

Performance analysis of Solar Roof-top System Under DPDC

**A Thesis submitted in partial fulfilment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering**

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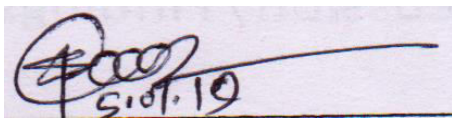
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DECLARATION

I hereby declare that, this thesis report is done by me under the supervision of **Prof. M.Samsul Alam**, Professor, Department of EEE, Faculty of Engineering, Daffodil International University, impartial fulfilment of the requirement for the degree of Bachelor of EEE. I am declaring that this project is my original work. I am also declaring that neither this thesis nor any part therefore has been submitted elsewhere for the award of Bachelor or any degree.

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A handwritten signature in black ink on a light-colored background. The signature is stylized and includes the date '5.10.19' written below it.

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Dedicated to:

Our Parents

&

Teachers

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List of Abbreviations

SRS- Solar Roof top Systems

IDCOL- Infrastructure Development Company Limited

GS - Grameen Shakti

GDP – Gross Domestic Product

PV – Photovoltaic

BD – Bangladesh

BPDB – Bangladesh Power Development Board

REB- Rural Electrification Board

LGED- Local Government Engineering Directorate

NGO - Non Government Organizations

SODIS -sun based water sterilization

LGED – Local Government Engineering Department

BWDB- Bangladesh Water Development Board

SRE - Supportable Rural Energy

PDB - Power Development Board

DC –Direct Current

LED- Light Emitting Diode

RERC- Sustainable power source Research Centre

IFRD- The Institute of fuel Research and Development

BCSIR- Bangladesh Council of Scientific and Industrial Research

IFST -The institute of Food Science and Technology

CNG – Compressed Natural Gas

GOB- Administration of Bangladesh

NRECA- National Rural Electric Cooperative Association

DPDC- Dhaka Power Distribution Company

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Abstract

Bangladesh is a developing country facing many problems, lacks electricity shortage. The rural section of Bangladesh is the worst sufferers of this crisis having limited electricity or some rural has no grid electricity. Solar energy has been proven to be a very promising resource to improve the ongoing electricity shortage. The mining of non-renewable energy and the by-products they leave behind cause damage to the environment. When fossil fuel is burned, nitrous oxide causes photochemical pollution, sulphur dioxide creates acid rain and greenhouse gases are emitted. Moreover, fossil fuel is finite in amount and cost a lot of money as well. Hence, renewable energy is a potential solution to meet up the electricity demand for the developing country like Bangladesh. Along all the renewable technologies, Solar system is most potential technology which convert solar energy to electrical energy. The sun shine on the solar panel generating “DC” (Direct Current) electricity. The electricity is fed into a solar inverter that converts into “AC” (Alternating Current) current. The AC electricity is used to power appliances in our country. The government wants to fill up 10% of the demands of the electricity supply of solar energy within 2020. To accomplish the demand, Government established a rule that if any consumers get a new electricity connection they must build up a solar rooftop system. To follow the policy, DPDC provides SRS system to their new consumers. We visited some of those consumers according to the list provided by DPDC in Narayanganj area. We have tried to know about various types of consumer information from the users of the SRS system. According to the questionnaire form, we checked those SRS whether the systems are in operation or not. We collected the meter readings and calculated per unit cost from the system under operation. Many of the systems were not in operation properly, we tried to know the reason behind it. Moreover, we tried to find out the brought condition of the SRS system as well. We asked them whether they clean their solar panels or not and if they get any kind of training for solar operation from the government organization or private agency. Our main purpose was to find out the satisfaction of the consumers about how many of them are being satisfied with the system and how many of them are not. After all the preceding information, we informed them about the net metering system and usefulness of SRS.

Chapter One

Introduction

1.1 Introduction:

Electricity plays a significant role in developing the economy and the standard of living of a country. To increase work facilities, policies and incentives are there to enable the growth of both the agricultural and the industrial sector which are totally be depending on electricity. However, generation and supply of electrical power in the country are lagging much behind the growing demand prohibiting sustainable growth of the economy.

