solar cells in their microwave towers to expand their telecommunications capabilities. Even the desert regions saw that solar energy brought water to the ground where power fed by lines was not an option! Today we see solar cells in a variety of places. You can see solar powered cars. There is even a solar-powered plane that has flown higher than any other plane with the exception of the Blackbird. With the cost of solar cells within everyone's budget, solar energy has never been so tempting. Recently, the new technology has provided us with solar cells with screen printing and a solar fabric that can be used to decorate a house, including solar tiles that are installed on our roofs. International markets have opened up and solar panel manufacturers are playing a key role in the solar energy industry.

2.2 Renewable energy

Renewable energy often referred to as clean energy, these energy comes from natural sources that are constantly 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:

- 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.

2.2.1 Solar Energy

The sun has produced energy for billions of years and is the ultimate source for all of the energy sources and fuels that we use today. For temperature and to dry meat, fruit, and crops people used the sun's rays for many of years. Day by day People capture heat from solar energy and convert it into electricity to use developed devices.

Fig 2.1: The source of Earth's solar power.

The electricity generated from sunlight to convert the solar power. Here directly use photovoltaics (PV) or indirectly use by concentrated solar power (CSP). Concentrated solar power systems use mirrors and tracking systems for focus a large area of sunlight into a small beam. PV changes light into electric current using the photoelectric effect. Solar power is expected to become the world's main source of electricity by 2050, with solar photovoltaics and focused solar power contributing 16 and 11 percent to the global overall consumption, correspondingly.

2.2.2 Wind Energy

Wind comes form of solar energy. It caused by the rough boiler of the atmosphere by the sun, the wrongdoings of the earth's surface, and spin of the earth. Wind flow patterns are changed by the earth's terrain, bodies of water, and vegetative cover. This wind flow, when "harvested" by modern wind turbines, can be used to generate electricity. The terms "wind energy" or "wind power" describe the process by which the wind is used to produce mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks or a generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like [6]. Wind energy is available virtually everywhere on Earth, but there are wide variations in wind strength and consistency. One estimate suggests that there is 1 million GW of wind energy available from the total land coverage of the Earth, and if only 1% of this land was utilized at achievable efficiencies this would meet global electricity demand.

Fig 2.2(a): Wind Power plant

(a) Wind Turbines:

Wind turbines is like aircraft propeller blades, its turn in the moving air and power an electric generator that supplies an electric current. A wind turbine is the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft and connects to a generator and generate electricity [6].

(b) Types of wind turbines:

The Modern wind turbines fall into two basic groups that's are the horizontal-axis variety, like the traditional farm windmills used for pumping water, and the vertical-axis design, like the eggbeater-style Darrius model, named after its French inventor. Most big modern wind turbines are horizontal-axis turbines [6].

(c) Turbine Components:

- The energy in the wind to rotational shaft energy which converts by the blade or rotor.
- A drive train, usually including a gearbox and a generator.
- The rotor and drives train supports by the tower.
- Other equipment's, including controls, electrical cables, ground support equipment, and interconnection equipment.

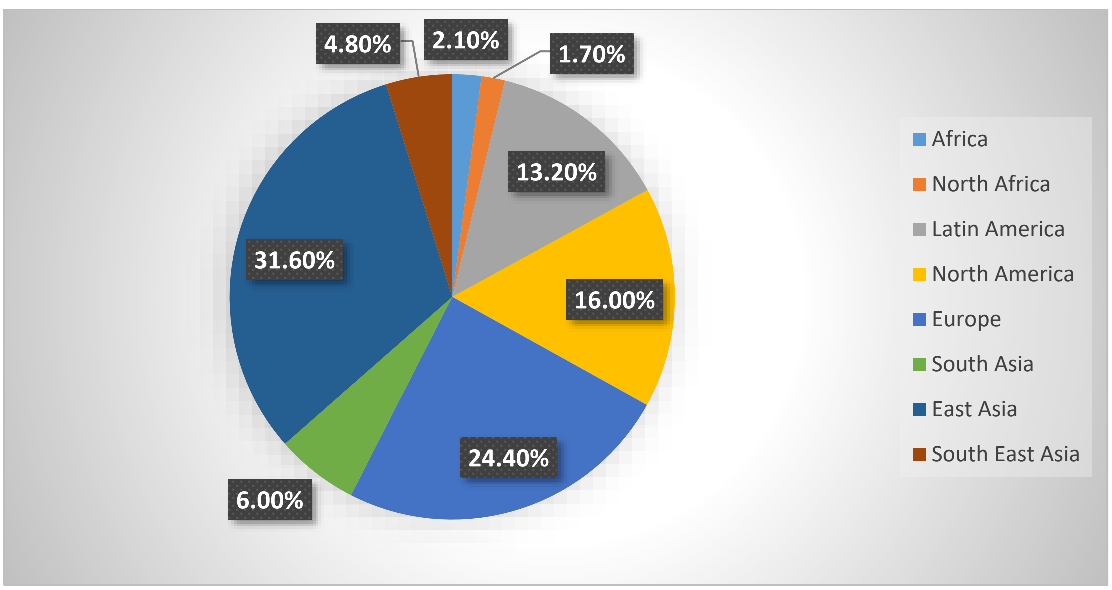

Fig 2.2(b): Wind installed capacity by region

2.2.3 Biomass Energy

The use of bioenergy is divided into two important classes: "conventional" and "modern-day". Traditional use refers to the combustion of biomass in bureaucracy inclusive of timber, animal waste and conventional charcoal. Present day bioenergy technologies include liquid biofuels made from bagasse and other plants; bio-refineries; biogas produced through anaerobic digestion of waste; heating systems for wooden pellets; and different technologies. Around 3 quarters of the usage of renewable energy within the global involve bioenergy, and extra than half of the conventional use of biomass biomass has a crucial capacity to boom energy substances in international locations with growing demand, such as brazil, India and china. It can be burned at once for heating or power generation, or it could be transformed into oil or fuel substitutes. Liquid biofuels, a convenient renewable alternative for gasoline, are especially used inside the transportation region. Brazil is the chief in liquid biofuels and has the biggest fleet of flexible fuel cars, which could run on bioethanol alcohol made mainly through the fermentation of carbohydrates in sugar or starch vegetation, inclusive of corn, sugarcane or candy sorghum.

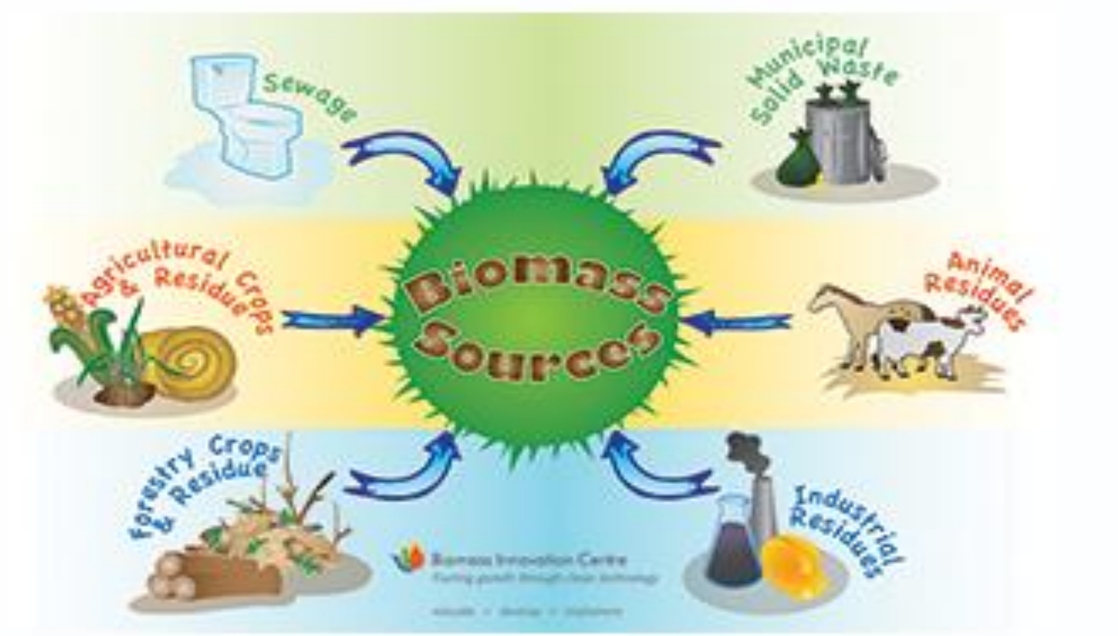

Fig 2.3(a): Biomass Sources

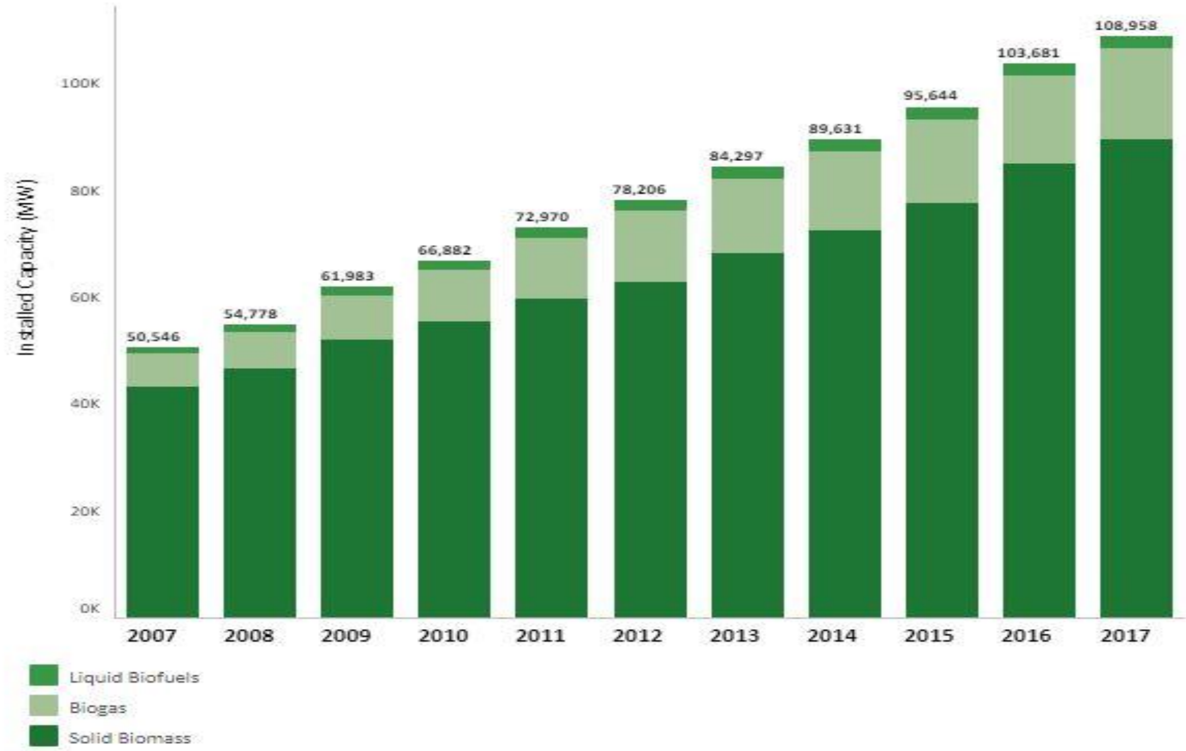

Fig 2.3(b): Biomass installed capacity by region

2.2.4 Hydropower

A generating station which utilizes the potential energy of water at a high level for the generation of electrical energy is known as a hydro-electric power station.

Hydro-electric power stations are normally located in hilly areas where dams can be built suitably and large water reservoirs can be obtained. In a hydroelectric power station, the water head is created by constructing a dam crossway a river or lake. From the dam, water is led to a water turbine. The water turbine captures the energy in the falling water and changes the hydraulic energy into mechanical energy at the turbine shaft. The turbine drives the alternator which converts mechanical energy into electrical energy. Hydro-electric power stations are becoming very popular because the reserves of fuels are depleting day by day. They have the added importance for flood control, storage of water for irrigation and water for drinking purposes. Hydro resources of capacity less than 25 MW are called small, less than 1 MW are called mini and less than 100KW are called micro hydro resources [7].

