

SOLAR ROOF TOP SYSTEM (SRS) ON BANGLADESH

**A 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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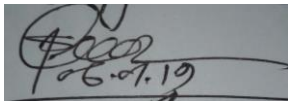
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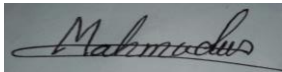
We finally declare our paper on the base of our research and survey work. We complete our paper entitled 'Solar Roof Top System (SRS) on Bangladesh' under my supervision. He has completed the report as a partial fulfilment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering, Daffodil International University.

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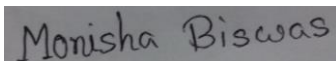


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‘Dedicated to our beloved parents’

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List of Abbreviations

BPDP	Bangladesh Power Development Board
REB	Rural Electrification Board
LGED	Local Government Engineering Directorate
IDCOL	Infrastructure Development Company Limited
NGO	Non-Government Organizations
SHS	Solar Home System
SRS	Solar Roof Top System
UK	United Kingdom
US	United States of America
ISA	National Renewable Energy Laboratory
NREL	Root Mean Square
BARC	Bangladesh Agricultural Research Council
RED	Rural Economic Development Initiative
TMSS	Thengamara Mohila Sabuj Sangha

List of Symbols

λ	Wavelength
c	Light's wavelength
η	Efficiency
h	Plank's Constant
n	Mode index
f	Fundamental Frequency
ω	Angular frequency
E	Energy

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ABSTRACT

This survey is an attempt to measure the impacts of Solar Rooftop Systems (SRS). After a brief review of previous survey works on SRS's importance, benefits and prospect, the study mainly focuses on the issues of SRS's impacts on the consumer's life. In this context, the literature of SRS related works is reviewed and afterwards, the methods and findings of an impact assessment study of SRSs in Bangladesh are described in detail. This survey study is based on data from a survey of 150 households from three former municipalities in our total unit. There are Narayanganj Municipality, Siddhirganj Municipality and Kadam Rasul Municipality. We survey 16 households where 8 household survey by me and 8 my partner. From the research findings, some recommendations for SRS dissemination programmers in Bangladesh are made. The research concludes with the following major findings

The utilization of SRS in the area of Bangladesh exhibits clear positive impacts. However, the economic impacts of the SRS are very limited as households lack knowledge and proper training of diversified uses of SRS for income generation activities.

On household level, children and women are benefited most as they spent most of their time within household premises using solar electric lighting and household appliances. At the same time, a large number of non-SRS households are being benefited indirectly from TV, radio, mobile phone, laptop and studying facilities from SRS households.

Positive environmental impacts are also observed as the substitution of traditional lighting fuels save carbon dioxide emissions.

CHAPTER 1

INTRODUCTION

1.1 Introduction

In the world renewable energy is becoming more popular day by day. Statistics show that quantity of consumption of fossil fuel is increasing at a higher rate in Bangladesh. The production of total electricity cannot fulfil the demand of the consumers adequately and many people do not getting sufficient electricity.

Now the public energy demand is increasing so government can't supply the whole energy that need to our public. Therefore, many Government and non-government organizations are working with different types of renewable energy sources such as solar energy, bio-gas, wind energy etc. to provide electricity to the common masses. In the process is more popular cause of its more advantages and many people solve their energy demand which they needed. Harnessing solar energy through solar PV has become popular in Bangladesh due to its decreasing price and soft loan system introduced by various financial institutions.

Besides, soundless, environmentally friendly and clean electricity can be obtained from such sources. Location of Bangladesh is one of the major factors behind the large use of SHS. At present, a good number of companies produce different sizes solar panels locally to meet the ever increasing demand of PV. People of the country has taken solar energy as the alternate of grid electricity.

However, they cannot rely on this new technology due to some management and technical problems. Therefore, to assess the overall prospect and constraint of solar home system is very important as there is a bright future of using solar PV panel based electricity generation in Bangladesh. It can be made as a reliable source of energy if some corrective measures are taken after critical study about the prospects, constraints, challenges and overall impacts on the users of solar roof top system in Bangladesh [1].

1.2 Problem Statement

In the perspective of Bangladesh the solar system is the one of the most important part of the renewable energy. We know that the sun offers the most abundant, reliable and pollution-free power in the world. Cause of that it's easy to produce energy because the sun light is available in the village or rural area or the roof top of the town building. So we can easily produce energy that we need to use. But if we transmit the national grid energy in the rural area it's very costly of our government if this area is need a small amount of energy. So in the both rural & city area we think that the solar base renewable energy is very effective for us.

It's very effective for the rural zone. Because the transmission cost of the national grid power is too high. So the calculation of cost we see that it's very harmful for the government. Cause they waste a high amount of money to a low amount of power. That's not effective for the government. So we use in the rural area solar roof top system or solar home system then it effective. So if we use in SRS then consumer easily get their energy and government easily save money.

In the city area we see that electricity faults regularly. Government should take more steps to solve this problem but they can't solve it properly. So now it's time to see another way to solve it. So we can use the renewable energy (SRS) for reducing the electricity faults. The solar roof top system is the best solution of the city area. In the city all buildings if we build up the solar roof top system then we can easily produce some power.

Solar energy based rural electrification begun in the country in 1988 at Norshingdi. Power Development Board (BPDB), Rural Electrification Board (REB), Local Government Engineering Directorate (LGED), Infrastructure Development Company Limited (IDCOL) and a significant number of private sector agencies including Non-Government Organizations (NGO) are involved in solar electricity development. Solar electricity is increasingly being used in a wide range of off-grid applications. Since the introduction of SHS, Bangladesh has installed more than 2.2 million units. In this context measuring the socio-economic impact of SHS would be an illustration for designing rural development alternative energy-model in the country [2].

1.3 Objectives

In the solar roof top system if we implement properly we can get easily benefited. So at first we set a target and then we complete it step by step. If we complete our goal then we minimize the pressure of power on the national grid using the renewable energy. Moreover some of the specific purpose of this exploratory research are-

- To provide training in installation, operation and maintenance of solar energy equipment.
- To provide maintain the existing PV system and keep the same in good repair.
- The equivalent impact of further growth in the solar energy sector on present power distribution system of Bangladesh.
- To collaborate with solar energy companies, utilities, and government to attract research grants from state and federal government agencies.
- To collected the consumer opinion about the SRS.
- In the socio economic impact in rural Bangladesh we want to try understand.
- The solar base energy system is a slow growth in the implementation and propose recommendation to fix the problem.

1.4 Scope of the research

From statement of problem section, it is already mentioned that, rural areas are not properly electrified though city areas have already come under the circulation of electricity. More over there is no real time line when remote rural areas are going to come under the supply of electricity. So, rural areas are the primary concern of this research. We basically gather the opinion of consumer and finding the problem then the next step is how solve this problem and how can improve this sector. This research is conducted from operational point of view. Other aspects such as technical, financial and social aspects of the subject are considered as secondary concern for the report.

1.5 Thesis Outline

This thesis is organized as follows:

Chapter 1 Introduction.

Chapter 2 Literature reviews.

Chapter 3 Methodology.

Chapter 4 Results and Discussions.

Chapter 5 Concludes.

CHAPTER 2

LITERATURE REVIEWS

2.1 Introduction

More we produce energy more we get power. Affordable, accessible and secure supply of energy plays a driving force for socioeconomic development of a country. A number of recent studies reveal how rural electrification from solar power in particular helps in socio-economic development of the country in various ways. In this circumstance, solar energy is widely perceived as a promising technology for electricity generation in remote location of the developing countries. This chapter attempts to focus on the review of selected literature, key concept of solar electricity as driving force for socio-economic development, issues and factors effecting socio-economic development like household income, health, education, agricultural production, access to information and other infrastructural services [3].

2.2 What is Energy?



Figure. 2.1 Energy

The various definition of energy. It's like as a constant amount because that the energy can't be created or destroyed. It simply changes his from to one from to another form. In simple definition of energy is called the ability to do work. Energy has various from in the world. But it's has some basic from of energy.

2.2.1 Forms of Energy

In our daily life we available use energy and its various form. In the world energy has various from. But it's has some basic from. There are some basic energy form:

- **Electrical energy:** Energy is the ability to do work, where work is done when a force moves an object. Electrical energy is energy that's stored in charged particles within an electric field. The electric field applies the force to the charged particle, causing it to move - in other words, to do work.
- **Potential energy:** This type of energy where we use the potential power to do work. Potential energy is the energy possessed by an object because of its position relative to other objects, stresses within itself, its electric charge, or other factors.
- **Heat energy:** Heat energy is the result of the movement of tiny particles called atoms, molecules or ions in solids, liquids and gases. Heat energy can be transferred from one object to another. The transfer or flow due to the difference in temperature between the two objects is called heat.
- **Thermal energy:** Here we use the thermal power to do work. Thermal energy can be transferred from one object or system to another in the form of heat. Is a great example of kinetic energy is thermal energy as it is due to the motion of particles, with motion being the key.
- **Water energy:** In this types of energy we use water and produce energy to do work. Like as the hydro power is the water energy. Here we use water to make power.
- **Solar energy:** Solar is the one of the best energy form. Here we use sunlight to generate power.
- **Mechanical energy:** Mechanical energy is the energy possessed by an object due to its movement or position. In other words, an object possesses mechanical energy when it has the ability to do work due to its position or motion.
- **Kinetic Energy:** In another form of energy is kinetic energy is the energy of motion, observable as the movement of an object, particle, or set of particle [4].