In Bangladesh, only 62% of the total population have access to it. In fact, this country has been suffering from a severe power crisis for nearly a decade. Furthermore, the reserves of natural gas, coal and other primary energy resources are decreasing at such a shocking rate that the situation is bound to get worse. Under this circumstance, she is forced to look for alternative energy resources which can meet her unprecedented energy needs. The renewable energy resources have the potential to fulfil many criteria of this demand and in this paper, we discussed the renewable energy such as rooftop solar home system and it is the subject of this paper.

Bangladesh is an over populated (1015 km^{-2}) [1] developing country, having no supply of power in numerous provincial regions of the nation country. Rural electrification through solar photovoltaic (PV) technology is promising and winding up more famous. Solar Home Systems are profoundly decentralized and especially appropriate for remote, blocked off zones, accordingly, the business of solar power system was presented by both governmental and nongovernmental associations. Solar power systems are contributing a colossal measure of vitality and changing the current vitality necessities, particularly in rustic territories of Bangladesh. At present there are 30 organizations conducting solar energy businesses in Bangladesh [2]. Grameen Shakti first make known to low budget solar systems to the rural people in 1996 [3] and in in 1997, Bangladesh Rural Advancement Committee, BRAC, a NGO, propelled Solar Energy Program for manageable improvement[4,5] .

Bangladesh is far behind other countries in the world in terms of entrance to electricity. The Government therefore has a determined target to confirm access to electricity for all by 2020. However, energy got from oil, gas, and coal will assume an essential job in taking care of the developing demand, the acknowledgment of the thorough fossil fuels has focused interest and effort on elective energy resources.

During the last two decades, both developed and developing countries have focused much interest in the utilization of renewable energy. The use of renewable energy free from environmental pollution, such as solar, wind, bio-mass, geothermal, tidal, hydro energy have taken on a greater sense of earnestness, especially in developing countries.

1.2 Statement of the problem:

Power production of Bangladesh usually depends on fossil fuel. About 89% of produced power from carbon radiating gaseous, fluid fuel, coal, and hydropower. The supply of natural gas isn't adequate to take care of the demand. the supply of this gas is not sufficient that Bangladesh can't bolster household needs and additionally more extensive power need for the country. The current save of oil and gas will be depleted soon. In the meantime, worldwide, there is an interest for spotless and maintainable vitality. The requirement for creating sustainable wellsprings of vitality like sun oriented, wind, bio-mass, and so forth. Has a more noteworthy feeling of criticalness. As a tropical nation, Bangladesh is supplied with sun-oriented vitality. In this unique situation, sunlight-based vitality is a dependable, moderate and secure energy for the nation. Be that as it may, the present offer of renewable source for power generation is just 0.5% of the aggregate. Real individuals of Bangladesh live in rustic regions. There is solid interest for power accessibility in remote towns. Bangladesh has installed with a lot of solar energy. We can possibly be a sun-oriented power rich nation. Institutional, money related and mechanical capacities go about as imperative factors in achieving a coveted dimension of sun-based power creation and uses. In any case, we have an absence of data and incorporated research in this field. Sun based vitality based provincial jolt started in the nation in 1988 at Norshingdi. Power Development Board (BPDB), Rural Electrification Board (REB), Local Government Engineering Directorate (LGED), Infrastructure Development Company Limited (IDCOL) and an essential number of private part associations including Non-Government Organizations (NGO) are locked in with sunlight-based power enhancement. Solar energy is

progressively being utilized in an extensive variety of off-framework applications. Since the presentation of SRS, Bangladesh has introduced more than 2.2 million units. In this setting estimating the financial effect of SRS would be an outline for structuring rustic improvement elective vitality demonstrate in the nation. The present examination is planned to recognize the elements related with the execution of sun-oriented vitality and sun-based power framework and how far it has been prevailing with regards to diminishing destitution in rustic region of the nation

1.3 Specific objectives of this research:

To find the potential results in respects to solar energy frameworks in our nation and also the issues in regards to the business. A cautious audit prompts the improvement of the accompanying explicit research goals:

- To know the present condition of SRS in Bangladesh and the opinion of the consumers about it.
- Calculate the per unit cost of solar electricity.
- Try to make concern consumers about the usefulness of using SRS system.
- Inform the consumers about net metering system of on grid SRS.