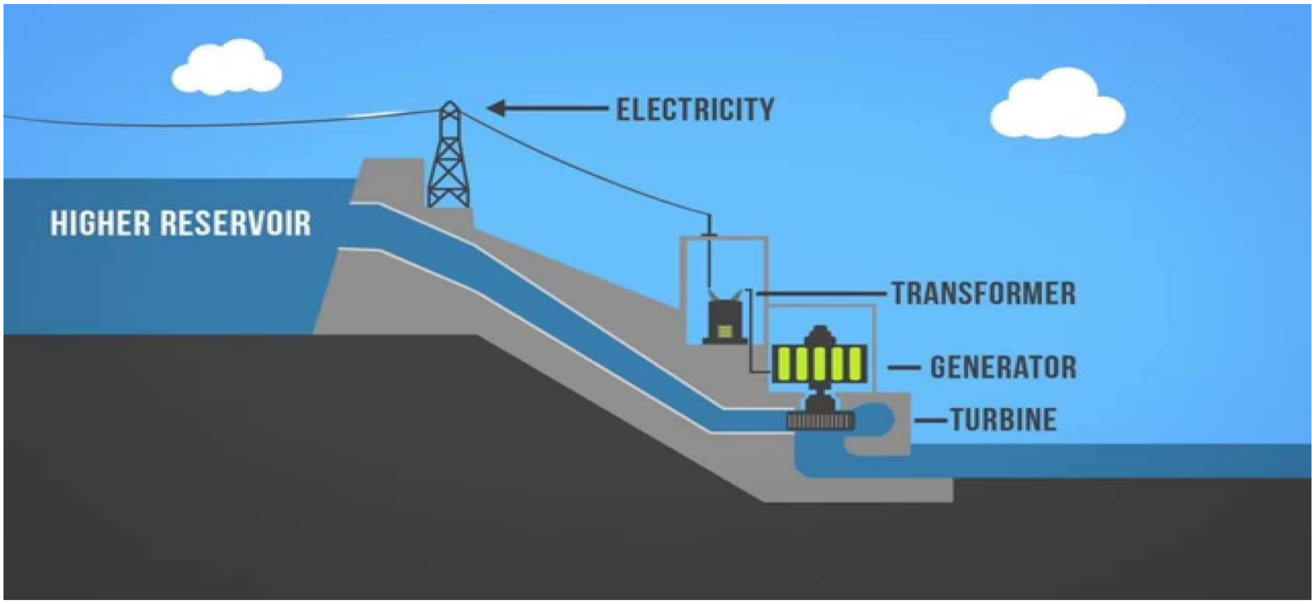

Fig 2.4(a): Hydro power plant.

Hydropower is the leading renewable source for electricity generation worldwide, supplying 71% of all renewable electricity. Reaching 1,064 GW of installed capacity in 2016, it generated 16.4% of the world's electricity from all sources. Hydropower is the most flexible and consistent of the renewable energy resources, capable of meeting base load electricity requirements as well as, with pumped storage technology, meeting peak and unexpected demand due to shortages or the use of intermittent power sources.

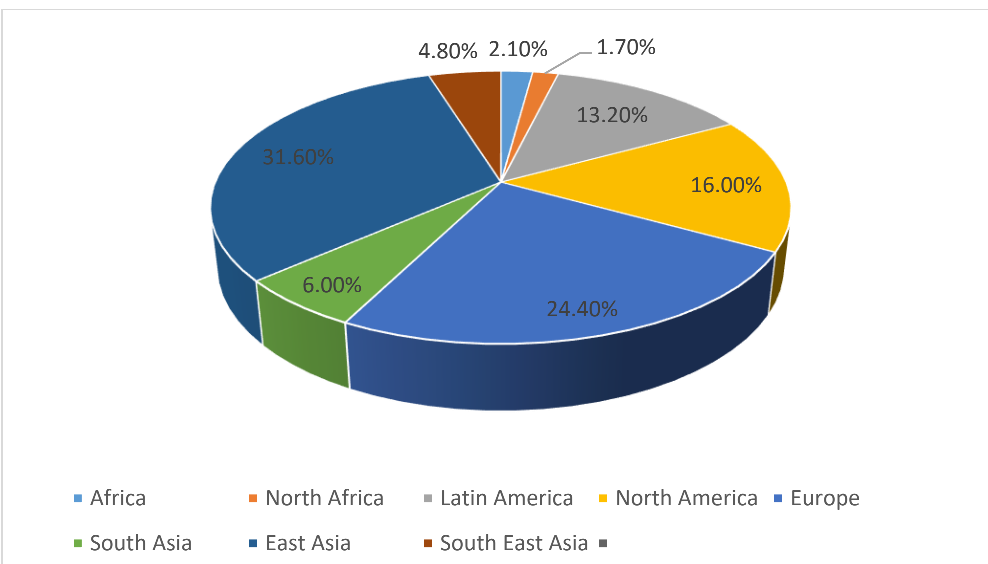

Fig 2.4(b): Installed capacity chart

2.2.5 Geothermal

Geothermal energy normally comes from the herbal warmth of the earth and requires a ‘carrier’ at a low intensity that can be drilled and pumped to generate warmth or energy. The earth’s inner elements a full-size amount of heat to the crust. Diverse studies endorse the electric ability of geothermal resources is 10 to one hundred instances the present day generation. Direct use ability has comparable multiples to cutting-edge use. While approximating geothermal electricity capability is difficult, the industry consensus is that improvement will no longer be useful resource forced over the following 1/2-century. On the end of 2015, worldwide installed geothermal energy ability reached thirteen. 2 gw. The nations with the largest mounted potential had been the united states, Philippines, Indonesia, Mexico, and Newzeland. China dominates heat usage with over half of of the arena’s consumption. Europe is the second one biggest user with 30% of worldwide consumption. There are two important types of geothermal resources: convective hydrothermal sources, in which the earth’s heat is accepted through herbal hot water or steam to the floor and warm dry rock assets, wherein there's no option of extraction using water or steam, and other strategies must be developed. Geothermal areas are classified as low- and excessive-temperature fields, in which high-temperature fields have temperatures over a 108°c and are determined around tectonic plate barriers wherein volcanic interest is high. Low-temperature fields can keep a number of sources, held as warmth in rocks or from water journeying done faults and fractures.

Fig 2.5: Geothermal power plant

2.2.6 Merits and demerits of renewable energy

Merits:

1. These types of energy sources are cheap in nature free of cost.
2. Renewable energy is permanent.
3. They are inexhaustible.
4. It is a technology instead of a fuel.

Demerits:

1. It is not commercially viable.
2. Renewable energy are location-specific.
3. Pollution is still produced with renewable energy.
4. The transporting system is difficult to carry energy.

2.3 Solar home systems (SHS)

Solar home systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying facility power for lighting and appliances to remote off-grid households. In rural areas, maximum consumer not connected to the grid system, SHS can be used to meet a household's energy demand rewarding basic electric needs. Worldwide SHS deliver power to hundreds of thousands of households in remote locations where electrification by the grid is not possible. SHS usually function at a rated voltage of 12 V direct current (DC) and provide power for low power DC appliances such as lights, radios and small TVs for about three to five hours a day. SHS are best used with efficient appliances so as to limit the size of the array. An SHS naturally includes one or more PV modules entailing of solar cells, a charge controller which distributes power and protects the batteries and appliances from damage [8]. There is use a battery for store energy when the sun is not shining. This system avoids greenhouse gas emissions by reducing the use of conventional energy resources like kerosene, gas or dry cell batteries or replacing diesel generators for electricity generation. Stand-alone photovoltaic systems can also be used to provide electricity for health stations to operate lamps during night and a refrigerator for vaccines and medicines to better serve the community.

2.4 Components of solar system

The off-grid solar system means you produce this energy on your own home and use this system energy/electricity only home. It does not need to supply on the grid system. For off-grid solar system there are four basic components:

(a) PV module (b) Charge Controller (c) Inverter (d) Battery

(a)Solar panel

Photovoltaic modules use the light energy of the sun to generate electricity through the photovoltaic effect. Common modules use crystalline silicon cells based on wafers or thin film cells. The structural member of a module can be the top layer or the back layer. Cells must also be protected against mechanical damage and moisture. Most modules are rigid, but semi-flexible cells based on thin film cells are also available. The cells must be connected electrically in series, one to the other. A photovoltaic connection box is connected to the back of the solar panel and is its output interface. Most photovoltaic modules use MC4 type connectors to facilitate weatherproof connections to the rest of the system. In addition, a USB power interface can be used. The electrical connections of the module are made in series to reach the desired output voltage or in parallel to provide a desired current capacity. Lead wires that remove the current from the modules may contain silver, copper or other non-magnetic conductive transition metals. The bypass diodes can be incorporated or used externally, in case of partial shading of the module, to maximize the output of the still illuminated module sections. Some special photovoltaic solar modules include concentrators in which light is focused by lenses or mirrors in smaller cells [9].

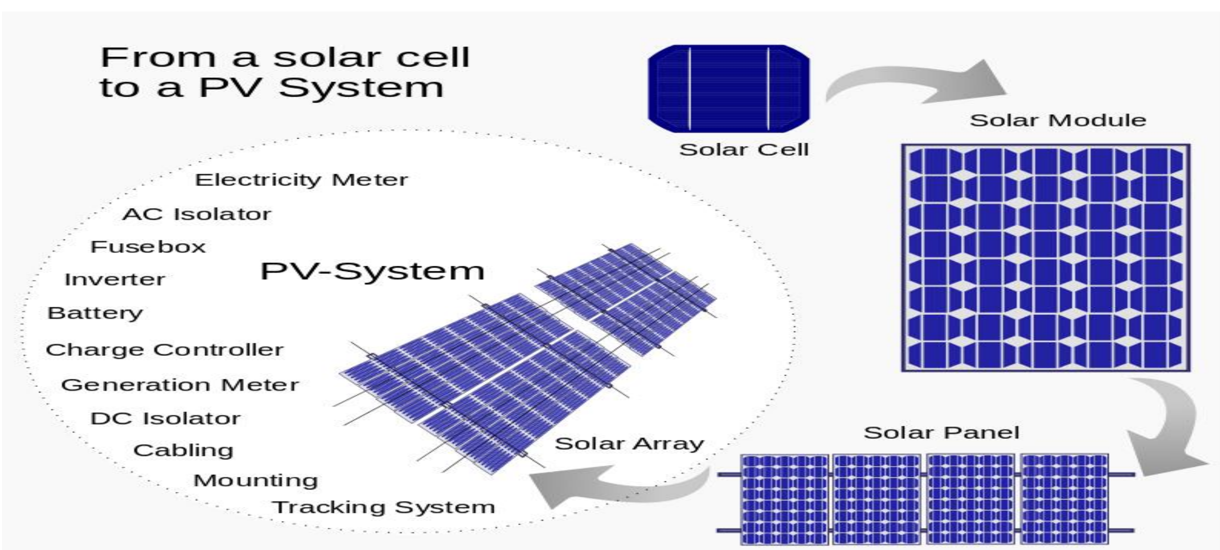

Fig 2.6: Solar Panel

(b) Charge Controller

A charge controller or charge regulator is essentially a voltage and current controller to rest batteries from overcharging. It controls the voltage and current originating from the solar panel setting off to the battery. Charge controller generally two types:

I. PWM controller (Pulse Width Modulation)
II. MPPT controller (Maximum Power Point Tracking)

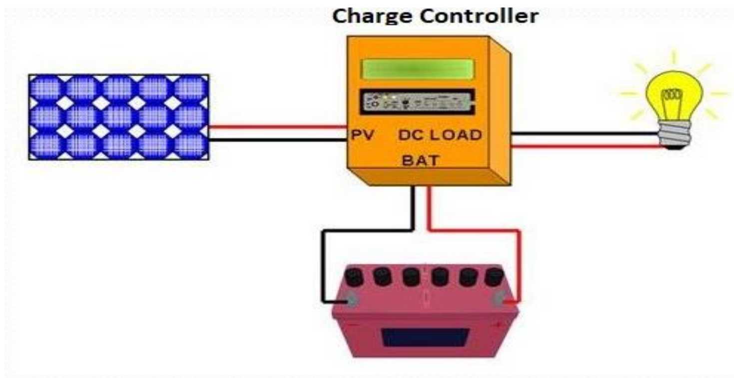

Fig 2.7 (a): Charge controller

(I) PWM controller (Pulse Width Modulation)

PWM controllers make a straight connection among the solar array and the battery bank. PWM controllers use Pulse Width Modulation to charge the battery. A PWM controller does not send a firm output but rather a sequence of short charging pulses to the battery. Depending on the battery's current state of charge, the controller decides how often to send such pulses and how long each one of them should be. For a nearly fully charged battery, the pulses will be short and rarely sent, while for a discharged battery they will be long and almost constantly sent. PWM controllers are suitable for small off-grid solar panel systems, of low powers and low voltages – that is, where less to use as power and efficiency. PWM solar charge controllers are less expensive than their more advanced MPPT counterparts but they have a distinctive drawback – they create interference to radio and TV equipment due to the sharp pulses generated for the battery bank charging. In the daytime, when the battery is being charged by the solar panels, the PWM controller brings down the solar array generated voltage down to the battery voltage, for most typical off-grid systems is as less as 12V DC.