2.2.2 Classification of Energy

There are some different types of energy. These are:

- **Primary Energy:** Primary energy is the energy that we get easily to the nature directly. The primary energy is used to designate an energy source that is extracted from a source of nature resources that has not undergone any transformation or conversion other than cleaning or removing in this types of energy is Coal, Natural gas etc.
- **Secondary Energy:** The secondary energy is depend to the primary energy. Secondary energy refers to any energy that is obtained from a primary energy. Simply say this types of energy is converted to the primary energy is called secondary energy. If we say some example electrical energy, coke etc.
- **Commercial Energy:** The commercial energy is the energy that have a market price. In this type of energy we buying by money. In another word commercial energy are those that are traded wholly in the market place and have market price. If we see some example Coal, oil, Natural gas, Electricity etc.
- **Non-commercial Energy:** The non-commercial energy is the energy that have no market price. In this type of energy we buying by without money that means according do not have a market price. If we see some example Biomass such as firewood, Cow dust etc.
- **Conventional Energy:** The conventional energy is the energy where we get a high amount of energy. Here we generate a big amount of energy. In the other word conventional energy are those that are obtained through commonly technology. For the example Thermal, Hydro power plant, Nuclear power plant etc.
- **Non-conventional Energy:** In this types of energy we generate a little amount of energy. Non-conventional energy are obtained using new and novel technology. For some example Solar, Wind, Biomass, Geothermal etc.

- **Renewable Energy:** If the energy consume is lower than the energy generation then it's called renewable energy. In the other word if the primary energy is obtained from a constantly available flow of energy that energy known as renewable energy. In the present situation the renewable energy sector is spread day by day in outbreak. For example Solar, Wind, Water, Biomass, Geothermal etc.
- **Non-renewable Energy:** If the rate of power consume is not equal to the power generation then it's called nonrenewable energy. In the other word if nonrenewable source of energy is one where primary energy comes from a finite stock of resources. In the present situation the non-renewable energy is highly use in the world. For example Coal, Oil, Natural Gas etc.
- **Modern Energy:** In the modern energy is another energy sector. Modern Energy is an energy asset management firm that invests in businesses that bring emerging energy technologies to market and the energy resources those businesses produce [5].
- **Traditional Energy:** Fossil fuels, sometimes known as traditional energy resources or nonrenewable energy resources, are formed over millions of years by decayed animal and plant matter buried under rock layers. Traditional Energy Sources. Fossil fuels coal, oil and natural gas currently provide more than 85% of all the energy consumed in the United States, nearly two-thirds of our electricity, and virtually all of our transportation fuels. Three main types of fossil fuels are coal, oil, and natural gas [6].

2.3 Renewable Energy

In the present world situation the renewable energy is more popular for his various good side. The renewable energy is good for our environment. So now it's really need to increase the use of fossil fuel base energy system. If the energy consume is lower than



Figure. 2.2 Renewable Energy [7].

the energy generation then it's called renewable energy. In the other word if the primary energy is obtained from a constantly available flow of energy that energy known as renewable energy. Now the renewable energy is most important in the whole world. Cause of that if the nonrenewable resources to be finished then the world energy system face a horrible situation. That's the thought it's time to convert the whole energy system to make renewable.

2.3.1 Classification of Renewable Energy

There are some different types of renewable energy. In this renewable energy there are many forms. Other renewable energies that do not depend on sunlight are geothermal energy, which is a result of radioactive decay in the crust combined with the original heat of accreting the Earth, and tidal energy, which is a conversion of gravitational energy. Solar energy is the direct conversion of sunlight using panels or collectors. Biomass energy is stored sunlight contained in plants. Most of these renewable energies depend in one way or another on sunlight. Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted.

- **Solar:** The solar of energy relies on the nuclear fusion power from the core of the Sun. The range is from solar water heating with solar collectors or attic cooling with solar attic fans for domestic use to the complex technologies of direct conversion of sunlight

to electrical energy using mirrors and boilers or photovoltaic cells. This energy can be collected and converted in a few different ways. Unfortunately these are currently insufficient to fully power our modern society.

- **Wind Energy:** In the environment atmosphere is driven by differences of temperature at the Earth's surface due to varying temperatures of the Earth's surface when lit by



Figure. 2.3 A figure of Wind Energy.

Sunlight. Wind energy can be used to pump water or generate electricity for using ore daily life, to produce significant amounts of energy requires extensive area coverage.

- **Hydroelectric Energy:** The hydro electric energy generate use to water flow. Here first create a dam to reserve the water.

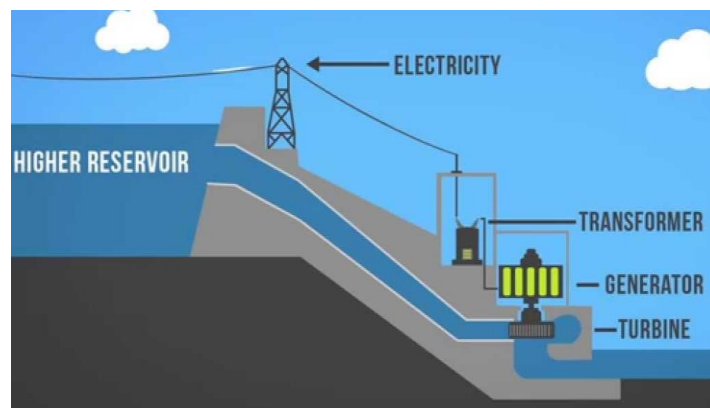


Figure. 2.4 A figure of Hydroelectric Energy.

When the full fill the reserve then the water flow the direct in the water turbine. When the water is reserve it's called potential energy but when the water is flow then the potential energy is convert to the kinetic energy and when the water flow in the turbine

then the kinetic energy is converted to the mechanical energy. At the final stage the mechanical energy is converted to the electrical energy using the alternator.

- **Biomass:** The biomass is the term for energy from plants. Energy in this form is very commonly used throughout the world.

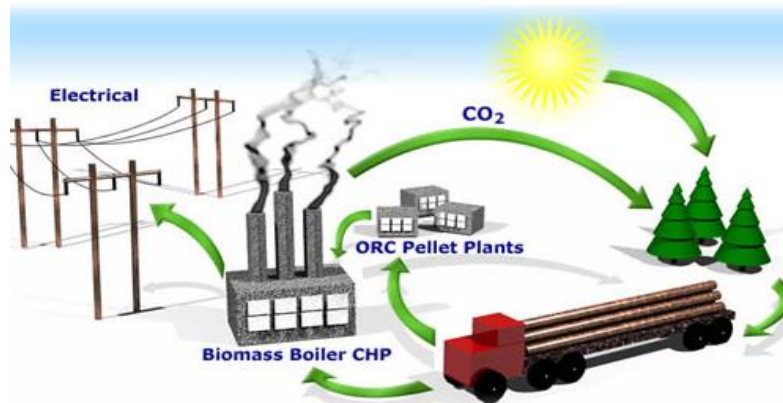


Figure. 2.5 A figure of Biomass Energy.

This process releases copious amounts of carbon dioxide gases into the atmosphere and is a major contributor to unhealthy air in many areas. Unfortunately the most popular is the burning of trees for cooking and warmth. Some of the more modern forms of biomass energy are methane generation and production of alcohol for automobile fuel and fueling electric power plants and use the daily life.

- **Geothermal Power:** It's the one of the renewable energy but it's too complex to using this power to generate electricity. This possibility is limited to a few locations on Earth and many technical problems exist that limit its utility. This power plant initial cost is high but after it running the cost is too little. The geothermal form of energy can lessen the need for other power to maintain comfortable temperatures in buildings, but cannot be used to produce electricity.

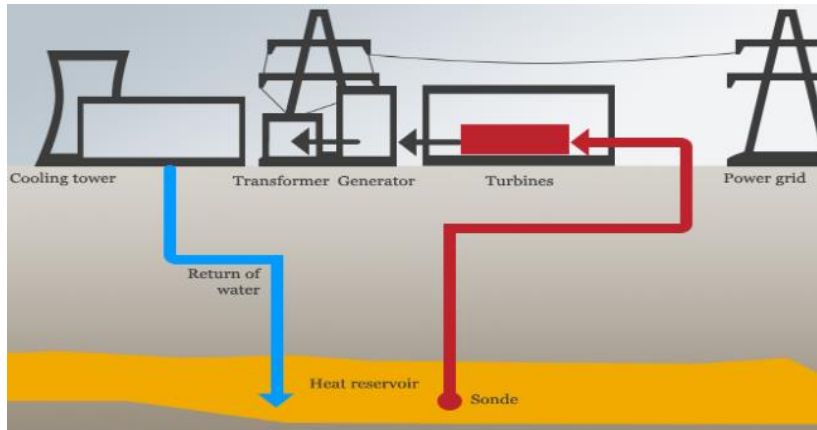
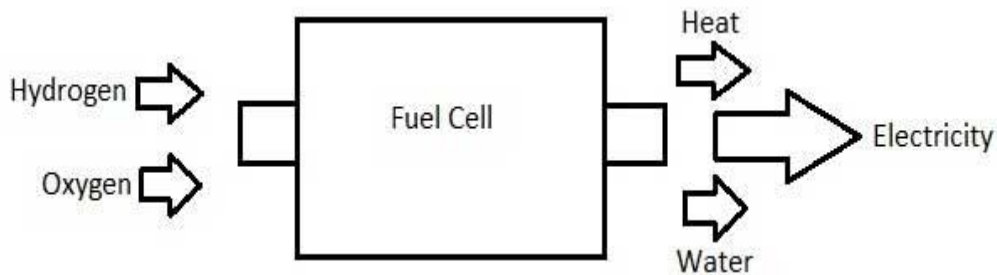


Figure. 2.6 A figure of Geothermal Energy.

- **Hydrogen and fuel cells:** These are also not strictly renewable energy resources but are very abundant in availability and are very low in pollution when utilized. Hydrogen can be burned as a fuel, typically in a vehicle, with only water as the



combustion product.

Figure. 2.7 Hydrogen and fuel cells energy.

This clean burning fuel can mean a significant reduction of pollution in cities. Or the hydrogen can be used in fuel cells, which are similar to batteries, to power an electric motor. In either case significant production of hydrogen requires abundant power. Due to the need for energy to produce the initial hydrogen gas, the result is the relocation of pollution from the cities to the power plants. There are several promising methods to produce hydrogen, such as solar power, that may alter this picture drastically [8].

- **Other forms of energy:** Energy from tides, the oceans and hot hydrogen fusion are other forms that can be used to generate electricity. Each of these is discussed in some detail with the final result being that each suffers from one or another significant drawback and cannot be relied upon at this time to solve the upcoming energy crunch.