1.4 Significance of the study:

Bangladesh is a tropical country of huge sunlight-based vitality. However, a significant amount of this sun irradiation is utilized in our country, in spite of the fact that the source of SRS in Bangladesh was unworked for a long time. At this point different utilizations of sun powered power are seen all through the world. Presently a-days Solar Panel gives power to sun-based antibody fridges, sun-based water sterilization (SODIS), sun-based nourishment dryer and sun-based sanitization. This aides in lessening waterborne sicknesses. Sun powered telephone, sunlight-based Wi-Fi, sun-based radio increment provincial correspondence, decreases transport cost and diminish the computerized separation. Next to sunlight based cooker and sun powered water warming, dependence on conventional fills, for example, wood or charcoal, lessens indoor contamination and carbon emanation. This expands the personal satisfaction in rustic regions, enhance wellbeing and training, decrease oil reliance, increment nearby work and lessen deforestation. Sunlight based power

exercises lead provincial improvement. Because of absence of data and study SRS is utilized just for family unit lighting in Bangladesh. Sun based water system innovation is likewise getting well known in Bangladesh. As agribusiness-based nation, utilizing sun-based power water system framework would be a noteworthy main impetus for rural advancement. Government association, Academic establishments, NGOs and privately-owned businesses are engaged with the sustainable power source area in the nation. Analyst, strategy producer, advancement accomplice in Bangladesh recognized the massive prospect of solar energy for rustic change. However, there is no coordinated investigation of the prospect and extent of solar energy for financial advancement in country zone Bangladesh. Starting at now there is exceptionally constrained scholarly examination on the financial or ecological effect of solar energy in rustic territory. So, the examination would help the worry policymakers and implementers to take fundamental measures for practical country advancement in Bangladesh. Distinguishing the new creative utilization of sunlight-based power in provincial zones would help the implementers for compelling arranging and undertaking programs. In addition, it will likewise help for new innovation move in country regions.

1.5 Outline of the study:

Chapter one contains introduction, statement of the problems, significant of the study and objective of the survey. Following the introduction to the second chapter of this report will concentrate on check of selected structure and theoretical survey of SRS. In third section, it will examine the system of the examination. The fourth section is examination of the information, results and discussions. The fifth section is ends and proposals and of this report.

Chapter Two

Literature review

2.1. Introduction:

The moderate, available and secure supply of energy plays a primary driving force for financial improvement of a nation. Recently some experimental applied on how rural area can be electrify from sun-based power specifically helps in financial enhancement of the country in various ways. In this circumstance, sun-based vitality is by and large observed as a promising innovation for power age in the remote zone of the creating nations. This section attempts to concentrate on the review of picked composing, key thought of solar energy as principle driving force for financial advancement, issues and factors affecting financial improvements like family unit salary, wellbeing, instruction, cultivating age, access to information and other infrastructural organizations.

2.2 Energy Definition:

Physicists, who are researchers who study force, motion and energy, say that energy is the capacity to do work, and work is moving something against a force, similar to gravity. There are a variety of sorts of energy in the universe, and that vitality can do diverse things. Energy can be found in numerous things, and takes numerous structures There is a sort of vitality called kinetic energy in items that are moving. There is something that researchers consider potential energy in objects at rest that will make them move if resistance is removed.

2.2.1 Energy can be classified into several types based on the following criteria:

- Primary and Secondary energy.
- Commercial and Noncommercial energy.
- Conventional and Non-conventional energy.
- Renewable and Non-Renewable energy.

Above all this criteria, renewable energy source is the best energy source because they do not create any negative impact on environment and most important things is that they can be replenished in a short period of time. The example is wind, biomass, hydro tidal and solar.