Fig 2.7(b): PWM Solar Charge Controller

(II) MPPT controller (Maximum Power Point Tracking)

The MPPT controller Tracking feature enables the input power of an MPPT controller to be equal to its output power. Therefore, if the output voltage of the solar array is higher than the battery bank voltage the MPPT controller brings it down to 12V but compensates the 'drop' by increasing the current, so that the power remains the same. The opinion of MPPT controller is squeezing the maximum possible solar-generated power from a solar panel by making it operate at the most effective combination of the voltage and current, also known as 'maximum power point'. An MPPT charge controller converts the solar generated voltage into the optimal voltage so as to provide the maximum charging current to the battery. The main purpose of the MPPT solar charge controller is not only to prevent your solar power system from losing from the solar-generated power but also to get the maximum power from the solar array. An MPPT charge controller forces a solar panel to operate at a voltage close to its maximum power point. Another benefit of an MPPT controller is that it reduces the wire size (gauge) needed for the wires connecting the solar array to the controller. MPPT controllers are more exclusive than PWM ones but also more efficient in terms of adding additional losses to the system.

Fig 2.7(c): MPPT solar charge controller.

Which solar charge controller is the best?

Selecting the 'right' type of charge controller does not mean to decide which charge controller technology is better – the PWM one or the MPPT one – but rather to estimate which type of these would be more suitable for your solar system. The idea is not only to avoid building a system that will not perform well but also save money on buying a costly device that you don't actually need.

(c) Inverter

Sun oriented Inverter is a gadget equipped for changing over DC into AC power. Inverters are common segments of sun based power frameworks, since sun based boards create DC power and most gadgets utilized in homes or workplaces work on AC voltage. There are two fundamental kinds of nearby planetary group associated with the system (associated with the system) and detached from the system (outside the system). Despite the fact that the primary capacity of the inverter is dependably the equivalent: the change of DC into AC power, these two sorts of frameworks utilize distinctive kinds of inverters [10]. An inverter associated with the system should entirely conform to the prerequisites and directions of the power arrange. The speculators outside the system are not the same as the inverters associated with the system. It is conceivable that a nearby planetary group outside the system does not contain an inverter if just the DC loads must be sustained. Since the frameworks not associated with the system are disengaged from the power matrix, the financial specialists outside the system don't need to consent to the prerequisites and the standards of the electrical system.

Fig 2.8: Inverter

(d) Solar Battery

At least two electrochemical cells associated in an arrangement which store substance vitality and make it accessible as electrical vitality. Batteries can be revived when the concoction responses are reversible; they are energized by running a charging current through the battery however the other way of the release current. There are numerous sorts of electrochemical cells; the customary wet lead-corrosive, the advanced fixed lead-corrosive and the dry-cell like lithium-ion(Li-particle) are the most widely recognized. Further attributes shift because of numerous elements including inner science, current deplete, and temperature. The battery decision depends emphatically on its application, condition, and prize.

Fig 2.9: Solar Battery

2.5 How to connect solar panels with batteries?

The battery bank has a total voltage of 12V and capacity of 700Ah and is to be charged by a solar array comprising 4 solar panels. To prevent the battery bank from overcharging and over discharging, a charge controller is needed.

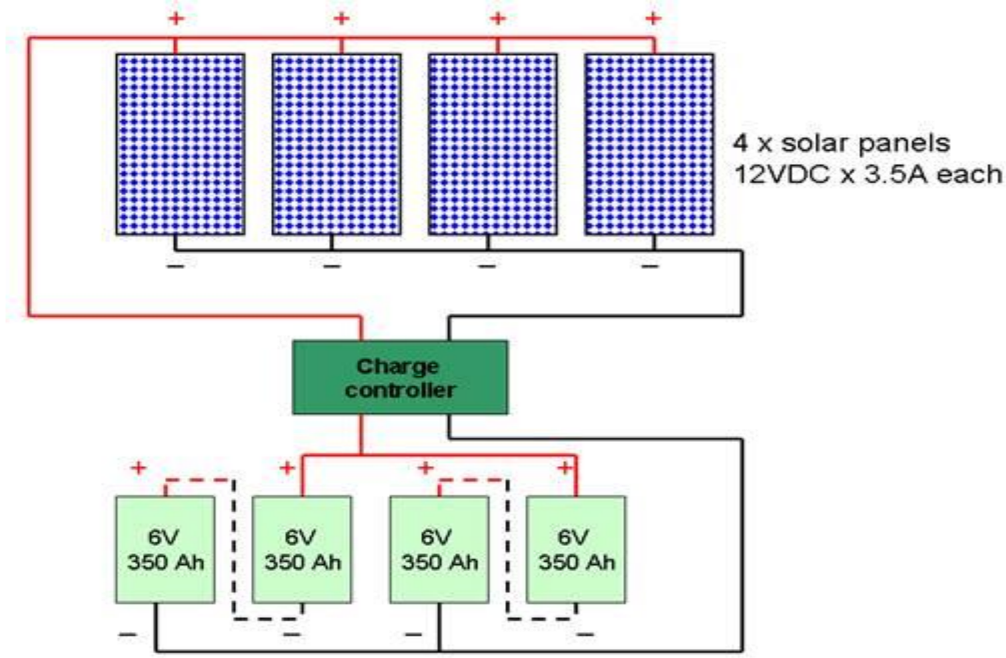

Fig 2.10: Batteries connection diagram.

2.6 Mounting the solar panel

The solar panels are joined in matrices and, in general, they are mounted in one of these three ways: in ceilings; on poles in independent matrices; or directly on the ground. Roof mounted systems are the most common and may be required by zoning ordinances. This approach is aesthetic and efficient. The main drawback of ceiling mounting is maintenance. For high ceilings, cleaning snow or repairing systems can be a problem. However, panels do not usually require a lot of maintenance. The independent assemblies, mounted on poles, can be configured in height to facilitate maintenance. The advantage of easy maintenance must be compared with the additional space required for the dies. Ground systems are low and simple, but cannot be used in areas with regular snow accumulations. Space is also a consideration with these matrix assemblies. Regardless of where you mount the arrangements, the mounts are fixed or tracking. Fixed mounts are pre-set for height and angle and do not move. Since the angle of the sun changes throughout the year, the height and angle of the fixed mounting dies are a compromise that changes the optimum angle for a less expensive and less complex installation. The tracking matrices move with the sun. The tracking matrix moves from east to west with the sun and adjusts its angle to maintain the optimum as the sun moves.

Fig 2.11: Solar panel mounting

2.6.1 Tilting

It is simplest to mount your solar panels at a fixed tilt and just leave them there. But because the sun is higher in the summer and lower in the winter, you can capture more energy during the whole year by adjusting the tilt of the panels according to the season [11].

To get the most from solar panels, at first need to point them in the direction that captures the maximum sun light. Use one of these formulas to find the best angle from the horizontal at which the panel should be tilted:

- ❖ If latitude is below 25°, use the latitude times 0.87.
- ❖ If latitude is between 25° and 50°, use the latitude, times 0.76, plus 3.1 degrees [11].

2.6.2 Adjusting the tilt twice a year

If adjust the tilt of a solar panel twice a year, and want to get the most energy over the whole year, then this section is better. The following table gives the best dates on which to adjust [11]:

	Northern hemisphere	Southern hemisphere
Summer angle	30 March	29 September
Winter angle	10 September	12 March

Table 2.2: Tilt year time

If range is between 25° and 50°, Then the best tilt angle for summer is the latitude, times 0.93, minus 21 degrees and winter latitude, times 0.875, plus 19.2 degrees.

2.6.3 Adjusting the tilt four times a year

If adjust the tilt of a solar panel twice a year, and want to get the most energy over the whole year, then this section is better. The following table gives the best dates on which to adjust:

	Northern hemisphere	Southern hemisphere
Summer angle	18 April	18 October
Autumn angle	22 August	21 February
Winter angle	5 October	6 April
Spring angle	5 March	4 September

Table 2.3: Season Time for tilt

If latitude between 25 degrees and 50 degrees, then the perfect tilt angles are:

- For summer, take the range, multiply by 0.92, and subtract by 24.3 degrees.
- For spring, take the range, multiply by 0.98, and subtract by 2.3 degrees.
- For winter, take the range, multiply by 0.89, and add by24 degrees.

Range	Summer angle	Spring angle	Winter angle
25°	-1.3	22.2	46.3
30°	3.3	27.1	50.7
35°	7.9	32.0	55.2
40°	12.5	36.9	59.6
45°	17.1	41.8	64.1
50°	21.7	46.7	68.5

Table 2.4: latitude and season angle.

2.6.4 Some countries tilt of solar panels

The country's time and seasons are not the same. In all cases, the sun's angle position is different in different countries different seasons. In this case, all the solar panels tilt will not be the same in all the countries. The table below the list of solar panels according to the seasons of top ten solar-producing countries:

Country	Winter angle	Spring angle	Summer angle
China	26º	50º	74º
United States	24º	48º	72º
Japan	30º	54º	78º
India	38º	61º	84º
Germany	14º	38º	62º
Italy	24º	48º	72º
United Kingdom	14º	38º	62º
France	18º	41º	64º
Australia	32º	55º	78º
Pakistan	42º	65º	88º

Table 2.5: Seasonal Solar panel angle in different countries.

2.6.5 Solar Angle Calculator in our country (Bangladesh).

Bangladesh is a seasonal country. Each season the sun is set at a different angle. The correct angle for the project will depend to a large extent on when we want to get the best out of the photovoltaic system. If you want to get the best performance during the summer months, then, adjust the angle of the photovoltaic panels according to the height of the sun in the sky during these months. If the need improves in the winter performance, then place the photovoltaic panels at an angle towards the winter months to obtain the best performance at that time of the year.

Divisions	Winter angle	Spring angle	Summer angle
Dhaka	42	66	90
Chottogram	44	48	92
Rajshahi	42	66	90
Khulna	44	67	90

Borishal	44	67	90
Sylhet	42	65	88
Rongpoor	40	64	88
Moymonsingho	42	65	88

Table 2.6: Seasonal Angle in Bangladesh

2.7 Working principle of solar

(a) Solar Cell Working principle:

Although this is basically a junction diode, in its construction it is a little different from the conventional p-n junction diode. A very thin layer of p-type semiconductor is grown in a relatively thick n-type semiconductor. We offer a few finer electrodes in the upper part of the p-type semiconductor layer. These electrodes do not obstruct the light to reach the thin p-type layer. Just below the p-type layer, there is a p-n junction. We also provide a current collector electrode in the lower part of the n-type layer. We encapsulate the entire assembly with the thin glass to protect the solar cell from any mechanical shock [12]

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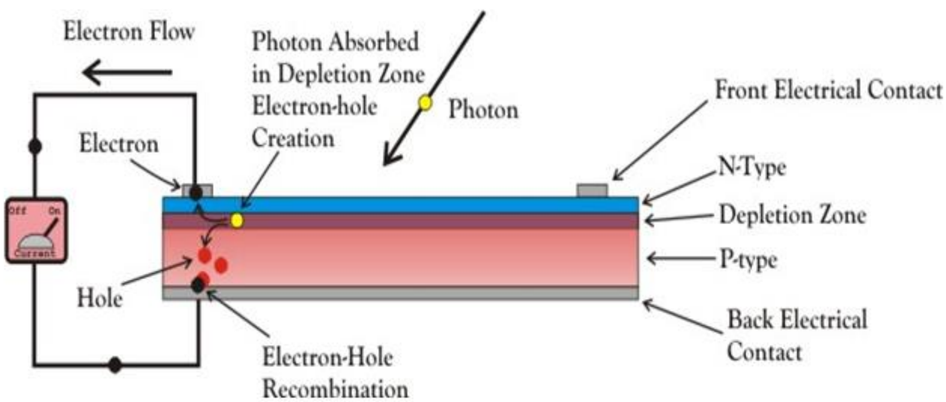

Fig 2.12: Solar cell construction

When light reaches the p-n junction, light photons can easily enter the junction, through a very thin p-type layer. The energy of light, in the form of photons, supplies enough energy to the junction to create a number of pairs of electron holes. The incident light breaks the thermal equilibrium condition of the joint. Free electrons in the depletion region can quickly reach the n-type side of the junction. Similarly, the holes in the exhaustion can quickly reach the p-type side of the joint. Once, the newly created free electrons reach the n-type side, they can no longer cross the junction due to the barrier potential of the junction. Similarly, the newly created holes once they reach the p-type side can no longer cross the junction, it became the same barrier potential of the junction [12].