2.3.2 Advantages of Renewable Energy

The renewable energy is the one of the best way to produce energy without any harmful effect of our environment. Its various good effect that's we benefited and the environment is also benefited. So now it's time to changes to our mentality to increasing the using the fossil fuel base energy system. Now we discuss some advantages of renewable energy

- In the renewable energy resources is not limited resources its resources is unlimited.
- For the unlimited resources so we can easily get it. Cause its available everywhere that's why we continuously supply it all time when it need.
- When we consume power within a short period time it's can be punished. So it's a very good advantages for us.
- In the most of the resources are available locally and fairly non-polluting.
- In the one of the best advantages is it's maintain cost is too little and the repair cost also be little.
- After installation the renewable energy system supplies power in the long time period with a little amount of cost.
- Its economic benefited that's why these economic benefits may be from the increased use of local services.

2.3.3 Disadvantages of Renewable Energy

The renewable energy have more advantages then disadvantages. But it's also some disadvantages. The disadvantages is not the major issue if we compare its advantages.

- First cost or initial cost of the renewable energy is too high.
- This types of power plant can't be generate a high amount of power that's why its cant supply power continuously. That's why its limited supply.
- In the solar power when sunlight is not present or rainy day in that time it's can't be generate power.
- For hydro when occurs drought then the hydro can't generate power.

So we see that if we want to avoid this problem or disadvantages we should take more steps before the power plant installation. If we exactly solve this problem then the renewable energy is helpful for us.

2.4 Solar Energy

The solar of energy relies on the nuclear fusion power from the core of the Sun. The range is from solar water heating with solar collectors or attic cooling with solar.



Figure. 2.8 Solar Panels.

Attic fans for domestic use to the complex technologies of direct conversion of sunlight to electrical energy using mirrors and boilers or photovoltaic cells. This energy can be collected and converted in a few different ways. Unfortunately these are currently insufficient to fully power our modern society.

2.4.1 On Grid Solar Energy

The on grid solar panels is connected to the national grid. In this types of solar panels both the consumer and the government also be benefited. In this types of solar system first supply his producing power to consumer. If the consumer need 5kw in that time the solar system generate 10 kw then the solar system supply 5kw in the consumer house and the another 5kw supply in the national grid.

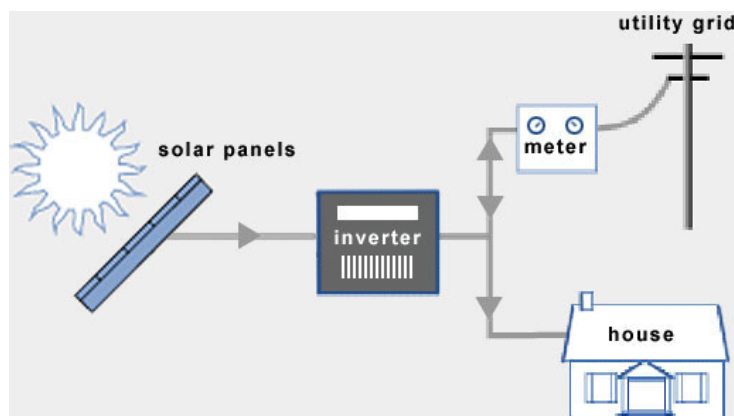


Figure. 2.9 On grid solar energy block diagram.

In this types of solar system is a great problem that when the grid outage then the system do not provide any power. In the on grid solar system we use dc/ac converter. Because our grid is ac current and solar system generate dc current.

2.4.2 Off Grid Solar Energy

The on grid solar panels is not connected to the national grid. In this types of solar panels only consumer to be benefited. In this types of solar system always supply his producing power to consumer.

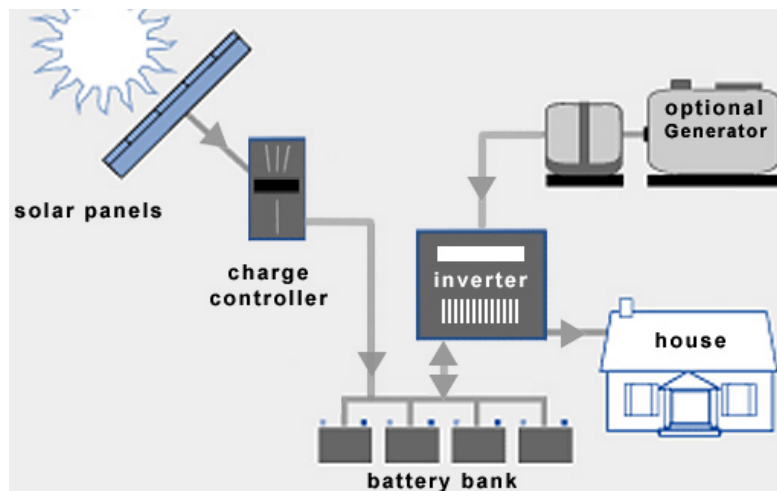


Figure. 2.10 Off grid ac solar energy block diagram.

The solar system supply power in the consumer all though the power grid is down. In this system specifically require a central/string inverter, a charge controller as well as a batteries.

2.4.3 Types of Solar Energy

There are two main types of solar energy system.

- **Photovoltaic:** Photovoltaic solar technology, which directly converts sunlight into electricity using panels made of semiconductor cells.
- **Thermal:** Solar thermal technology, which captures the sun's heat. This heat is used directly or converted into mechanical energy and in turn electricity, known as concentrated solar power. This heat is used directly (low-temperature solar thermal) or converted into mechanical energy and in turn electricity (concentrated solar power-CSP)

Two different types of installations are used:

- Individual systems for homes or small communities. Photovoltaic panels can power electrical devices, while solar thermal collectors can heat homes or hot water
- Photovoltaic or concentrated solar power plants that cover hundreds of acres produce electricity on a large scale, which can be fed into power grids.

2.5 How Solar Really Work

The solar photovoltaic systems, often called solar PV for short, are made up of a number of components, the biggest and most important being the solar panels, solar inverters, mounting platforms and cabling infrastructure.

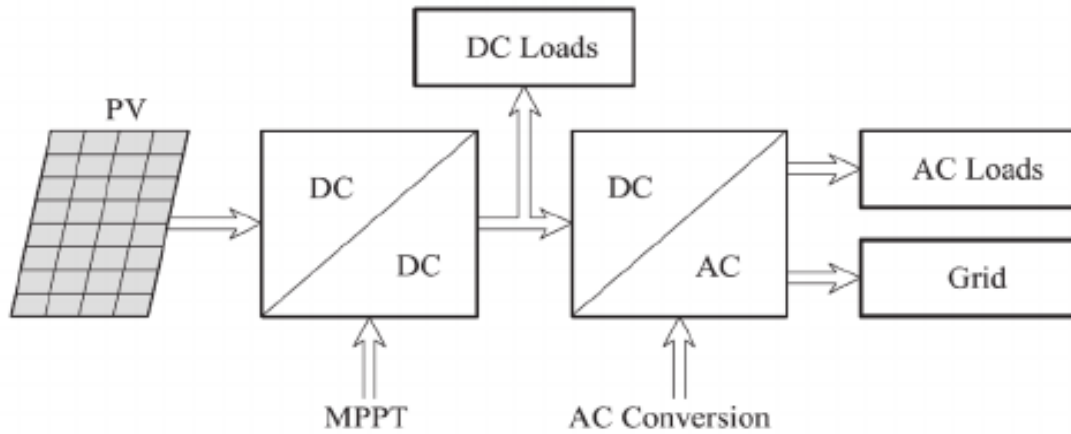


Figure. 2.11 Block diagram of solar system.

Combined, these components harness radiant light from the sun, convert it into electricity and transmit it into homes and businesses to power electrical devices, like lights and appliances, and provide heating and cooling via the electrical currents they create. Here is a general overview of how solar PV systems work [9].

2.5.1 Solar Panels

A solar panels how much electricity produce it's depend on three factors. This three factor is

- Panel's size
- Efficiency of solar cells
- Amount of sunlight that the solar gets.

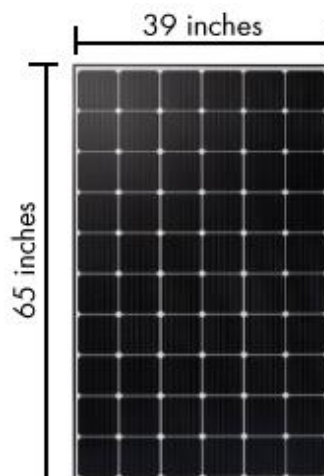


Figure. 2.12 A solar panels wide and length.

Now the think is that how much big a solar panel. Naturally a solar panel more than 5 feet tall and 3 feet wide. If you see the solar panel closely then you see that one solar panels have 60 little squares. These squares are actually individual solar ‘cells’ which are linked together by wires.

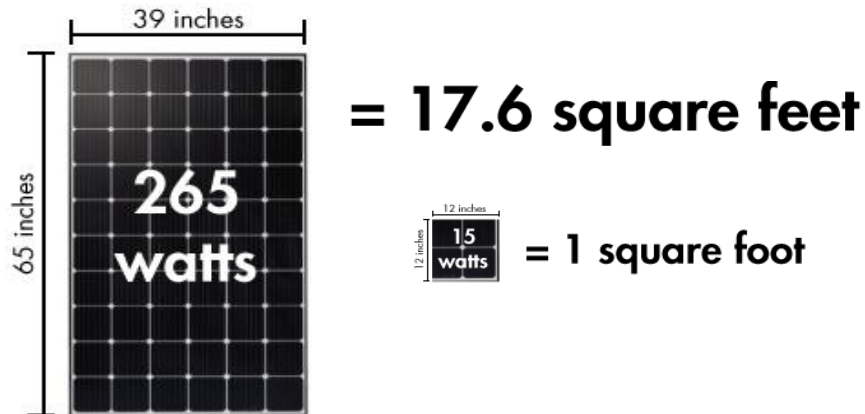


Figure. 2.13 A solar panel per square generation.

This cells made electricity then the wires carry the electricity to a junction box where the panel is hooked into a larger array. The average-sized solar panel takes up an area of 17.6 square feet and produces 265 watts under direct sunlight. That translates to just over 15 watts per square foot.