2.2.1.1 Wind:

Wind Energy can be an elective source of energy for Bangladesh. Since, through wind energy control is directly relative to the speed of the breeze. This suggests progressively the breeze speed increasingly the power age. Bangladesh has an ocean side line of 724 km along the Bay of Bengal. It blows over Bangladesh from March to September with a normal speed 3 m s^{-1} to 6 m s^{-1} . Winds are available in Bangladesh for the most part in the midst of the tempest and around one to two months when the rainstorm and from October to February wind speed remains either calm or too low [6]. There are various islands along the Bay of Bengal where the breeze speed is high. Krakatoa, Sawndip and St. Martin are among those that have an ideal territory for wind turbines. There is no plausibility that they can get control from the national power cross section as it is hard to convey the line through to this domain. Wind vitality can be the answer for this issue.



Fig-2.1: wind power plant

2.2.1.2 Tidal:

Tidal Power becomes another source of energy which can fulfill our electricity demand. Tidal energy is delivered because of the variety of the ocean level. Bangladesh is a surge plain delta having a 710 km coastline with the Bay of Bengal. Bangladesh has its 19 regions in the shoreline front zone in which 12 are in direct contact with the sea. Tidal power exercises can be developed along the ocean side locales. They can provide the imperativeness demands in the meantime and furthermore is used as a protective extent of the, of the natural disaster. The below fig content the general symmetric arrangement of tidal power. Bangladesh is a Riverine country, so tidal power can be an extraordinary wellspring of sustainable power source of our country.



Fig-2.2: Tidal power plant

2.2.1.3 Biomass:

Biomass is the fourth biggest energy source in worldwide and gives essential energy prerequisites to cooking and warming in rustic family units in developing countries. Vitality age utilizing biomass offers an incredible answer for ecological issues by diminishing the emanation of regular ozone depleting substances. This gas is burnable and can be utilized to create power. Biogas can be utilized for cooking and power generation. Grameen Shakti is a standout amongst the most articulated NGO in the field of biogas. They have completed 13,500 biogas plants. Recently Seed Bangla

Establishment has proposed a 25 kW Biogas based Power plant in Rajshahi. IDCOL a Government claimed Investment Company repaired an objective to set 60,000 biogas plants in Bangladesh by 2018.



Fig-2.3: Biomass gas plant

2.2.1.4 Hydro:

Hydropower is another source of renewable energy that requires both water current and flow and tallness to create electricity. The arrangement of this reachable energy is considered as protection and retention energy in the diagram of programmed stream energy. Smaller scale hydro control is skilled to create up to 5– 300 kW of power. This is one of the easiest innovations, which exchanges hydropower to mechanical power the developing country like Bangladesh is very much suitable for Micro-Hydro technology and the cheapest technology as well. Many canals and branches of the rivers in Karnafuli, Shangu, and Matamuhuri are supposed to be good prospects for installing micro-hydro power along with the Chittagong Hill Tracts. Recently, the principal small-scale hydropower unit at Bamerchara, Chittagong, has been set up by the Sustainable Rural Energy (SRE) under LGED [7]. In any case, just around 4 KW of power can be delivered on account of inadequate water current and flow. In 1981, Bangladesh Water Development Board (BWDB) and Bangladesh Power Development Board (BPDB) in the year 1981 investigated potential destinations, which are appropriate for smaller scale hydro control ages [7]. Supportable Rural Energy (SRE) has additionally found some conceivable areas for miniaturized scale hydro locales in Chittagong regions

in 2004. It is clear that there is immense option of generating electricity from the micro-hydro energy. However, unfortunately, Bangladesh has been unable to generate power energy from the hydro energy. The total hydropower potential of Bangladesh in the three locations (Kaptai, Sangu and Matamuhuri) is about Gwh/year (755MW) of which 1000GWh/year (230MW) has been harnessed at Kaptai through 5 operational units of hydro power plants. For obtaining the advantage of hydro power, proper attention should be imparted for its further development. BPDB has submitted a proposal to the government to install a 25KW power plant at the Teesta barrage [7]. Further analysis can open a new door of success in this regard. The Bangladesh Water Development Board (BWDB) and Power Development Board (PDB) carried out a joint study for the future prospects of micro-hydro power potentials in the country. If by dint of proper planning, we can make the best use of hydro power electricity then the whole nation can be benefited to a great extent from the view point of energy security and energy reserve.