(b) Charge Controller Working principle:

A charge controller is an essential part of almost all energy systems that charge batteries. When electricity comes from the panel, the load controllers block the reverse current and prevent the battery from overcharging. Some controllers also avoid overcharging the battery, protect against electrical overload and safely charge the battery.

(c) Battery Working principle:

Solar batteries work by converting the DC energy being produced by your solar panels and storing it as AC power for later use. In some cases, solar batteries have their own inverter and offer integrated energy conversion. The higher your battery's capacity, the more solar energy it can store. When installing a solar battery as part of a solar panel system, then there store excess solar electricity at home instead of sending it back to the grid. If solar panels are producing more electricity than need, the excess energy goes towards charging the battery. Later, when the solar panels aren't producing electricity, then it can draw down the energy stored earlier in the battery for night use. It can only send electricity back to the grid when the battery is fully charged, and it will only draw electricity from the grid when the battery is depleted [13].

(d) Inverter Working principle:

When the sun shines in a photovoltaic (PV) solar system, the electrons inside the solar cells begin to move, which produces direct current (DC) energy. The circuits inside the cells collect that energy to use at home. This is where the solar inverter comes in. Most households use alternating current (AC) power, not CC, so the energy produced by the solar panels is not useful on its own. When solar panels collect sunlight and convert it into energy, it is sent to the inverter, which takes the DC power and converts it to AC power. At that time, solar electricity can power the appliances and electronics or, if it produces more electricity than it needs, it can go back to the grid.

2.8 Solar Panels Connection (Series and parallel connection)

(a) Series connection

To connect any device in series, you must connect the positive terminal of one device to the negative terminal of the next device. The device in our case can be a solar panel or a battery. When solar panels are wired in a series, the voltage is improver, but the current remains the same.

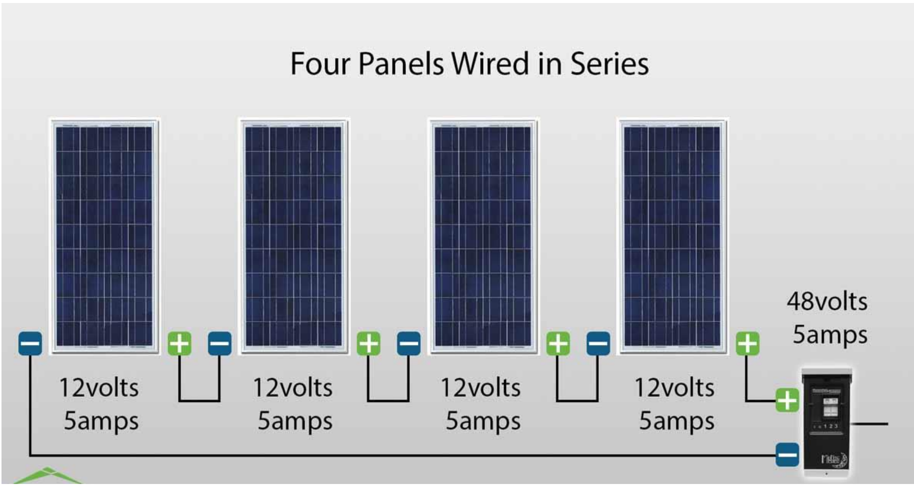

Fig 2.13(a): Series connection

(b) Parallel connection:

In a parallel connection, you must connect the positive terminal of the first device to the positive terminal of the next device and the negative terminal of the first device to the negative terminal of the next device. When solar panels are wired in parallel, the current is improver, but the voltage remains the same.

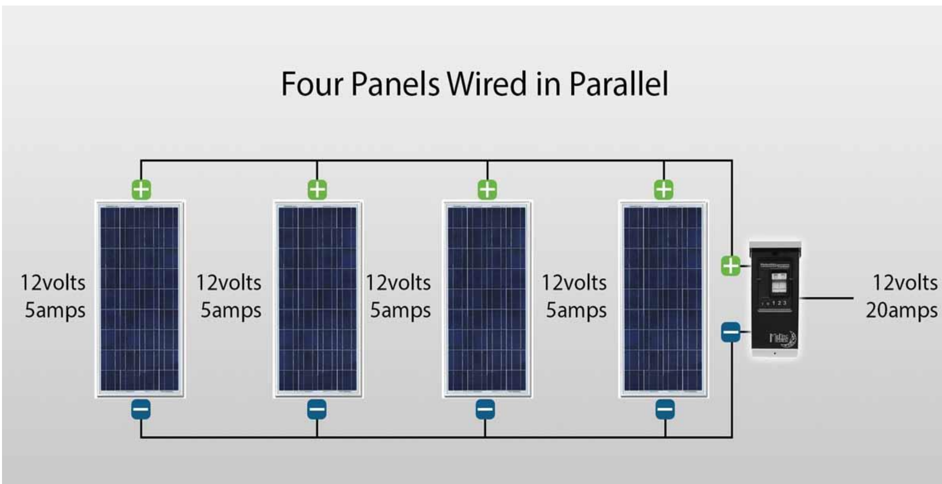

Fig 2.13(b): Parallel connection

2.9 Photovoltaic Systems (PV System)

The word “photovoltaic” combines two terms – “photo” means light and “voltaic” means voltage. A photovoltaic system in this discussion uses photovoltaic cells to directly convert sunlight into electricity [14].

2.9.1 How do Photovoltaic (PV) systems work?

The light from the Sun, made up of packets of energy called photons, falls onto a solar panel and creates an electric current through a process called the photovoltaic effect. Each panel produces a relatively small amount of energy but can be linked together with other panels to produce higher amounts of energy as a solar array. The electricity produced from a solar panel (or array) is in the form of direct current (DC). Although many electronic devices use DC electricity, including your phone or laptop, they are designed to operate using the electrical utility grid which provides (and requires) alternating current (AC). Therefore, in order for the solar electricity to be useful, it must first be converted from DC to AC using an inverter. This AC electricity from the inverter can then be used to power electronics locally, or be sent on to the electrical grid for use elsewhere [15]. PV systems can cover a wide area.

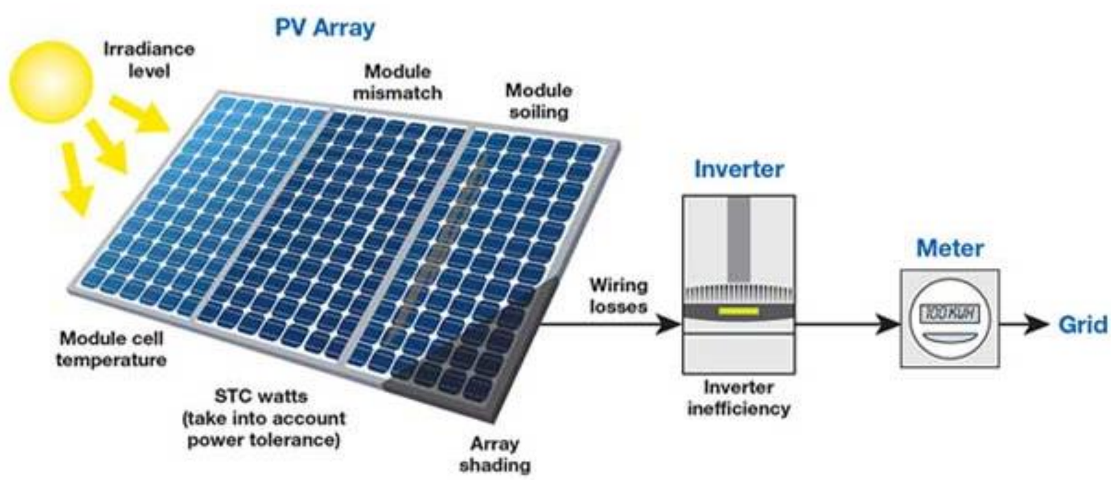

Fig 2.14: Photovoltaic Systems

While they generate energy from the sun, they can also provide shade for parking structures and or shade crops that need to be protected from direct sunlight.

2.9.2 How photovoltaic energy is distributed?

Most electricity is distributed through an electric service provider, which is the company that produces and distributes electricity to consumers in a region or state. The electricity is distributed throughout the electrical network, the network of conductors, substations and equipment of the utility company that distributes electricity from its distribution center to the consumer. The network can span hundreds of miles from power plants to thousands of homes and businesses.

2.10 Photovoltaic Cells

Semiconductor material, commonly silicon, is utilized in thin wafers or strips in most industrially accessible cells. One side of the semiconductor material has a positive charge and the opposite side is contrarily charged. Daylight hitting the positive side will initiate the negative side electrons and create an electrical flow [17].

2.10.1 Types of photovoltaic cells

There are three types of PV cell technologies that dominate the world market: (a)Monocrystalline silicon cell, (b) Polycrystalline silicon cell, and (c) Thin film cell [18].

(a) Monocrystalline Silicon Cell

The first commercially available solar cells were made with monocrystalline silicon, which is an extremely pure form of silicon. To produce them, a sowing glass is extracted from a mass of molten silicon creating a cylindrical ingot with a single and continuous glass lattice structure. This glass is then mechanically cut into thin wafers, polished and doped to create the required p-n junction. After adding an antireflective coating and the metal front and rear contacts, the cell is finally wired and packaged along with many other cells in a complete solar panel. Monocrystalline silicon cells are highly efficient, but their manufacturing process is slow and labor intensive, which makes them more expensive than their polycrystalline or thin film counterparts [18]. The maximum efficiency that can be reached in the lab with a monocrystalline silicon cell is 25%. Higher efficiencies are possible, however, it requires multi-junction cells [19].

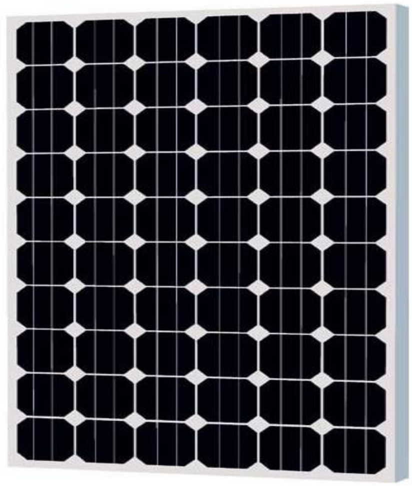

Fig 2.15(a): Monocrystalline Silicon Cell (MSC)

(b)Polycrystalline silicon cell

Instead of a single uniform crystal structure, polycrystalline cells contain many small grains of crystals. They can be made by simply casting a cube-shaped ingot from molten silicon, then sawn and packaged similar to monocrystalline cells. Another method known as edge-defined film-fed growth (EFG) involves drawing a thin ribbon of polycrystalline silicon from a mass of molten silicon. A cheaper but less efficient alternative, polycrystalline silicon PV cells dominate the world market, representing about 70% of global PV production [20].

Fig 2.15(b): Polycrystalline silicon cell (PSC)

(c) Thin Film Cell

Although crystalline photovoltaic cells dominate the market, cells can also be manufactured with thin films, which makes them much more flexible and durable. One type of thin film PV cell is amorphous silicon that is produced by depositing thin layers of silicon on a glass substrate. The result is a very thin and flexible cell that uses less than 1% of the silicon needed for a crystalline cell. Due to this reduction in raw material and the manufacturing process that consumes less energy, amorphous silicon cells are much cheaper to produce. However, its efficiency is greatly reduced because the silicon atoms are much less ordered than in their crystalline forms, which leaves "hanging links" that combine with other elements making them electrically inactive. These cells also suffer a 20% drop in efficiency within the first months of operation before stabilization and, therefore, are sold with power ratings based on their degraded performance. Other types of thin film cells include copper, indium, selenide galide (CIGS) and cadmium telluride (CdTe). These cellular technologies offer greater efficiencies than amorphous silicon, but contain rare and toxic elements, including cadmium, which requires additional precautions during manufacturing and final recycling.

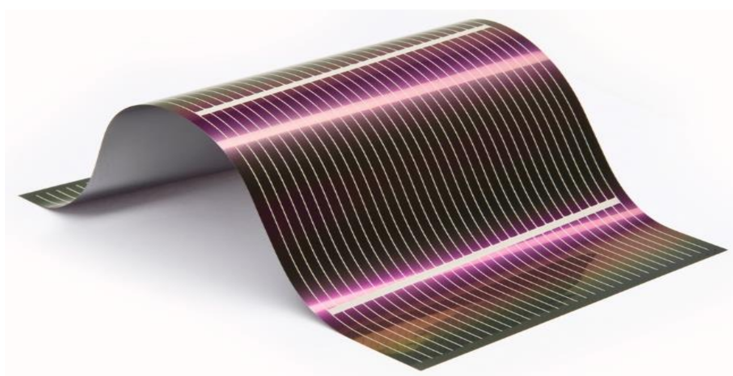

Fig 2.15(c): Thin Film Cell

2.11 On-Grid Solar System

Solar systems connected to the grid or connected to the network are by far the most common and extensively used by families and businesses. These systems are connected to the public electricity network and do not require battery storage. Any solar energy that you produce from a system in the network is exported to the electricity grid and, in general, you are paid a fee for the energy you export.