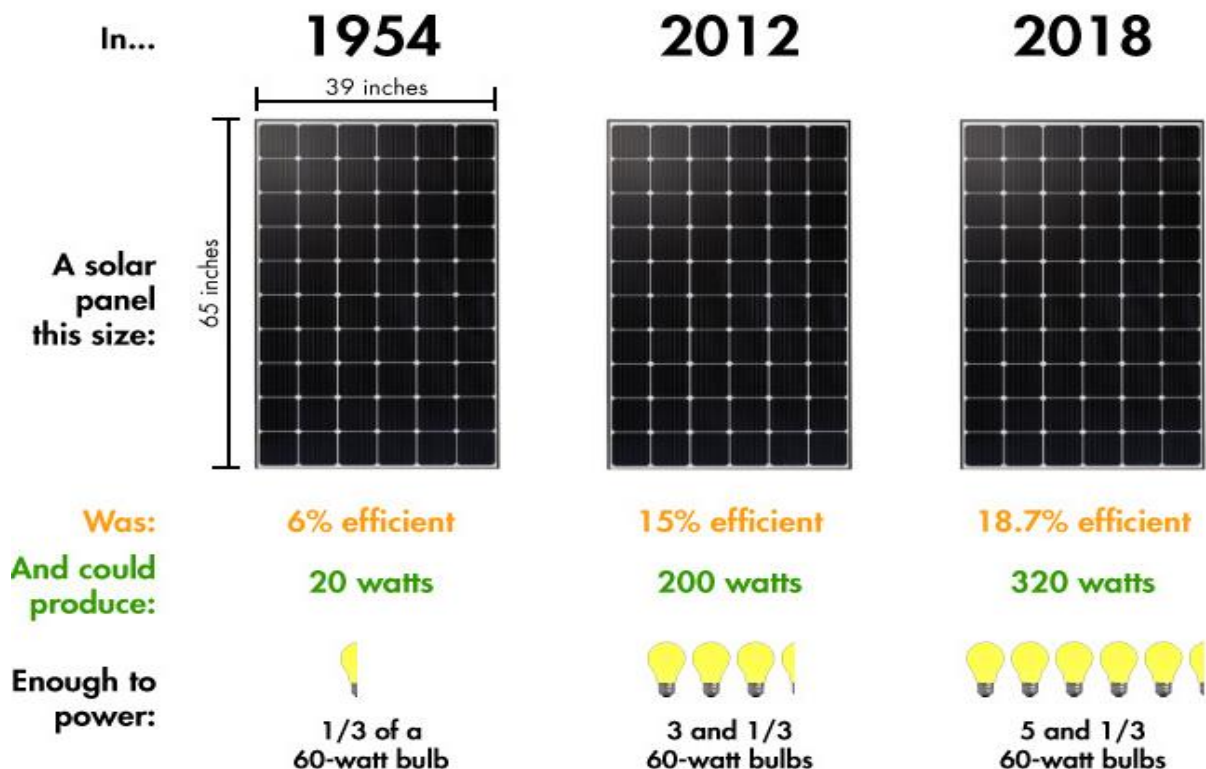


Figure. 2.14 Solar panels generation in different years.

In this figure discussion we see that the generation of power is increasing day by day all though the panel size is same. In 1954 the first solar cells were capable of taking 6% of the energy from the sun and converting it into electricity 20W. Then 2012 the first solar cells were capable of taking 15% of the energy from the sun and converting it into electricity 200W.

Finally 2018 the first solar cells were capable of taking 18.7% of the energy from the sun and converting it into electricity 320W [10].

So we see that in 1954 and 2018 the solar panels size is same but we see that the generation of power is increasing. In the next future this percentages is more increase than the present time. Solar panels can come in all shapes and sizes, but are typically comprised of a grouping of solar cells that are wired together and encapsulated by a glass casing that protects the equipment against the elements. Solar cells are essentially made up of semiconducting materials - often silicon - that are sandwiched together between positive and negative charges. When sunlight hits a cell, the photons within the sunlight knock electrons free from the semiconducting material. This starts the flow of electricity. Then, conductive plates made of metal on the sides of the cells gather the electrons and transfer them through wires. At this point, these electrons can flow just like any electrical current.

The solar panels themselves are perhaps the most well-known of all the system components, since they're the most visible part of the package, often perched atop homes and businesses roofs. Solar panels are also considered the life blood of a solar power system, because solar panels actually capture the sun's radiation, thereby initiating the entire process of converting sunlight into an electrical current. The job of solar panels is to essentially create the electrical current.

While there are a number of factors that determine the electrical output of a solar power system, the number of solar cells and overall size of the solar panel array, are the major determinants in how much electricity can be generated from a solar system. The more solar cells and larger the solar panel array is, the more electricity can be generated. They type of solar cells will also impact the efficiency with which a solar panel generates energy. Generally speaking, monocrystalline silicon is the most efficient material to use in solar cells. Polycrystalline silicon and thin film cells are also commonly used and are less expensive than monocrystalline.

2.5.2 Solar Inverters

This step is necessary, because solar panels cannot create AC power on their own and in the United States, most electrical devices run on DC power. In a DC system, the electrical current flows in one direction. By contrast, AC power is a bit more complex, moving in both directions, backwards and forwards.



Figure. 2.15 A figure of Solar Inverter.

Solar PV systems would be worthless without solar inverters - as such, many consider solar inverters the "brains" of the entire system. The way they work is, once radiant sunlight is converted into electricity, solar inverters transform the electrical current from direct current (DC) power to alternating current (AC), so it can actually be used in various applications. Typically, solar inverters are about 95% efficient, so they only lose about 5% of the electricity during the conversion process

2.5.3 Cables and Wires

Cabling networks can vary, but typically are designed to be UV and weather resistant and capable of dealing with extreme fluctuations in temperature (both heat and cold), since one common factor for these system is that they're used outdoors.



Figure. 2.16 Solar panels wires and cables.

The most common type of cabling used is a DC voltage of 1.8 kV and a temperature range from - 40 degrees Celsius to 90 degrees Celsius. This protects against the weather elements,

including the sun's radiation and humidity that would otherwise erode the system over time. Important feature of the solar cable is that it must be insulated well enough to withstand the thermal and mechanical loads. To achieve this, most solar cables use plastic that are cross-linked using electron beams.

2.5.4 Mounting System

Solar mounting systems must be installed according to local building codes. However, generally speaking, rooftop PV arrays are generally mounted parallel to the surface of the roof with just a few inches of space between the system and roof. Arrays are mounted at angles that enable them to optimize sunlight capture - i.e. closest to a 90 degree angle with the sun.

Finally, the mounting system is the skeleton of the solar power system. Mounting systems are the platforms upon which solar arrays reside. Most commonly, home and business owners mount their solar systems on top of their roofs so that they can gain greater access to direct sunlight. However, mounting systems can also be built on the ground or on other erected structures, like a pole.

2.6 Use of Solar Energy

Did you know that the amount of sunlight that strikes the earth's surface in an hour and a half is enough to handle the entire world's energy consumption for a full year? Solar energy has amazing potential to power our daily lives thanks to constantly-improving technologies.

- **Generating Electrical Energy:** Basically the solar energy use to generate the electrical energy. The three types of generating solar power. One is on grid system, off grid system and another is hybrid system. Solar (Photovoltaic or PV) panels turns photons from the sun into DC electricity. Micro inverters mounted on each PV panel will convert the DC voltage from the PV panel to voltage suitable for your home.
- **Solar Tech:** In the present world there are many types of solar base technology. In the common think our phone. There are many phone now us solar energy. They use the solar energy to charging the phone battery and so on. Calculator is most commonly equipment where we see that the solar energy use in highly.

- **Satellites:** The sun powers the biosphere, which is to say that the energy used by almost all plants and animals comes from the sun. So why not use solar energy to power industry, transportation, and the home as well? Well, a principal difficulty with solar power is that the sun doesn't always shine on a particular location: half the time the earth blocks the sun, and for much of the remaining time clouds and fog do. But what if the solar energy were collected by a set of satellites above the earth's atmosphere? Then we might obtain solar power for 24 hours every day of the year. This is the idea behind solar-power satellites.
- **Heat water:** Solar water heating systems use solar panels, called collectors, fitted to your roof. These collect heat from the sun and use it to heat up water which is stored in a hot water cylinder. A boiler or immersion heater can be used as a back-up to heat the water further to reach the temperature you want.
- **Solar Dryer:** Solar applications useful for drying agro produces are briefed here. Solar energy can be used to increase temperatures needed for most of the drying applications. Solar dryers use air heated through solar energy collectors, which can be installed in modules according to the requirements of hot air.

2.7 Present condition of solar system in the World

Many countries are making efforts to generate renewable energy using solar power. Now they start to use solar base energy system for its good advantages. For the changing of global environment they understand that the solar system energy is the one of the energy producing system that minimize the pollution of the global environment. Now we discuss the top ten countries about their thinking on solar system energy and what is the present steps about the renewable energy system.

China: China is one of the country to producing solar system power. They not only generate the solar system power, they manufacturer the solar panels. Now china is the one of the largest solar panels manufacturer country in the whole world. They produce photovoltaic power. China surpassed Germany as the world's largest producer of photovoltaic power in 2015. They set a

goal in 2020 for solar installations. We know the china is the one of the top country to CO2 Emissions. They emissions CO2 6.59 in 2015 per capita carbon dioxide emissions from fuel combustion (metric tons). So now this country helping to offset the country's significant carbon footprint

Japan: Japans government is also be announced they generate the power on the solar system 28 GW and 53GW respectively 220 and 2030. Already japans government producing 5% energy using the solar system energy. Since the Fukushima Daiichi nuclear disaster the Japanese government should take more steps to increasing the renewable base energy system. Now japan is upcoming top country to generate solar system energy.

Germany: In the Germany government is the highest priory to generate the electricity from the renewable sources base energy system like as solar system. They set a target in 80% energy generate to using the renewable sources in 2050. In the photovoltaic power Germany is the leader of this side. It is the first country to introduce grid-scale solar power in 2004.