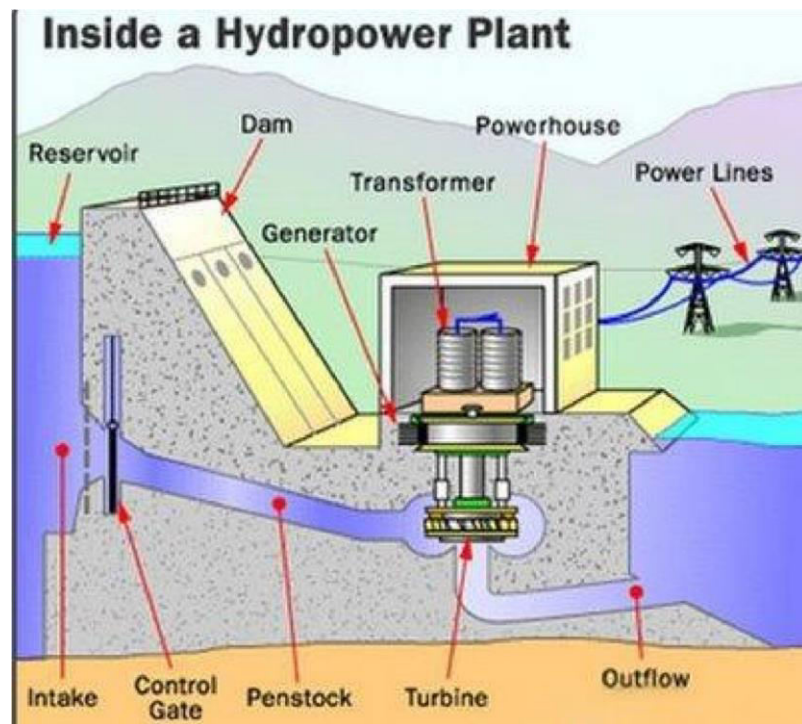


Fig-2.4: Hydro power plant

2.2.1.5 Solar:

Because of the limitation of non-renewable energy source worldwide and in Bangladesh, the requirement for an extreme change to elective sources is needed. The solar energy requires a colossal

interest in costly silicon boards. The solar panel covering a family housetop would be sufficiently hard to supply its family unit prerequisites likewise, would require batteries for use amid the night.



Fig-2.5: Solar

2.2.1.6 Rooftop solar home system:

The immediate change of sunlight into power is called photovoltaic solar energy. A fundamental segment of Photo Voltaic (PV) framework is the sunlight-based cell, in which the photovoltaic impact happens. At the point when light falls on the semiconductors of the cell, it delivers a little electric flow. Photovoltaic modules, or boards, comprised of various cells associated together to give voltages and flows sufficiently high for down to earth utilize. More typical in rustic jolt program is the utilization of sun-oriented PV as remain solitary frameworks in families, social establishments, or spots of beneficial or business exercises. For the most part, the framework is alluded to as 'Housetop Solar Home System' (SRS). The SRS giving burden is low (underneath 100 W), anyway can be satisfactory for controlling of lights, radios, TVs, and to refrigerate remedies at commonplace offices. In spite of the way that SRS is apparently expensive at first look, it is fiscally astute in giving force at little scales in areas without access to system power or some other feasible power source. Its application can additionally be sensible where ask for is depicted by low measurements or the securing cost of fuel is high (GOLDEMBERG 2000: 376, SUDING et. al 2004: 72) [7]. In any case, with rising fuel costs SRS headways may end up being more cost-profitable than off-network alternatives subject to oil subsidiaries. subsidiaries.