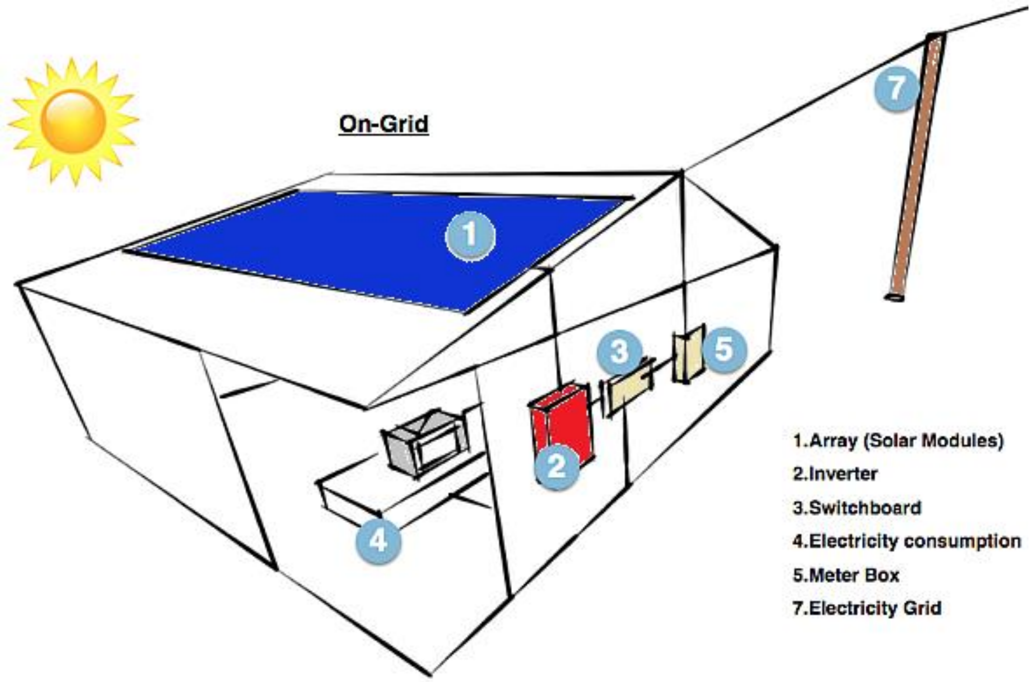

Fig 2.16(a): On-Grid solar system

On-grid and off-grid solar systems component and working methods are same. But something is there different. In on grid system, there is no need for a battery for storing energy. The generated power is used home and export the power in the electricity grid. On the other hand, for the off-grid system, there is a battery for storing energy and power, not export in the electricity grid.

2.11.1 Advantages and disadvantages of on grid solar systems

Advantages:

1. It is comparatively easier to install since there is no require a battery system.
2. It has the advantage of the effective use of the generated energy because there are no storage losses involved.

3. It is a 100% efficient battery, which has the potential to absorb all the additional energy [21].

Disadvantages:

1. These provide less incentive to conserve.
2. These are battery-less systems, which provide you with no backup.

2.12 Off-Grid Solar System

An off-grid system is not connected to the electricity grid and therefore requires battery storage. It only for home. An off-grid solar system must be designed properly so that it will generate enough power throughout the year and have enough battery capacity to meet the home's requirements, even in the depths of winter when there is less sunlight.

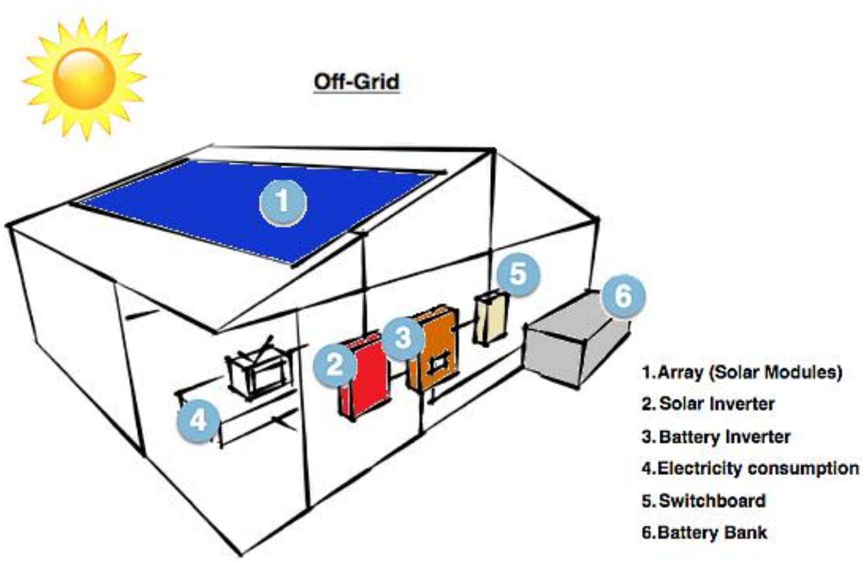

Fig 2.16(b): Off-Grid System

The battery bank. In a system outside the grid, there is no public electricity network. Once the appliances use solar energy, any excess energy will be sent to the battery bank. Once the battery bank is full, it will stop receiving energy from the solar system. The devices will consume energy from the batteries when the solar system does not work.

2.12.1 Advantages and disadvantages of solar off-grid systems

Advantages:

1. These are less expensive.
2. These systems are good in terms of expandability.
3. These systems help to make efficient use of electricity, which benefits the environment.

Disadvantages:

1. These require regular maintenance and troubleshooting.
2. Batteries of off-grid systems have less tangible cost, which means energy waste.

2.13 Solar Systems in Agriculture

Solar power technology would be a logical choice for agricultural tools. Solar energy is an alternative renewable energy that is increasingly becoming normal due to cost probability and high efficiency. Power producing for offices and home, solar energy can be used to power dryers, cookers, lighting, solar stills, refrigeration, and even air conditioning. There is expanding utilization of sunlight based vitality for rural purposes, which devours a lot of intensity on the planet.

2.14 Advantages and Disadvantages of Solar Rooftop system

(a) Advantages

1. Solar energy is a clean and renewable energy source [22].

2. Diminishes Electricity Bills.

3. Low Maintenance Costs.

4. Solar power is pollution free and causes no greenhouse gases to be produced after installation [23].

5. Solar energy sources no pollution.

6. Solar cells make unconditionally no noise at all.

7. Additional power can be sold to the power company's electrical network.

8. Can be installed practically anywhere in a field to on a building.

9. Use batteries to store additional energy for use at night.

10.Safer than traditional electric current.

(b) Disadvantages

1. Material and installation initial costs is high.
2. Uses a Lot of Space.
3. If there is no solar power at night then need for a large battery bank.
4. Electricity generation depends totally on a countries contact to sunlight this could be limited by a countries climate.
5. Devices that run on DC power straight are more expensive.
6. It do not produce much energy in cloudy days.
7. Lesser manufacture in the winter months.
8. The pollution related to solar energy systems is much less related to other sources of energy, solar energy can be connected to pollution.

2.15 Solar home system(SHS) in Bangladesh.

Bangladesh has a history of achievements in the development of off-grid rooftop solar energy, known as the solar system (SHS), which has provided electricity to a large number of people living in areas outside the network remote and that otherwise would not have electricity. More than four million SHS installed nationwide have elevated the lifestyle of these impoverished people by providing them with small-scale energy in their homes. But in the situation of demand and generation of national energy, the contribution of SMS is small, barely 250 megawatts, which represents only two percent of the total capacity of power generation in the country. In fact, in the solar industry worldwide, the generation of solar energy on a large scale essentially means solar energy in the network (connected to the grid). According to the government's plan, renewable sources must provide approximately 10 percent of the total power generation capacity by 2021, importing 2400MW of power generation from renewable sources. The prospect of wind energy (currently total installed capacity is 2MW), bioenergy (current installed capacity of 1MW) or new hydropower has been limited in Bangladesh and, therefore, the growth of renewable energy in Bangladesh will depend mainly of the development of solar energy in network. At present, the capacity of generating solar energy in the network amounts to 15MW (Sreda 2018), including a well-publicized solar park with a capacity of 3MW built on 8 acres of land in Sarishabari, in the district of Jamalpur. With such a low level of development, it would not be reasonable to believe that the growth of solar energy would reach something close to the goal projected for 2021. To date, the government has approved proposals to launch 19 solar energy parks on the network presented by different private companies. Separately, the proposed solar parks have a generation capacity ranging from 5 MW to 200 MW and the increasing power generation of all these facilities would amount to 1070 MW. Among them, only six companies have reached the final stage of negotiations through the signing of the power purchase agreement (PPA) and the application agreement with the government. According to the main regulation, a company must complete the construction and begin the generation of energy within a year and a half after the signing of the PPA and IA. Without tact, none of the companies could complete the construction and start generating power to date, although the deadlines have already passed. From the above, it seems that the development of solar energy in the network so far has not provided a realistic hope of achieving the goal of the projected government. One of the main challenges is the difficulty of buying land. According to the government's rule, agricultural land can not be used for the solar energy project. Bangladesh is a fertile and densely populated agricultural land, and non-agricultural land not used is not readily available. A 100MW solar park, for example, would require about 300 acres of land. It is expected that the efficiency of the solar panel will grow in the future through new technological developments, which will require a smaller area to generate per unit of energy. But until that happens, the purchase of land will be a major problem for the rapid growth of solar power in the network in Bangladesh.

2.15.1 The Associations working on Rural Solar Electrification

1. Bangladesh Rural Electrification Board. (BREB)
2. Infrastructure Development Company Limited. (IDCOL)
3. Local Government Engineering Department. (LGED)
4. BRAC Solar.
5. Grameen Shakti. (GS)
6. Bangladesh Solar & Renewable Energy Association. (BSREA)
7. Bright Green Energy Foundation. (BGEF)
8. InGen Technology Ltd.
9. Greenfinity Energy Limited.

2.16 Sarishabari power plant, Jamalpur

This is the first ever solar power plant in Bangladesh located at Shimla bazaar, Sarishabari of Jamalpur cohering eight acres of land. It stands in Sarishabari, Jamalpur, Bangladesh. Its main objective to growth the reliability of electricity to the consumers and enhance system generation capacity and to improve grid stability. The Project Performing Agency by Bangladesh Power Development Board (BPDB). Its Type of Technology is Grid-Tied Solar photovoltaic power plant (PV Module: Poly Crystalline). The Sponsor name is Engreen Sarishabari Solar Plant Ltd. Its Project Location is Sarishabari 33\11KV BPDB Substation, Jamalpur, Bangladesh. Total Area of this plant is 8 (Eight) Acre. This power Plant total capacity is 3 MW. Its Tariff cost is 0.1897 US Cent / KWh, Equivalent 14.7491 BDT / kWh (Exchange rate: 1 USD = 82 taka). The contract was Signed in 18 February 2015.This plant Evacuating Voltage 33 KV [24]. The edge of tendency is 38° in the winter and 7° in the summer. The solid purposes of network associated sunlight based power frameworks are: there is no fuel cost required, there is no clamor and vibration as plants work in a strong state with no moving segments, there are no carbon impressions and no outflow of ozone-depleting substance.

2.16.1 Technaf's Hnila solar power plant

The power plant in Technaf's Hnila has a capacity to produce 28 megawatts (MW) and will feed 20MW to the local substation during sunlight hours.

The Bangladesh Power Development Board or BPDB had previously signed a 20-year deal for 20MW of power with the plant's owner, Joules Power subsidiary Technaf Solartech Energy Ltd or TSEL, said TSEL in a statement. The solar plant is the first step towards the government's target of producing 2,000MW of solar power by 2021. The plant emits 20,000 fewer tonnes of carbon dioxide each year than a similar sized diesel-run plant does. The project was co-financed by One Bank Ltd and Standard Chartered Bank [25].

2.17 Top ten solar-producing countries

Over the next few years, the global solar energy leader board is set to change significantly. As momentum for solar gathers in large countries like India and the USA, it has been predicted that these nations will a make a massive leap forward on the global stage. We take a look at what the global top 10 energy rankings are predicted to look like in terms of installed capacity. here are the top 10 solar-producing countries: China, United States, Japan, India, Germany, Italy, France, United Kingdom, Australia, Pakistan.