United States of America: The US many state now already use the solar home system. Here domestic photovoltaic installations is more popular. Many state now set a goal to producing the renewable energy. Now many industry use to power in solar system.

Italy: In this country they almost used their energy to import from another countries. Recently should take more steps to generate power on the base of solar system. Now they should take to generate solar energy system and the introduction of generous government schemes to incentivize domestic renewable energy production. They set a target to generate renewable energy. They generate 20% energy from renewable resource b 2020. In this country is one of eleven nations to reach the objective years in advance of the deadline.

United Kingdom: In the United Kingdom government should take more steps to increasing solar system energy. In the almost every school, college, office and many industry now use to the solar system energy. In UK government in 2016 3.4% of electricity generate to using the solar system energy. In the United Kingdom government should take 4 million homes will be solar-powered by 2020.

India: India is one of the fastest-growing solar industries. Now this country try to increasing to generate the solar system energy. In this country quadrupled its solar-generation capacity from 2014 to 2017. We know the India is the one of the country to CO2 Emissions. They emissions CO2 1.58 in 2015 per capita carbon dioxide emissions from fuel combustion (metric tons).

France: In 2016 the Prime Minister of India and the President of France together laid the foundation stone at the headquarters of the International Solar Alliance (ISA). In the International Solar Alliance (ISA) is working to development of solar products in countries lying between the Tropics of Cancer and Capricorn. Now France is steadily growing as a generator of photovoltaic energy.

Australia: Federal mandatory renewable energy targets and feed-in tariff schemes have contributed to the recent growth of solar power in Australia. Despite the progress the country has made, however, Australia still attracts criticism for producing relatively little of its energy through solar power while it has the sunshine, resources and infrastructure to do a lot more.

Spain: Since 2013, there has been little growth in Spanish photovoltaic technology, but it still accounts for a respectable 3% of total electricity generation.

2.8 Present condition of solar system in Bangladesh

Now Bangladesh has 15 MW solar energy capacity through rural households and 1.9 MW wind power in Feni and Kutubdia. Bangladesh has planned to produce 5% of total power generation by 2015 & 10% by 2020 from renewable energy sources like wind, waste & solar energy.

- We know now many garments factory using SRS. The “Tongi Garments” installed 200KW solar panels and generate 1000KW power daily [11].
- In the big solar power plant in Bangladesh is Shorisha Bari, Jamalpur. This power plant operate by PDB, The power plant is non-government power station. The power plant generate 3 MW power in this power is directly connected in the national grid. The government buy this 3MW 14.75TK per KW. It’s too costly for government.
- In the Bangladeshi island name of “Monpura Island” is the big solar mini grid in Bangladesh. Here establish a small mini grid power station. This station generate 177KW power. The power supply 500 houses, 179 business place continuously. Now this island people not to depend in the national grid power.
- Another mini grid power plant on the base of solar in Saidpur. Many village people use the power to irrigation and many business purposes. In Saidpur is now another role model of Bangladesh for using solar base technology.

Here we discuss the major point to producing solar base power. In the other hand many village and city people generating power to use solar base system.

Table 2.1 Present status how many solar system installed in Bangladesh.

Partner Organization	Number of SHSs installed
Grameen Shakti	750,657
RSF	199,209
BARC	75,440
Srizony Bangladesh	54,011
Hilful Fuzul Samaj Kallyan Sangstha	32,630
UBOMUS	23,651
BRIDGE	19,148
Integrated Development Foundation	12,618
TMSS	11,787
PDBF	9,869
SEF	16,783
AVA	10,564
DESHA	9,593
BGEF	13,684
FDF	15,911
COAST	6,181
INGEN	8,487
CMES	5,543
NUSRA	7,651
RIMSO	6,798
Shubashati	4,933
REDI	5,209
GHEL	4,981
SFDW	7,417
PMUK	2,046

In the table we see how many solar system install in Bangladesh. This table help us how much demand of solar system in Bangladesh. But this demand is depend on area[13].

2.9 Solar system future in Bangladesh

In Bangladesh now using the solar system is increasing day by day. In future I hope the use of solar system is more popular. In the present situation the knowledge about solar is too little in Bangladeshi people. In future when it overcome and understand about the benefit then they increasing to use the solar base energy system.

Now renewable energy is the one of the part of our government policy and plant. The policy of renewable energy 2008 the goal at 10% energy we try to achieve by 2020.

2.10 Solar system contribution for socio-economic development

Economic development depends on energy. In general, energy is not considered as a basic human need. In the past, rural energy, in particular, was not widely accepted as a basic need like water and food in the development circles. Now we discuss in various sector where the solar system contribute.

- **Education:** In the education sector the solar system in play a important role. Any effort that contributes to promote education is welcome everywhere. Solar lighting provides higher quality illumination than kerosene lanterns, extended study time as well as better comfort and safety. In solar light children enjoy better facilities for education. It can improve educational opportunities and provide entertainment. In many rural area where electricity can't reach here the electricity problem solve the solar home system. In many school and college where electricity can't reach here solar system play a important role. So we see that solar system is one of the part to developing the education side.
- **Health:** Public health is a critical sector in off-grid communities. Solar energy can have a significant impact on livelihoods in rural areas. In many hospital and clinic where electricity can't reach there solar system full fill the demand of electricity. In solar lighting is good for a children health. So it is necessary to re-emphasize the need for pragmatic policies to set up environmental health-friendly technologies like SHS to operate remote rural health centers efficiently.

- **Agricultural:** In the irrigation system in rural area the solar system is effective for the village farmer. Now many village farmer is totally depend of solar system to using irrigation.



Figure. 2.17 Using irrigation of solar pumping system.

There are more advantages of solar pumping system.

- 1: Auto-operation, labor free
 - 2: Suitable to all kinds of pumps, including three-phase AC pumps, single-phase AC pumps and DC pumps
 - 3: Wide range of input voltage, suitable to different PV modules Modular design, easy to maintain International advanced components, safe and reliable
 - 4: Solar and mains power hybrid, 24 hours operation Remote control and monitor Customized solutions
- **Environmental:** If we think our environment then the solar energy is the best way to protect our environment. The solar energy generating system is too friendly to our environment. Here is no harmful effect to using the solar system. In the environmental benefit of solar energy is creates clean, renewable power from the sun and **benefits the environment**. Alternatives to fossil fuels reduce carbon footprint at home and abroad, reducing greenhouse gases around the globe. Solar is known to have a favorable impact on the environment. In the solar energy is decreases greenhouse gas emission. In the solar energy system reduces respiratory and cardio health issue. An analysis by the National Renewable Energy Laboratory (NREL) found that widespread solar adoption would significantly reduce nitrous oxides, sulfur dioxide, and particulate matter emissions, all of which can cause health problems. So the using the solar system energy is good for our health and good for our environment if we properly use the system.

- **Social:** Solar panels help maximize the earth's resources and conserve energy. When cities or companies decide to build and operate solar energy facilities, the projects often help to create numerous jobs. Thus, many new jobs can be fulfilled by workers as a result of a city or state using solar energy facilities to generate electricity for the area, and this would in turn help increase the employment rate of the given area. The one of the social gathering the people now watching TV, Listening Radio and other electric device. Increasing the ability of the dark in the village area and the steeling of the village area is more than reduce before when we use the solar system energy.
- **Communication:** In the communication sector now the using solar energy is increasing. Many car and bus service use solar energy power.



Figure. 2.18 A car where using solar system power.

The solar car are good for our environment. Like solar-powered homes, solar cars harness energy from the sun by converting it into electricity. This electricity fuels the battery that runs the car's motor.

2.11 Summary

In this chapter we discuss the energy types basically we importance the renewable energy. The solar energy is the best power producing renewable energy in the world and Bangladesh too. For this various positive attitude the solar energy is more popular in our country. I hope in the next future of Bangladesh the solar system energy play vital role to producing power.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study is designed to explore the socio-economic impacts of SRS in remote rural areas of Bangladesh. The study is based on primary data. Secondary sources are also used. Due to technology based social research a mixture of qualitative and quantitative methodological approaches are applied. General information regarding the SRS dissemination program and socio-economic impacts of solar electricity are collected from secondary source and interviews with local experts. Primary data of the study are collected through an extensive household survey method using questionnaire. Secondary sources are also used to support the survey data. Questionnaire is designed as present and before SRS installation to measure role of SRS in socio-economic development of rural area.

3.2 An overview of sample city

Narayanganj is the one of the city of Bangladesh. The Narayanganj city stand near by the capital city of Dhaka. The total population of the city is 2.2 million. The city stands by one of the biggest river Shiyalakshya River. Here is also most of the famous shopping complex and industry. The biggest jute mill is here. The city under the Dhaka division. The total area of the city is 12.96 square mile. The post code is 1420 and the calling code is 02. The present mayor is Dr. Salina Hayat Ivy. In the city corporation established 5 May 2011. In the city have three former municipalities. There are Narayanganj Municipality, Siddhirganj Municipality and Kadam Rasul Municipality. The Bank of Bengal introduced the first telephone service in 1882. A post office was set up in 1866, and Dhaka-Narayanganj telegraph service was started from 1877. Main occupations Agriculture 13.37%, fishing 1.21%, wage laborer 4.07%, commerce 19.9%, agricultural laborer 8.61%, service 23.36%, weaving 5.49%, transport 4.09%, construction 1.48%, industries 2.74% and the others 15.68%. In this district communication facilities is 225.98KM road is Pacca, here is mud road is 748KM, the railway

is 18KM and the water way is 111 nautical mile. The Adamjee Jute Mills (closed in 2002) is one of the biggest jute in in the Bangladesh and many big industries present here. Narayanganj Zila consists of 5 upazilas and here is also 7 police station. First we create a list of the Narayanganj Zila's Union, Mouza, Upazila, Village and areas that's easy to make our survey. In this survey we visit the Narayanganj division. The division is divided into two part. One of the east zone and another is west zone.



Figure. 3.1 Satellite view of Narayanganj division.

Table 3.1 A list of the Narayanganj Zila's Union, Mouza, Upazila, Village and areas.