Fig-2.6: Rooftop Solar home system

2.2.1.7 Technical background of SRS:

Solar energy comes from the Sun. The photovoltaic/solar module changes over the daylight into power. It ordinarily has a limit of between 20 to 100WP. The battery stores the electric vitality for around night time amid shady climate. The charge controller is a device that bargains with the electric travel through the framework and shields the battery from harm. It alerts the customer when the battery needs charge or when the module isn't working really. Wires and related switches scatter the power inside the framework and to the heap for instance, lights or electric machines. Ordinary SRS work at 12 volts coordinate current (DC) and use capable fluorescent or Light Emitting Diode (LED) lights and machines to make best usage of the given power (HANKINS 1993: 10) [8] . A conventional 50WP SRS can give enough ability to work four minimal bright lights, and a little 15-inch exceptionally differentiating TV for up to five hours (CABRAAL et al.1996: 8) [9]. The below figure is the solar home system module, where we can see that how SRS worked.

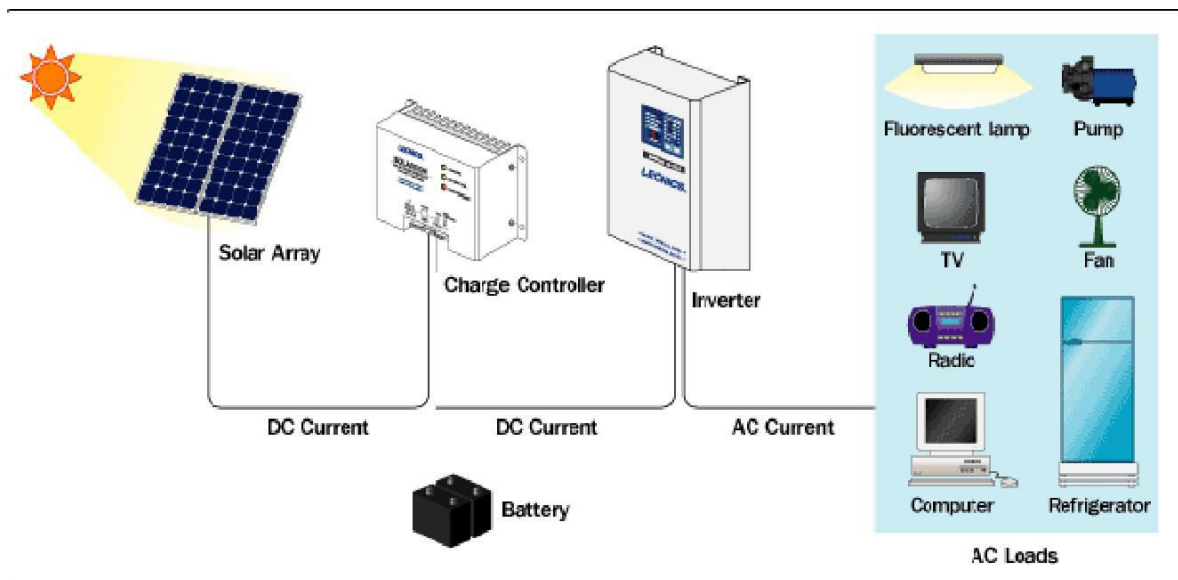


Fig-2.7: Technical background

Solar panel: Solar panels are made of photovoltaic (PV) cells, which transform daylight into electricity. This power would then be able to be encouraged into our home's mains power supply.