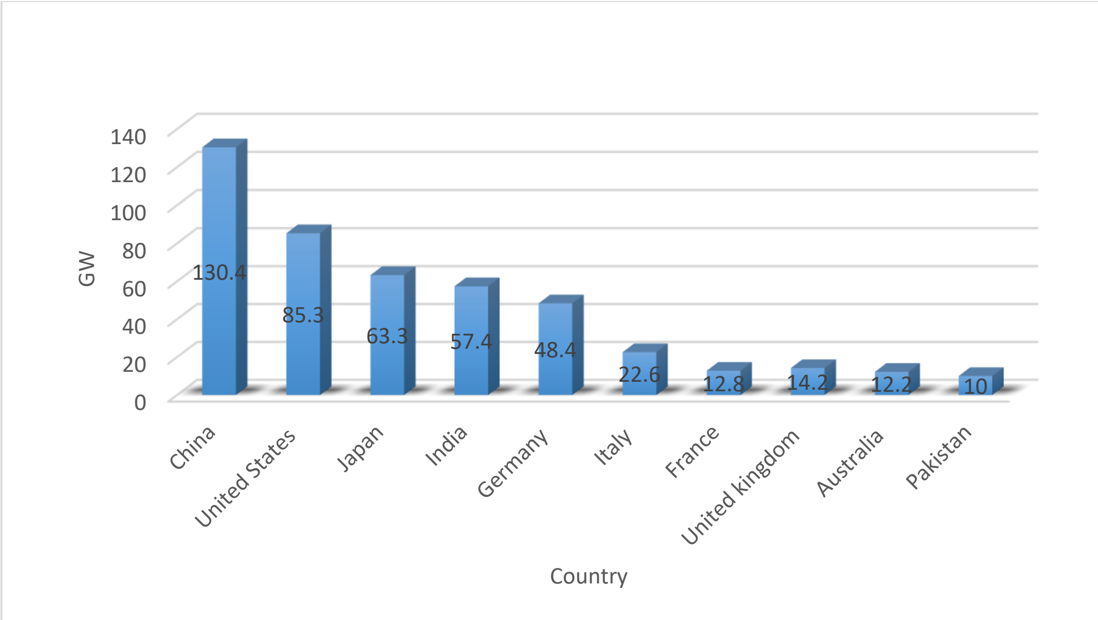

Fig 2.17: Top ten solar countries chart.

2.18 Summery

In this chapter, we come to know solar energy records and components of the solar device. We additionally recognize that the additives element details. The solar running principle is also defined right here. Additionally, defined a part of solar device components. We understand how solar photovoltaic work. Additionally, explain approximately solar On-Grid and Off-Grid system. Here we recognize about a few solar power plant and also know about the Solar home system in Bangladesh.

Chapter 3

Research Methodology

3.1 Introduction

This chapter eventually comprises the analysis methodology of the survey. NOCS Narayanganj. DPDC was infrequently visited for this survey. In additional details, during this section, the originator outlines the analysis strategy, the analysis methodology, the analysis approach, and the strategies of information assortment, the choice of the sample, the analysis method, the sort of information analysis, the moral issues and therefore the analysis limitations of the project. This audit was intended to research the socio-economic effects of the solar roof system and find the answers about what do the users think about its appropriateness. This study is applied to the business and industrial areas of Bangladesh. As the survey initially based on social analysis, some qualitative and quantitative methodological approaches are applied. 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

1. First of all we go to Narayanganj DPDC office where we can group two east and west
2. I were served west side of the solar system some home and grid systems and some home off-grid systems.
3. Most of the people do not want to take solar system but it has taken by the government policy and also very big problem initial cost is high.
4. Surveys on Solar Systems Here, most of the solar system users know how to maintain the solar system.
5. Some people doesn't know about off-grid and on-grid system.

3.3 Flow chart of the working procedure

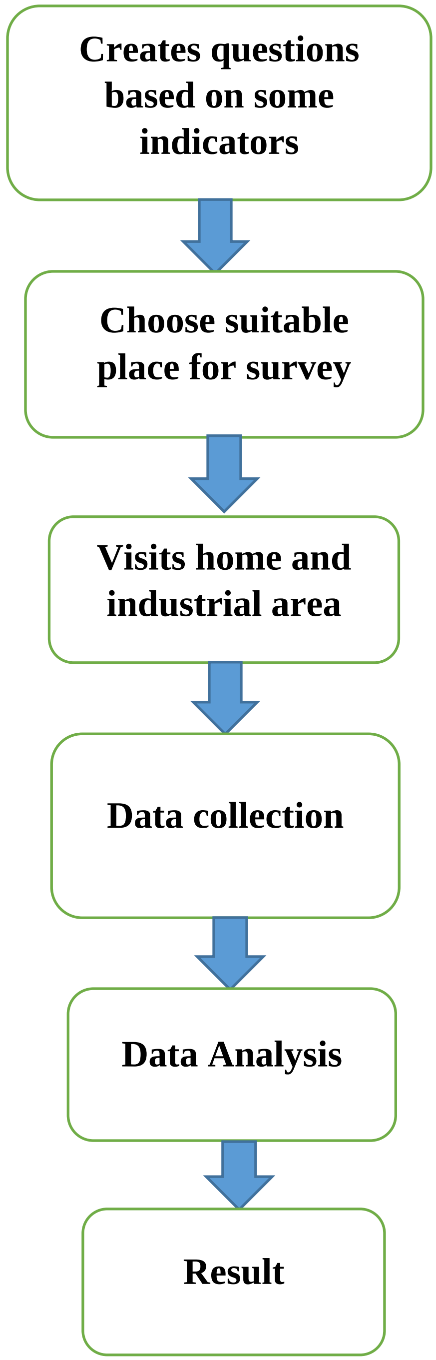

Fig 3.1: Flow chart

3.4 Research area

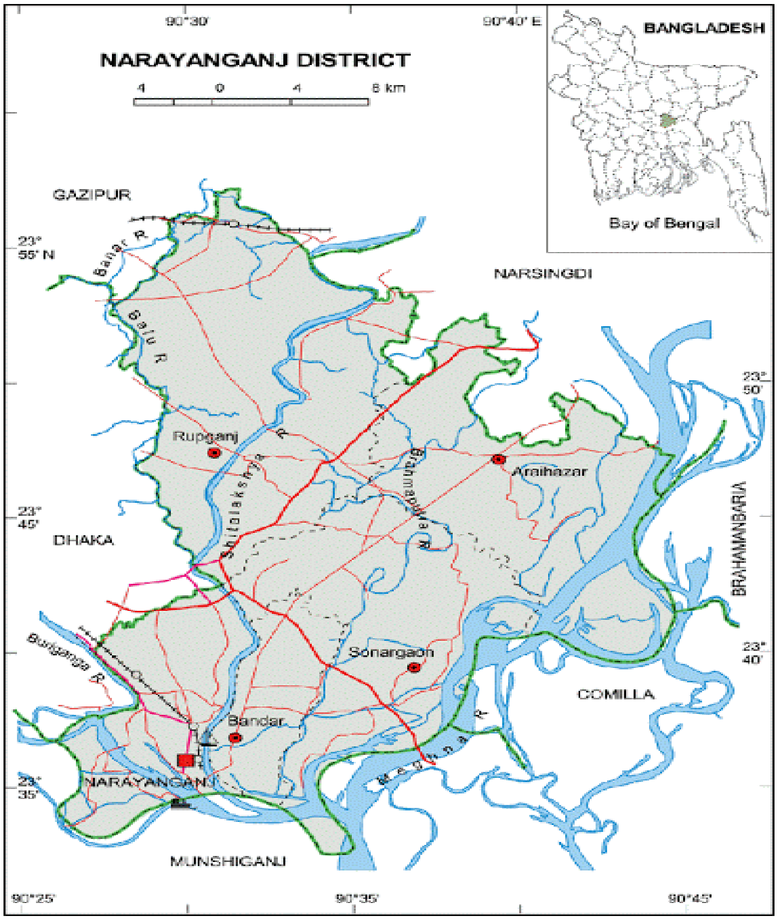

Fig 3.2: Survey Location

Narayanganj District is a district in central Bangladesh, part of the Dhaka Division. The ancient city of Sonargaon is in Narayanganj. Its located in the bank of Meghna and Shitalakshya River . The main center of the district is Narayanganj City. Its adjuncts with is capital city of Dhaka. Narayanganj is one of the oldest industrial District of Bangladesh. The area of the city is 33.57 km^2 (12.96 square meters). It is also a center of business and industry, especially the jute trade and processing plants, and the textile sector of the country. It is nicknamed the Dundee of Bangladesh due to the presence of many jute mills. Dundee was the first industrialized "Jute polis" in the world. It is number one district for economy of Bangladesh.

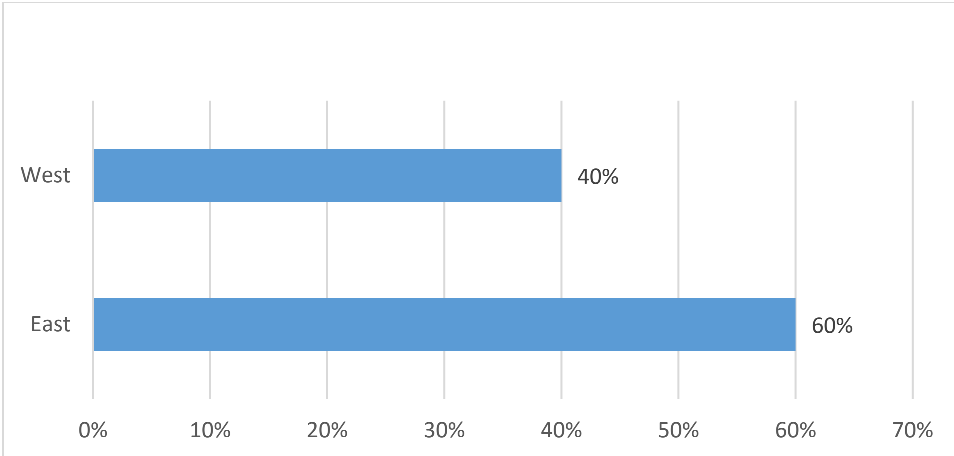

Fig:3.3: Total consumer chart

We see from the graph Narayanganj East side has about 60% solar user and the remaining 40% is on the west side. Since there are many sand wood and garment factories on the west side, so the solar system is used less on the west side.

3.5 Survey Questionnaires 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	i) Why do you install this SRS? ii) How many days ago you install this SRS? iii) What kind of solar roof top system SRS are you using? iv) 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	i) Is your SRS in operation? ii) Do you test it regular basis? iii) What is the main reason of system disorder? iv) Do you want to repair it? v) Do you get any training for SRS operation? vi) 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 noted here.
04	Consumer Satisfaction	i) Do you think this SRS are useful? ii) Do you think it is a waste of money? iii) Do you face any kind of survey? iv) Do you want to increase capacity of your SRS? v) Do you satisfied to use SRS?	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	i) What is the total cost of your SRS? ii) Is the meter reading of the solar electricity taken? iii) Do you have record on solar electricity? iv) 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.

3.6 Summery

Solar system is the best way to use solar system, so if there is no harm in the environment when producing electricity but There are many major problems for the rain time then The solar system does not work properly in cloudy sky. In this chapter, the proper details over Survey site are explained. In addition, the consumer name, consumer address, survey questions, and visited area are also described intricately.

Chapter 4

Result

4.1 Introduction

This chapter contains the decision of the study where the analysis of the thesis result is prominently described. Also, it takes a look over the consumer information about how many consumers use the SRS system and the chart is also demonstrated in this article. It also provides the maintenance result, consumer satisfaction, and cost analysis according to the consumer answer, additionally with all the correlated charts.

4.2 Consumer Information

The following chart has been made from approximately 15 consumer information.This consumer's area is Fatullah, Chashara, Basic area, Kutubail and Hajiganj.

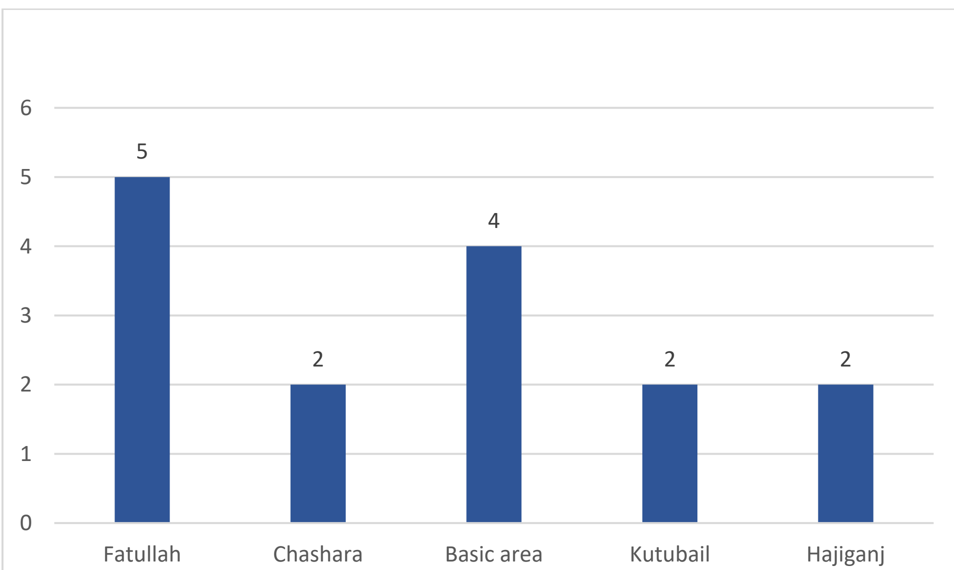

Fig 4.1: Total Consumer area.