No.	Upazila	Union	Mouza	Village	Area
1	Bandar	05	90		55.84 km ²
2	Araihaazar	12	184		183.5 km ²
3	Sonargaon	11	352		171.66 km ²
5	Narayanganj Sadar	10	55		100.75 km ²
5	Rupganj	09	146		247.95 km ²

Narayanganj Sadar is our survey area its 13% area of the whole area of Narayanganj district. In this area more than 286,330 people living where 90 thousand are females and rest of the people are male. A total of 90 respondents are interviewed for primary data collection in the survey. 70% household heads and 30% respective spouses participated in interview. In the

interview section male member in each every houses are interested too much but females not interested but some houses women also show their keen interest in answering the questions. Cause of that the female member have too little knowledge about the solar system. So in overlay 68% male and 32% female interest to the interview section.

Table 3.2 Solar system installment in East & West

Zone	On Grid	Off Grid	Not Working	Total
East	97	15	28	140
West	87	13	30	130

Here we note down the total solar installment in the east zone and west zone. If we see it in graphically then we easily discuss the present position in both zones. In the graph we see that the on grid solar system in the east zone is 97 and the other side west zone the on grid solar system is 87. Both of the zone the on grid solar system is almost equal but the off grid solar system in the west zone is too small amount of consumer uses. On the other side the east zone have 15 consumer who use the off grid solar home system. Now a large amount of solar system both east and west zone is not working condition. And this consumer they are not interested to repair it. Cause of that they think the solar system is totally waste of money. They also think that they are not benefited from the solar system. Actually this types of consumer totally don't know how they use solar system, how they maintained solar system, how actually working solar system and how they benefited from solar system that's why their thinking is negative. In this types of consumer we try to teach how they use solar system, how they maintained solar system, how actually working solar system and how they benefited from solar system.

3.3 Information procurement

In the thesis we gather more knowledge about the solar system energy and its impact of our life. We collect more information about the solar system. We collected the public opinion, what is they thinking about the solar system? And how much knowledge to operate this system? What kind of solar rooftop system (SRS) are they using? And so many question we want to know form the consumers. We actually follow a questionnaires' from where we input the whole question that we want to know. The first step in the procedure comprised data mining with regard to the surrounding conditions to substantiate the present need for the analysis. The main sources of required information were scientific papers, the publications of linked and relevant departments, and the contents of scientific databases. Both of the zone more than 120 houses

who uses the solar system in their houses. We went to go every houses to collect the information and we explain their advantages of solar system. And also to inspire to spread the solar panels to generate more power. We sometimes teaching them how the solar system help them and how they spread the solar panels to generate more power. When we properly teach them than understand the benefit. But most of the consumer not interested to install the solar system and to spread the solar panels too. Basically we want to know this types of question and information.

Table 3.3 Survey Questionnaires for Solar Roof Top (SRS) (under DPDC)

Items	Question		Comments
Consumer Information	Owner Name:	Consumer No.:	In each every house when we collect data we firstly note down this information about the consumer. We note down the owner names who install the solar system in his house and his consumer number that's given by NOCS.
	Name of the NOCS:	Address :	
	Capacity:	Date of installation:	
	Mobile No:	Email :	
	Date of survey:	Time:	
Panels Information	What kind of solar rooftop system (SRS) are you using?		After note down the consumer information then we try to want, to know about the solar system.
	Is your SRS in operation?		What kind of solar rooftop system (SRS) are they using on grid or off grid?
	From where you bought SRS?		We collect their total installment cost and how much electricity do you get from solar system. They
	How much electricity do you get from SRS?		

	What is the total cost of SRS?	bought solar system 45% market and 55% agency.
Consumer Opinion	Do you think this SRS is useful?	We also collect the consumer opinion. What they think about the solar system. 60% consumer say it's totally waste of money but 40% think that it's useful. But most of the consumer do not want to increase the capacity of solar system. But many consumer want to get training if government give any training but government should not take any steps to teach their consumer about the solar system.
	Why do you install this SRS?	
	Do you think, it is a waste of money?	
	Do you want to increase the capacity of your SRS?	
	If government get any training for SRS operation do you get it?	
Solar Maintained	Do you ever clean your SRS? How often it is done?	In 40% consumer clean it regularly and they are also test it too. But most of the consumer are not interested to clean the solar system and also not be interested to test it in regular basic.
	Do you test it regular basis?	
	How many days ago you test it?	

This format base information we collect to the consumer who use the solar roof top system. We also collect the meter reading although the maximum consumer meter is not working. We went to go regularly in every consumer houses which solar system is in active.

In the figure 3.2 we collect data in Mr Ullah house. In this house the SRS is fully active and we get the all data that we need. And we analyze cost in this consumer SRS in chapter 4.



Figure. 3.2 Collecting data from the consumer house.

In the base of the information we discuss how to do and what to do develop in this side. And how to people interested to installed solar system. And also we teaching about the solar system and its advantages that's why they more inspire to install solar system. Some consumer are inspire and think that it's helpful for them and some consumer is not.

3.4 Summary

Major information is collected in this part. It is designed to collect data on economic situation, sources of energy for lighting and expenditures, productive activities in the household, and employment, working hour, about the SRS technology, environmental and social approaches of SRS. And format base information we collect to the consumer who use the solar roof top system.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The main objective of this study is to assess the impacts of consumer life in rural areas of Bangladesh. To verify the objective empirically, a cross-section of 8 randomly selected households in three municipality Narayanganj Municipality, Siddhirganj Municipality and Kadam Rasul Municipality. The survey results are analyzed as follows in the following sections.

4.2 Consumer Information

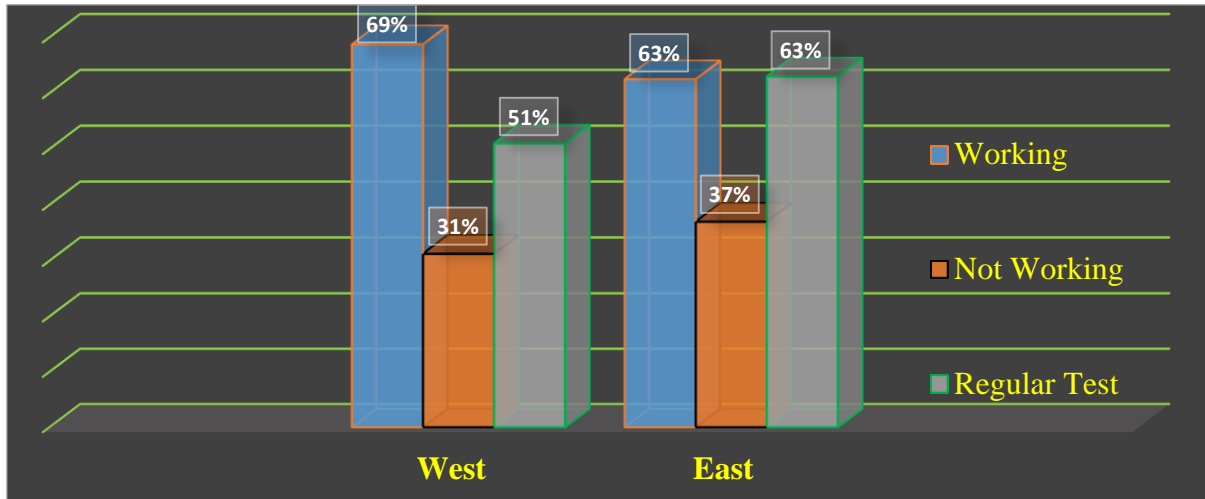
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We compare the responding the consumer in different age level. We divided the whole consumer in five different levels 18 to 30, 30 to 40, 40 to 50, 50 to 60 and above 60. We see that the both east and west zone the range of 18 to 30 consumer to more interest to our interview section. Then the second position is 30 to 40 range consumer and the lowest position is above 60 age's consumers. But the 50 to 60 age's consumer in the west zone more interested to the east zone.

4.2.1 Still operation & testing SRS

When we asked the consumer is your SRS in operation? If the consumer say yes then we asked the consumer do you test it regular basis. The answer is different between east and west zone. If we see a graph.

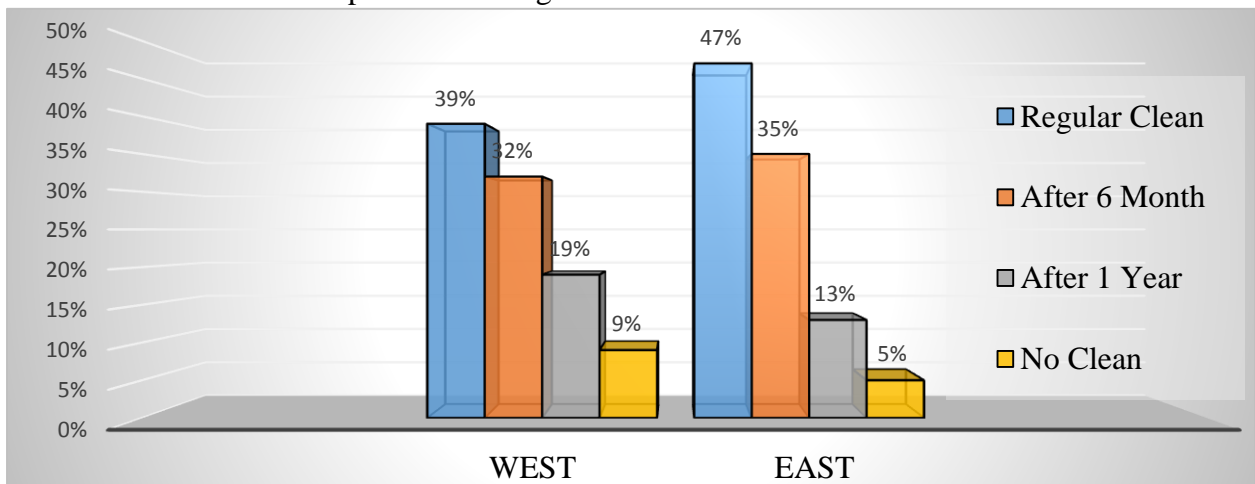
Graph 4.1 Still operation, testing SRS in East and West zone.