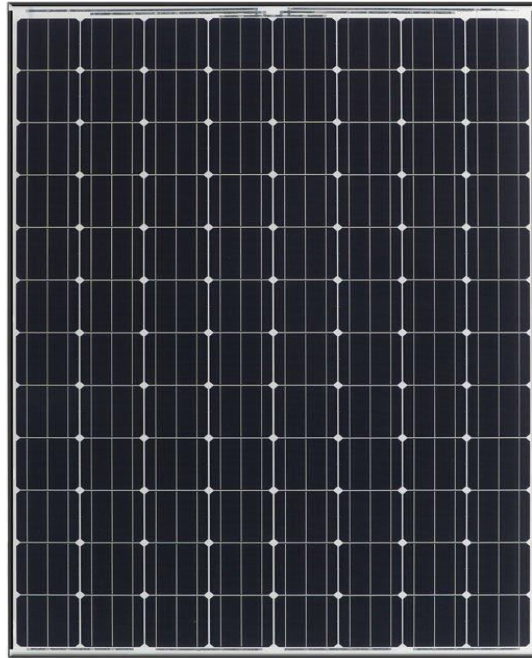


Fig-2.8: Solar panel

Charge Controller: It is a device which is basically a voltage and/or current regulator to keep batteries from overcharging. it controls the voltage the voltage and current coming from the solar panels going to the battery.



Fig-2.9: Charge Controller

Inverter: An inverter changes over the DC voltage to an AC voltage. basically, the input DC voltage is usually lower while the output AC is equal to the grid supply voltage of either 120 volts, or 240 Volts depending on the country.



Fig-2.10: Inverter.

Battery: A battery is a device which is store electricity. In solar home system, battery can play an important role it store energy when it is day light and it is ready to supply the power in night .



Fig-2.11: Battery.

2.3 Present condition of solar energy in Bangladesh:

Bangladesh is a subtropical nation, subsequently 70% of year daylight is fallen in Bangladesh. For this rationale, we can utilize solar boards to deliver power to a great extent. Sun powered radiation contrasts from season to season in Bangladesh. Bangladesh gets a normal day by day sunlight-based radiation of 4– 6.5 kW h m⁻² with the most noteworthy sum in April and least sum in December (Fig: 2.12). Sustainable power source Research Center (RERC), Dhaka University is the fundamental source which has whole deal evaluated data of Dhaka; thusly, sun-based imperativeness can be an inconceivable hotspot for handling the power crisis in Bangladesh. The Bangladesh government has as of late found a way to motivate individuals to utilize PV vitality. Basically, every as of late built level building is at present used sunlight-based boards alongside the matrix association with getting bolster amid the heap shedding period.