4.3 Installation Information

Most of the consumer informed that the SRS was actually installed by Policy obligation of Electricity connection. And 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. Some people said that they bought this system on their own choice from the market. And some people installed it from policy obligation.

4.3.1 Installation Source

This survey report found that there is 11 consumer installed solar system from the policy obligation and only 4 consumer installed it by their own choice overall 15 consumers.

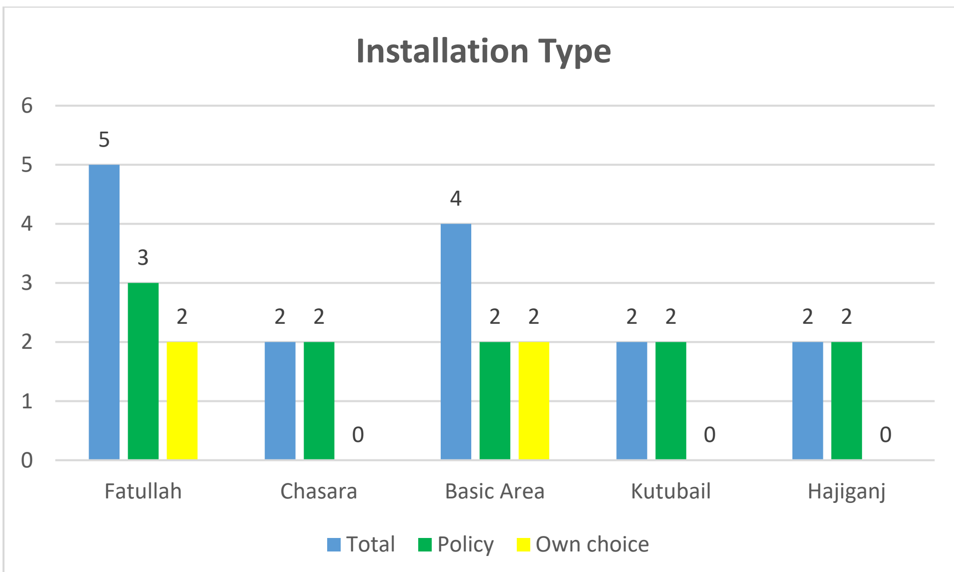

Fig 4.2(a): Type of install Chart

4.3.2 Buying System:

This survey report found that only 20% of the solar system is bought from the market, 80% has been taken from the Solar System Agency because they are not aware of the solar system.

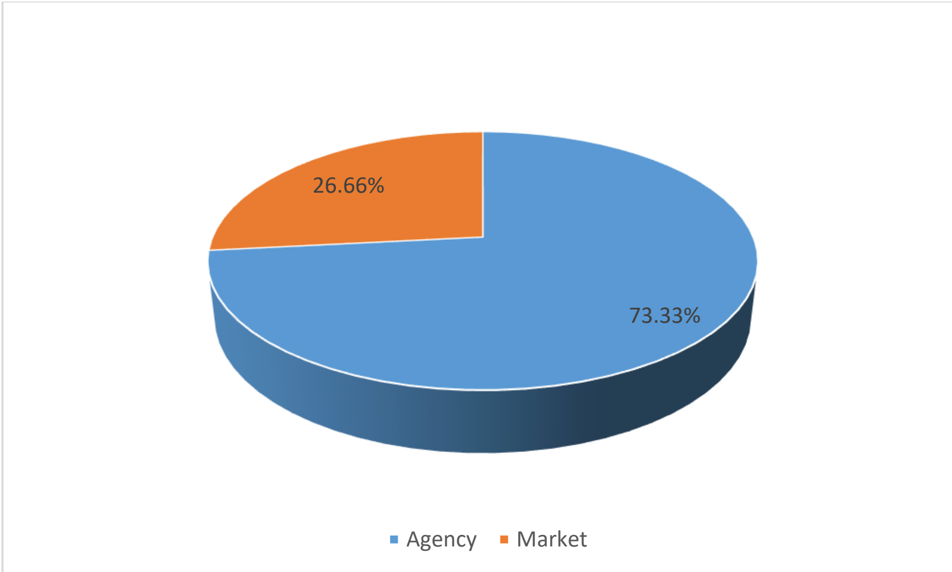

Fig 4.2(b): Buying System chart

4.3.3 Installation year

The maximum Installation of SRS was in 2017 and the minimum installation of SRS was in 2018.

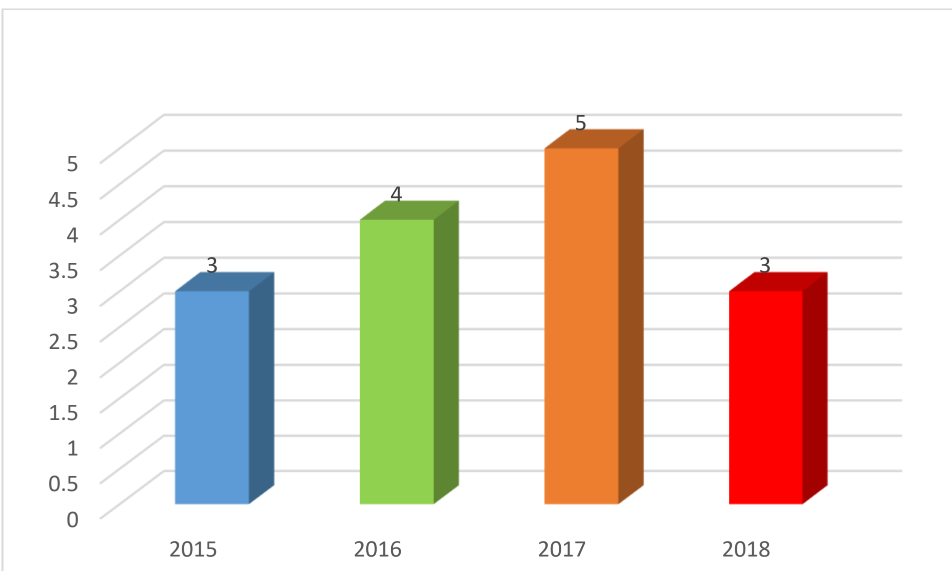

Fig 4.3(c): Installation Chart

4.3.4 Grid Types of solar

In our Survey time we found that 9 consumers are used this system for their own use and 6 consumers use it for own home and export the power in the grid.

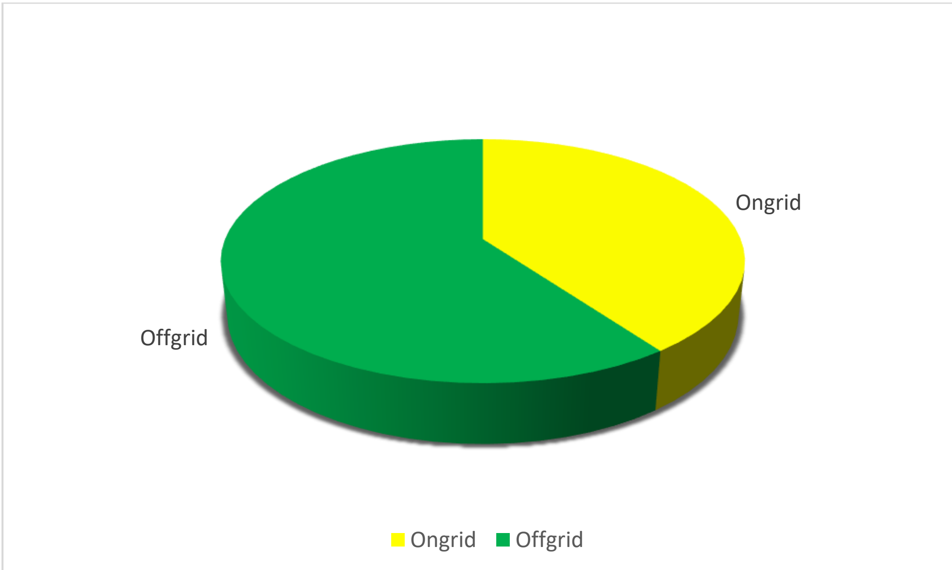

Fig 4.3(d): Kind of solar rooftop system

4.4 Maintenance Information

From this chart we see that only 3 consumer clean the panel,2 consumer check the equipment,5 consumer keep the record and 4 consumers want to repair disordered system other hands 12 consumer doesn't clean the panel,13 consumers never test the equipment,10 consumers have no record and 11 consumers not want to repair the disordered system.

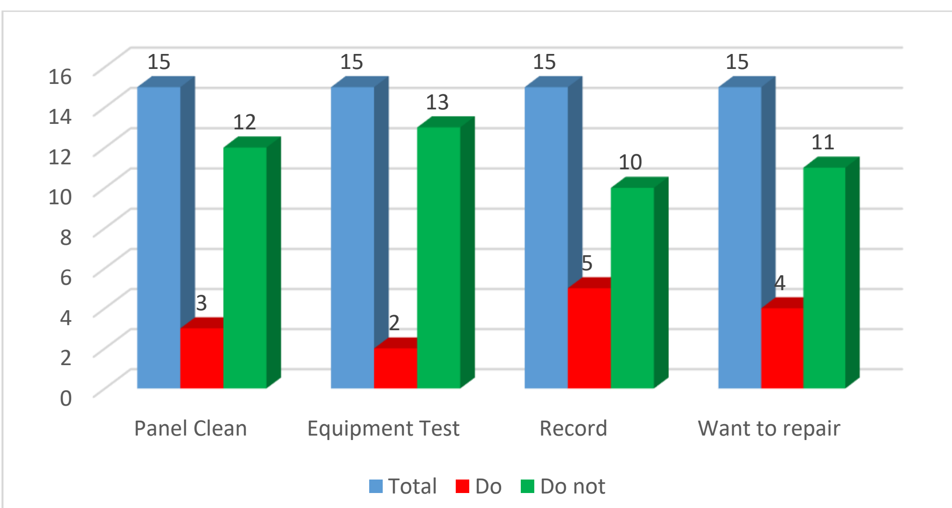

Fig 4.4(a): maintenance information chart

4.4.1 Operation

Operation in SRS means does the solar system work or does not work. In my surveys report, 90% of the solar system is in Work and 10% no work, here due to the battery charge controller and solar panels, some solar systems do not work.

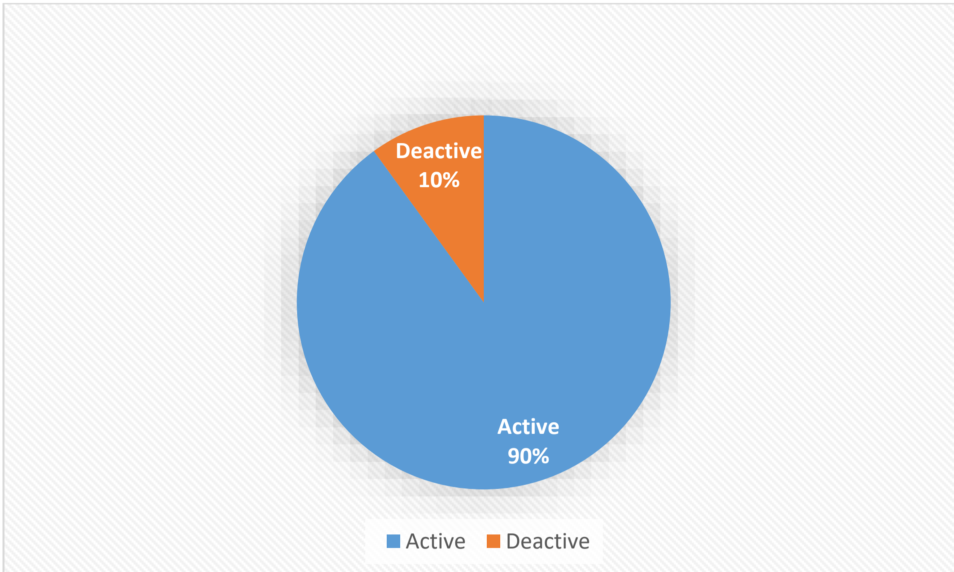

Fig 4.4(b): Operation in SRS chart

4.5 Consumer satisfaction

Some consumer is satisfied and some are not and others have no comment about this. Some consumers think solar system waste of money. Its maintancy is large. large space is taken for install. But some consumer thinks it is useful though a waste of money it's give much electricity and export this energy earn money.