In this graph we see that 78% solar system is working in the west zone and other side the east zone 86% solar system is now working. So 22% solar is not working condition in the west zone and 14% solar system is not working in the east zone. And the east zone consumer percentages about regular testing the solar system is more efficient to the west zone consumer. If we compare between the two zones then we can easily say that the overall position of the east zone is better than west zone.

4.2.2 Cleaning condition of SRS

Graph 4.2 Cleaning SRS in East and West zone.

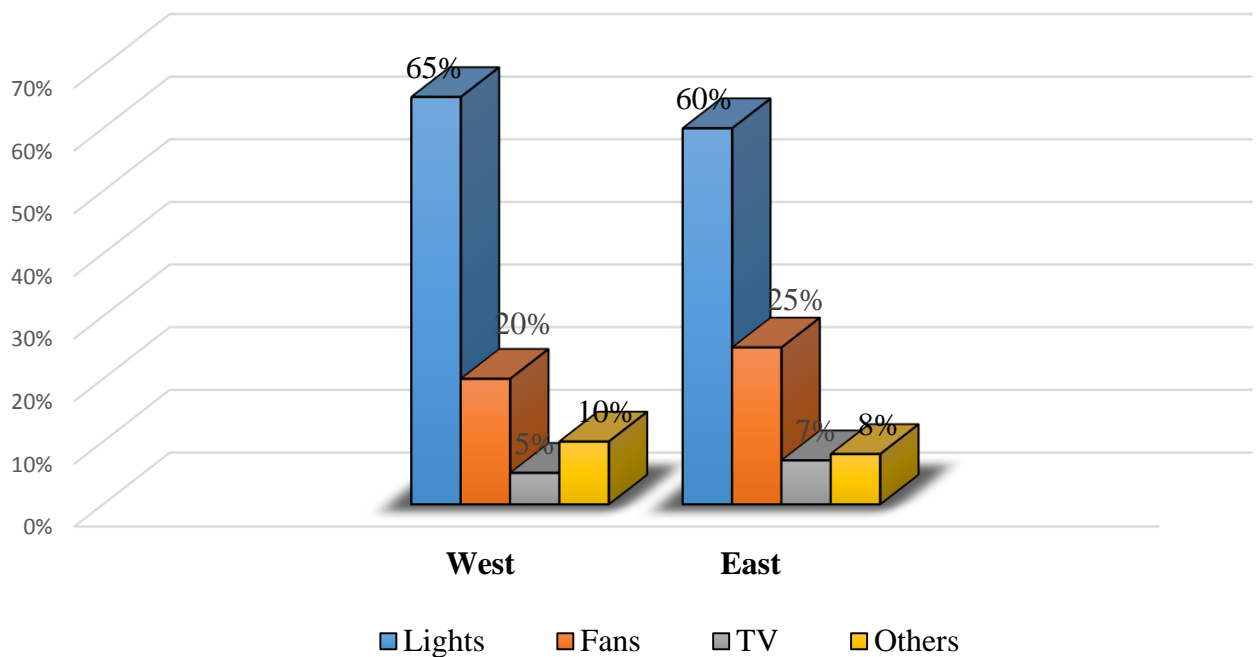


In the graph most of the consumer of the both zones clean the solar panels regularly. In the west zone 39% consumer clean the solar panels regularly and the east zone 47% consumer clean their solar panels regularly. In the both zone less than 10% consumer do not clean their solar panels.

4.2.3 Using sector of SRS power

After generating the power consumer use this power in difference sector. Someone use TV, fan and light and someone use only staircase light in their house. If we see a graph.

Graph 4.3 Using sector of the generating power of SRS.

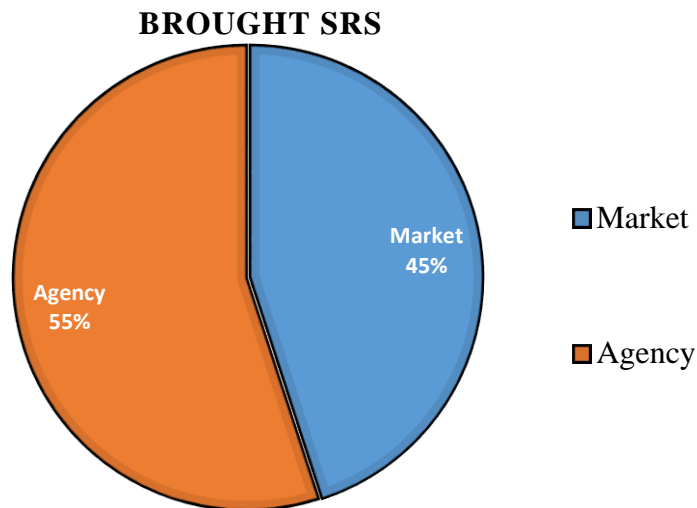


After the installment the solar system when the solar system generating power the consumer use the power in different sector. In the both zone we see that most of the consumer use the power in lighting. In the west zone 65% power use in lighting and the east zone 60% power use the lighting. So we see that most of the power of the both zone using lighting. And rest of the power using fans, TV and other sectors.

4.2.4 Brought the SRS system

In the maximum number of the solar panels provide some agencies. Some consumer rented the solar panels for three months. They installed solar system only full fill the government policy. A little amount of the consumer installed their solar system of own choice. If we see it in graph.

Graph 4.4 From where consumer brought SRS in the both zone.

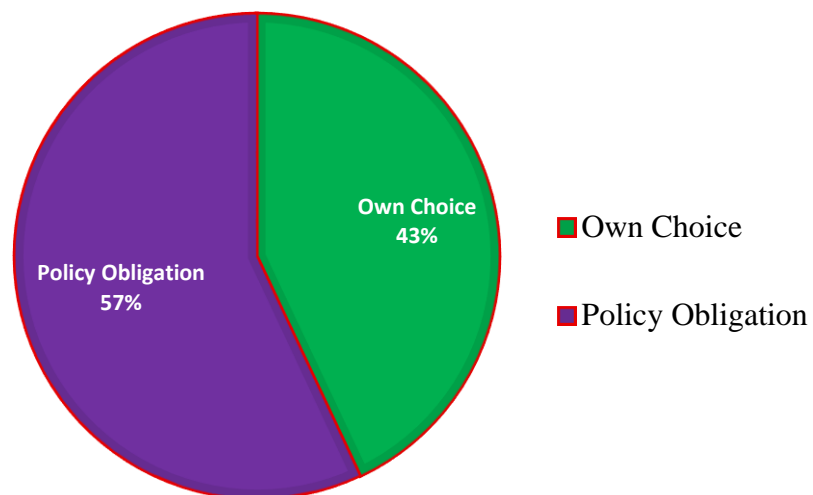


The high amount of solar panels brought consumer in agency. The 55% consumer brought agency and 45% consumer brought solar panels in markets. In the 55% agencies consumer most of the 30% consumer rented the solar panels only for three or four months.

4.2.5 Why the consumer brought SRS

Graph 4.5 observation we can easily say that most of the consumer not interested to installed the solar system. They only full fill the government rule. If we see a graph.

Graph 4.5 Why the consumer install SRS in the both zone.

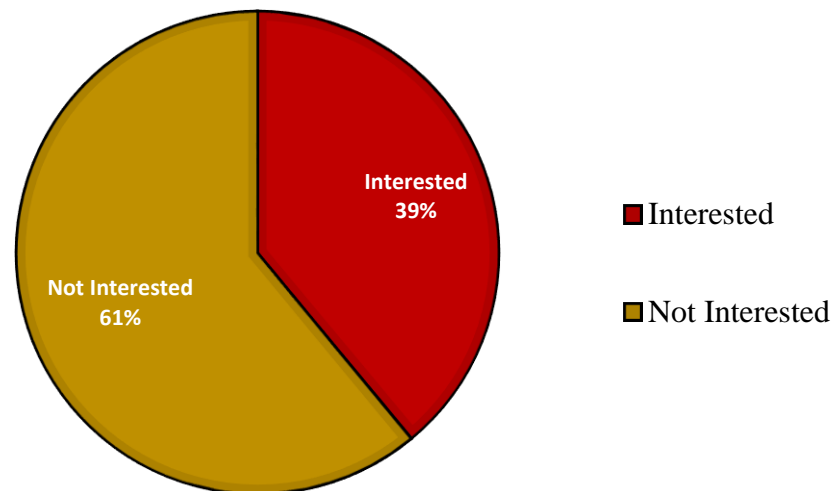


In the graph 57% consumer install their solar system in policy obligation and the 43% consumer install their solar system in own choice. So we see that the amount of SRS installed only for the policy obligation. So we can say that the most of the consumer installed the solar system only for show up.

4.2.6 Increase the capacity of SRS

In the graph-4.5 we see the most of the consumer installed the solar system only for show up. That's why most of the consumer not interested to increase the capacity. If we see it in graph.

Graph 4.6 Increase the capacity of SRS in the both zone.

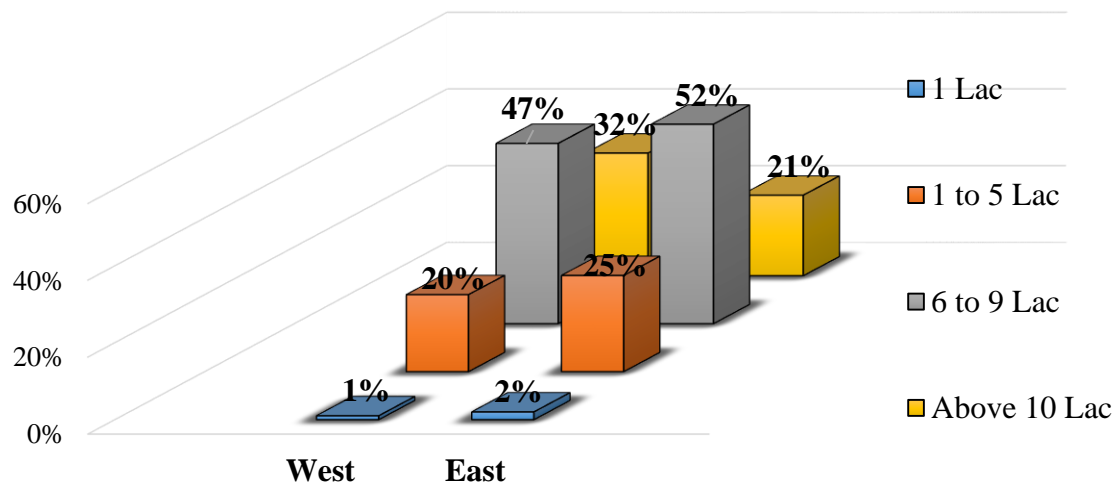


Here we see 61% consumer do not interested to increase their solar system and only 39% consumer want to interested to increase their solar system. So in graph 4.4, 4.5, 4.6 we say that most of the consumer are not satisfied to use the solar system.

4.3 Average Installment Cost of SRS in Survey Area

The solar installment cost is vary consumer to consumer. Some consumer generate a lot of power to using solar system and some consumer generate a little amount of power. So the installment cost is vary, it's basically depend on how much power generate to using solar system. Now we see a graph.

Graph 4.7 Power generation cost of SRS in East and West zone.



In this graph we see that most of the solar system installment cost above 6 lac. Cause of that we basically survey industry, apartment and markets. An industry, markets and apartment consume a high amount of power so they need to install a large solar system that's why their installment cost is high. In the both east and west zone a little amount of solar system installment cost under 1 lac.

After installing the SRS many consumer think that it's totally waste of money and it's not useful for them. For this reason they do not want to increase the capacity of their solar system.

4.4 Cost Analyze of a Consumer SRS

Here we analyze 4.3kW capacity PV SRS. In the SRS system installed Ullash Ahmed, Fotulla Narayanganj.

Now we see the total cost to 4.3kW PV SRS. The total cost of 4.3kW PV SRS is 294500tk. We know a SRS supply power minimum 15 years and this SRS also supply the power minimum 15 years.

In this SRS the total cost of installation is = 294500 tk

And we know the 11 months generation is 4154.56 kWh

Now the per month generation is $(4154.56 \div 11)$
 $= 377.68 \text{ kWh}$

So one year generation in the solar system is (12×377.68)
 $= 4532.24 \text{ kWh}$

So after 1 year the generation cost per unit is $(294500 \div 4532.24) \text{ tk/kWh}$
 $= 64.97 \text{ tk/kWh}$

" " 2 " " " " " " $[294500 \div (2 \times 4532.24)]$
 $= 32.48 \text{ tk/kWh}$

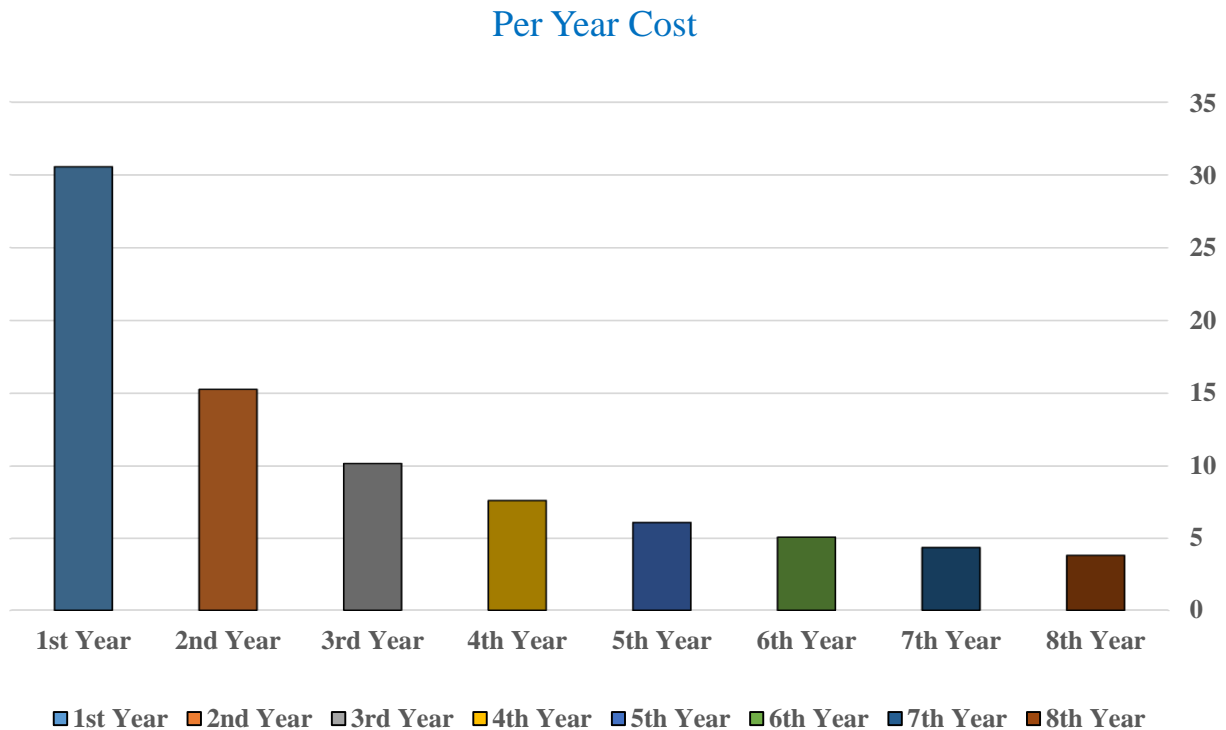
" " 3 " " " " " " $[294500 \div (3 \times 4532.24)]$
 $= 21.66 \text{ tk/kWh}$

" " 4 " " " " " " $[294500 \div (4 \times 4532.24)]$
 $= 16.24 \text{ tk/kWh}$

.....
 " " 15 " " " " " " $[294500 \div (15 \times 4532.24)]$
 $= 4.33 \text{ tk/kWh}$

In calculate the per unit cost after one year the cost per unit is 64.97tk cost per kWh. But second year this cost is 32.48tk cost per kWh. Then the third year 21.66tk cost per kwh, 4th year 16.24tk cost per kwh. So we see that each every year per unit cost is decreases. After the 15 years the cost is 2.24tk cost per kWh. If we see the cost analysis per year in graph 4.9 the cost is decreases gradually after one year.

Graph 4.9 Per Year power generation cost of solar station.



4.5 Summary

In this chapter we know both east and west zones solar system using activity. We discuss the condition after using solar system both east and west zone. And also compare the consumer activity about using solar system how they clean, how they maintain, how they use their generating power in which purpose. The whole discussion and information note down based on ten consumers houses on Narayanganj Sadar.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In a present situation the momentum, dynamics and sustainability of a civilization depend on energy. A country can be deliberated as civilized one if the country has enough access to energy as required for the agricultural, industrial and economic growth. In rural Bangladesh there are lots of sectors to use solar electricity. The results of analysis energy requirements for renewable electricity production technologies solar system has been presented. In the analysis we found that there is a wide range in energy requirements for producing electricity from different renewable resources. In solar system installment we need a lowest capital costs. So in Bangladesh perspective solar energy is the best way to producing energy. Cause of that the environment of the Bangladesh most suitable to generate solar energy. We know that Bangladeshi people's economic condition is not highest position. Most of the people are middle classes and solar system install a lowest capital costs. So people can easily installed a solar system in their houses.

In survey we see that the solar system increases the afford ability to purchase a solar system in the rural Bangladesh. The role of the solar system (SRS) on household income is observed to be quite limited, as SRS electricity is hardly ever used productively. But we badly say that lack of knowledge & proper training each every consumer. Government should take any steps to increase their knowledge about the solar system and need to provide any training. But government do not takes any steps that's why most of the consumer have a little knowledge about the solar system. So they do not want to increase the capacity of their solar system. They think that it's totally waste of money and it's not useful for them. When the consumer think that it's not benefited for them then they do not take care the solar system. In the both zone we see that 45% consumer clean their solar panels. In the west zone 39% consumer clean the solar panels regularly and the east zone 47% consumer clean their solar panels regularly. In the both zone less than 10% consumer do not clean their solar panels. In the maximum number of the

solar panels provide some agencies. Some consumer rented the solar panels for three months. They installed solar system only full fill the government policy. A little amount of the consumer installed their solar system of own choice. Reduction of carbon dioxide (CO₂) emissions is obeyed in comparison to former utilization of candle, kerosene for lighting purposes. But disposal of old batteries constitutes the only potential negative impact of SHS that might represent a serious threat to environment and natural resources. Strengthen old batteries collection and introduction of reliable battery recycling system can easily reduce the threat. Now it is high time to integrate structural set up for using this untapped resource like as solar energy.

5.2 Recommendations

We have found from the household survey that insignificant benefits and more activities are promoted by the use of solar system. Solar light is used mainly for household lighting, running TV, mobile phone battery charge, and radio etc. The application is limited to household lighting, running TV, mobile phone battery charge, and radio. If we use the power on productive working its most efficient for us. So how we use the power to productive way then we need knowledge. Moreover, due to lack of knowledge and proper training, these applications are not flourished to the remarkable extents. So we need a proper training how we efficient our solar energy.

In survey we see that most of the consumer think that its waste of money. The consumer view its right because they do not know the benefits of solar system. If we give them any training the government and consumer both are benefited. It is very much essential to disseminate the solar led household appliances for increasing household productivity. Using solar water heating, solar drier, solar lanterns, solar water desalination, solar blending machine, solar sewing machine, solar driven small machines for power looms, solar water pump, and solar rice grinding machine can be popularized for increasing household productivity. At the same time proper training and marketing facilities is necessary for increasing household income generating activities.

In our recommendation when a consumer install a solar system at the same time if the government giving a tinning I think it more efficient. Then the consumer know how they maintain the solar system, how they properly use the power in productive working. And we see that the installment cost of solar system is a big amount of money that's why many consumer

do not want to increase their solar system. So our recommendation is if government give any load without any interest for installing the solar system. Then we think consumer interested to increase the solar system. We see that after install the solar system then the government doesn't take any news properly about the solar system. The solar rooftop system is the government policy so we think that government should need to take care it properly.

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