In this flowing chart, we see that 15 consumers are shown above where the result says that only 9 consumers are satisfied with the system and 4 consumers are not. Alternatively, 1 of them did not comment on this question.

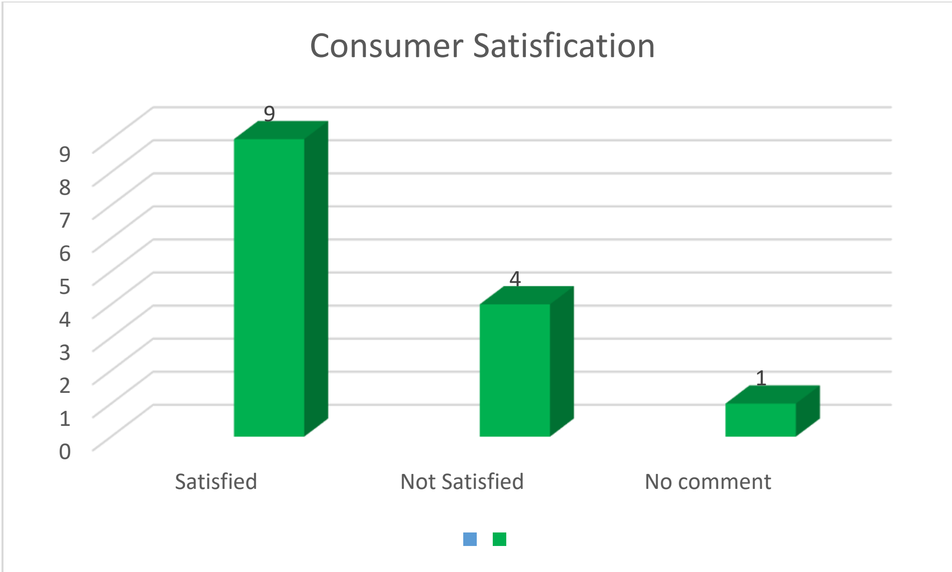

Fig 4.5 (a): Consumer satisfaction chart.

4.5.1 Consumer Opinion

In this flowing chart, we find that 53% of consumers think that SRS is useful in daily life and 34% of consumers think that it's installed system is a waste of money. Only 13% of consumers didn't make any comment for this question.

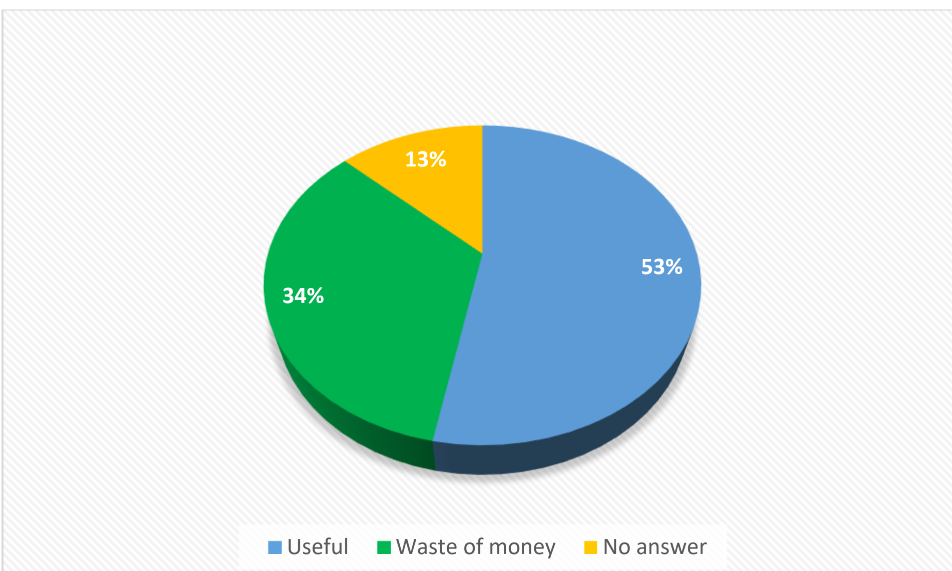

Fig 4.5 (b): Consumer opinion chart

4.5.2 Capacity Increase

Solar system uses only 8 consumers want to increase solar system but the rest 5 of the consumers do not want to increase the solar system because they think the installation of solar system cost is more.

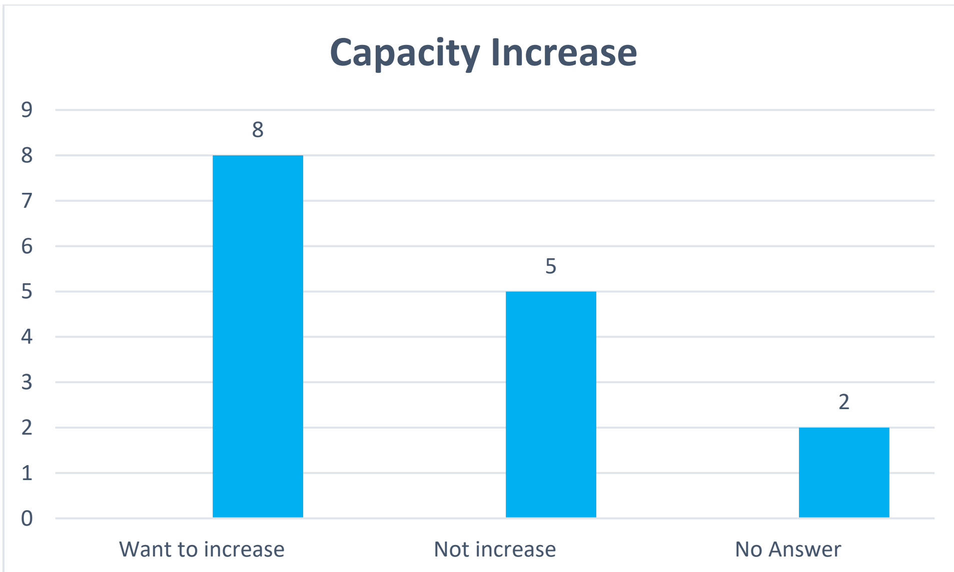

Fig 4.5(c): Capacity increase chart

4.6 Cost analysis

K.Khan Classic Tower 55/58 S.M. Malleh Road, Narayanganj brought a SRS by181250 Tk in september 2017. Installation capacity is 2.5 kWh. The system was Installed 1.5 year ago. Present reading of the system is 3127.5 kWh. Life time of SRS is 15 years. What is the unit cost of this SRS per kWh?

Solution:

Date of Installation = September 2017

Total cost of SRS = 181250 Tk

Present Reading = 3127.5 kWh

Installed capacity = 2.5 kW

$$In\ 1\ month, the\ SRS\ produces = 208.5\ kWh$$

$$In\ 1\ year, the\ SRS\ Produces = 2502\ kWh$$

$$\therefore In\ 15\ years, the\ SRS\ produces = 2502\ kWh \times 15$$

$$= 37530\ kWh$$

$$So, the\ \text{cost}\ of\ SRS\ Per\ kWh = \frac{181250}{37530} = 4.82\ Tk$$

SL No:	Name of Consumer	Total cost of SRS	Installation Capacity	Electricity Produce From Installation	Life Time	Cost per Watt
01	Anwar Fashion Lit. 5 No North Hajiganj, Fatullah Narayanganj.	2,32,320 Tk	3.2 kW	6 months - 2135.04 kWh	15 years	3.6 Tk/kWh
02	Jahanara Garden 40/1 New Khanpur Bank Colony, Narayanganj	1,97,400 Tk	2.8 kW	8 months - 2490.88kWh	15 years	3.5 Tk/kWh
03	K.Khan Classic Tower 55/58 S.M. Malleh Road, Narayanganj	1,81,250 Tk	2.5 kW	15 months - 3127.5kWh	15 years	4.82Tk/kWh
04	West Apparels Woabdapul/Aynaeatpur, Narayanganj	1,05,750 Tk	1.5 kW	1 year - 2001.6 kWh	15 years	3.5 Tk/kWh

05	Mersas Amzad Dying Kutubail, Fatullah, Narayanganj	75,000 Tk	1 kW	6 months - 673.2 kWh	15 years	3.7 TK/kWh
06	Rajiya Tower 32/41 Esha Kha Road Shitalakshya, Narayanganj	3,38,400 Tk	4.8 kW	1 year 6364.8kWh	15 years	3.5 Tk/kWh
07	Eye Ar Bulb Company 615-Noyamati,Fatullah ,Narayanganj	3,30,000 Tk	4.7 kW	Not operation	15 years	-----------
08	Pace View 39 Khanpur, Fatullah, Narayanganj	1,63,206 Tk	2.5 kW	14 months - 3904.6 kWh	15 years	3.2 Tk/kWh
09	Model D Capital 02 No Hajiganj, Narayanganj	3,94,200 Tk	6 kW	9 months - 6053.4kWh	15 years	3.2 Tk/kWh
10	Mersas Rasel Nitting 37, Esha Kha Road, Narayanganj	1,35,000 Tk	2 kW	7 months - 1566.6 kWh	15 years	3.3 Tk/kWh

11	P.M Nittex Godnail, Narayanganj	-------------	-------------	Data not collected	15 years	-----------
12	Prime Jeans Culture 32 Esha Kha Road, Narayanganj	2,17,500 Tk	3 kW	1 year - 4042.8 kWh	15 years	3.5 Tk/kWh
13	Paradise Complex Kutubail, Fatullah, Narayanganj	--------------	--------------	Data not collected	15 years	-----------
14	Lab-Aid Chashara, Narayanganj	1,06,200 Tk	1.5 kW	1 year 2663 kWh	15 years	2.59 Tk/kWh
15	Moyna Bhobon 43/3 North Chashara, Narayanganj	2,95,000 Tk	2.5 kW	1 year 1334.4 kWh	15 years	3.2 Tk/kWh

Table 4.1: Consumer information and correlated data.

4.7 Result analysis

This thesis reports that most people do not check whether the solar system works or not, then the solar system does not clean it regularly. Solar systems are used to get the entire Building Solar System for Government Policy. Most people buy the solar system and do not buy it from the market and the agency is at a higher price. Most people using solar system do not keep meter readings because of the use of electricity. How to maintain a system using solar system and never use the solar system? Solar system users, it is a good solar system, but nobody wants to increase the solar system because the primary cost is much more. The solar system is very small and grid attached to most of the bullet-off grids. The government has not helped the government to use the solar system.

4.8 Thesis findings

1. Initial cost is high for install solar roof top system, this is the very big problem in our country because our country economy situation is very less
2. This thesis reports find that most people do not check the solar system works or not, then the solar system does not clean it regularly.
3. some people don't have enough training about the solar system.

4.9 Summery

From this chapter we find our survey questions answer from the consumer. And we make charts from their answer.

Chapter 5

Conclusion

This document analysis in the solar roof system with its utility and meaning for modern society. As technology itself grows day after day, human beings are getting used to this and using everything to improve their future. The advantages and disadvantages, several limitations of the sunroof system have been discussed here. As mentioned above, the survey was conducted with the assistance of the DPDC. DPDC is a very familiar name. It is one of the best practical fields for electrical and electronic engineers in our country. This initially started to analyze the current solar power system at Dhaka Power Distribution Company. Around 15 domestic solar systems formed in Fatullah, Chashara, Basic area and Hajiganj in the Narayanganj area have been surveyed at random. It is very unfortunate that most systems have been found inactive or not connected properly. Although urban people are more likely to know about the efficient use of solar energy, they still prefer fossil fuels for their generation of energy. In this way, they are contributing indirectly to environmental hazards and also spending a lot of money. The main objective of our fieldwork is to analyze all the possible information of solar systems, such as cleaning, operation, network measurement system with respect to energy supply and cost. To influence people, we try to circulate the usefulness of the system and inspire them to increase the generation of energy from solar energy, as well as the number of solar panels that depend on renewable energy. In this study and survey period, this was the initial basis to study whether users of the system are taking it in a positive way or not. In this study, it is found that most people do not know the importance or usefulness of the sunroof system. Being among the developing countries, the government obviously should be concerned about the growth of the system about how the system can develop in modern society.

5.1 Future work

Now we surveyed on solar system in Narayanganj, our next goal is to survey the solar system on whole Dhaka city

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