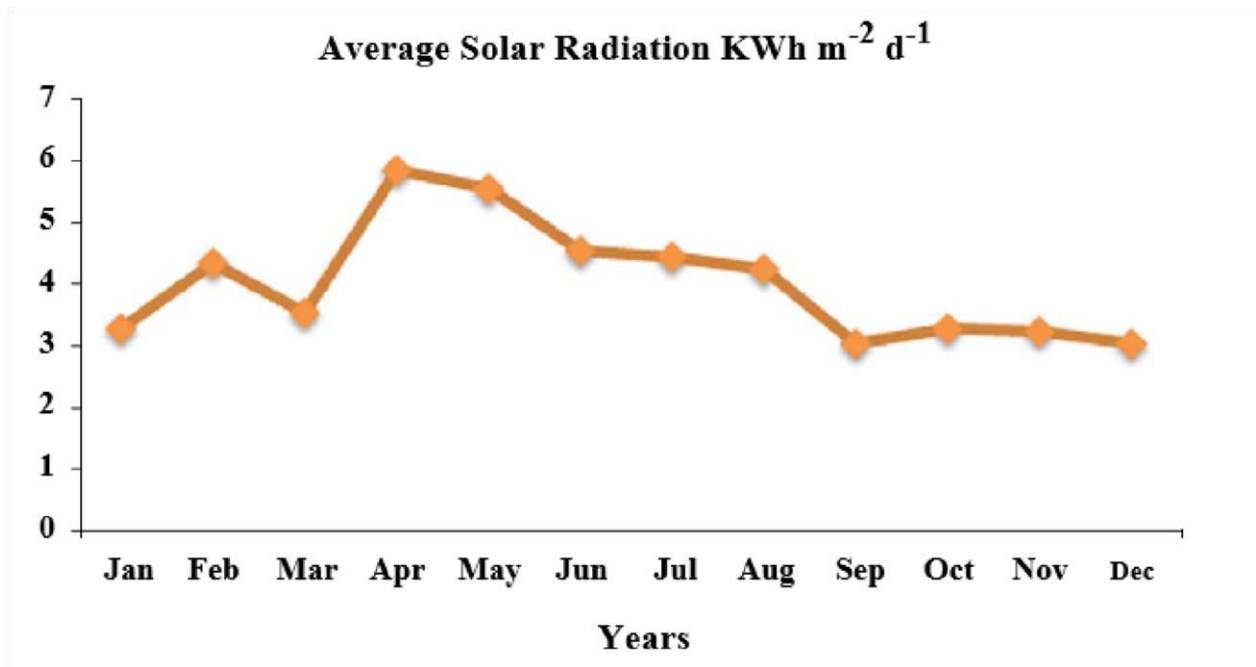


Fig-2.12: Monthly average solar radiation profile in Bangladesh

Even in the rural areas, some NGO's have been attempting to convey solar boards to the villagers at a low-evaluated price. The SRSs establishments have significantly greater up to 2015. The chart

enlightens that the appropriation of the SRSs is most elevated in Dhaka area, while least in the Sylhet.

We can figure sun-oriented power using the going with condition. Solar power, solar=area per sqft×watts per sq-ft

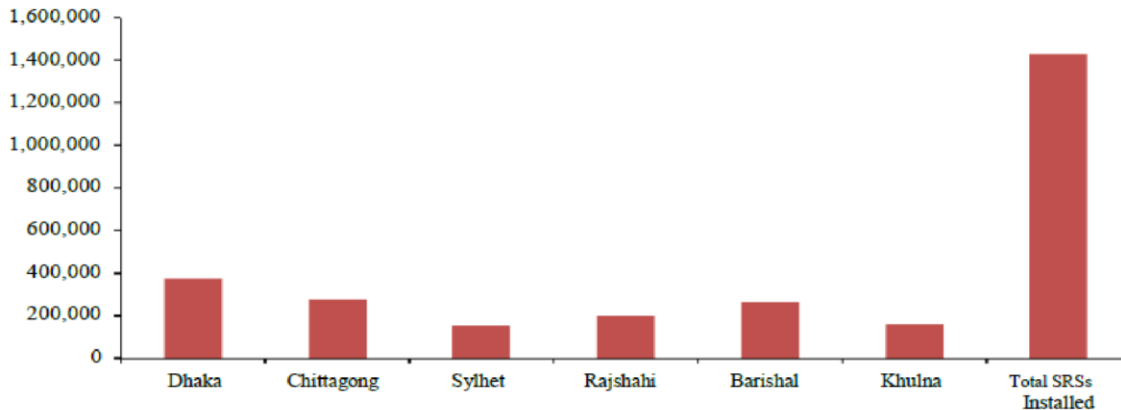


Fig. 2.13 Distribution of SRSs in six divisions of Bangladesh up to Jan 2015

2.4 Benefits of solar energy:

The Institute of Fuel Research and Development (IFRD) of Bangladesh Council of Scientific and Industrial Research (BCSIR) and Centre for Mass Education in Science (CMES) cooperated and effectively made one cooker which is low in expense and light (presumably about 2–3 kg) in weight. But it has one disadvantage, as it has to track down the sun manually on a splendid bright day it will take around three hours to cook for a group of 5–6 individuals.

The Institute of Food Science and Technology (IFST) is working on increasing Solar Dryer. They have built up a bureau dryer for drying organic products, vegetables and fruit.

It is structured by IFRD and has a covered level plate which assimilates solar radiation, changes over into heat and transfers the resulting heat to circulating water. This kind of heater is valuable for providing low grade thermal energy at temperatures below 90°C [10]. Solar PV based irrigation is not a new concept in Bangladesh. It does not require any highly sophisticated component. The main challenge comes from the actual cost of irrigation, which is mainly dependent on the irrigation model.

in the context of the socioeconomic condition of rural Bangladesh. Since necessities are intense just in the midst of the dry months (3– 4 months), the overhead cost ends up being too high for significant irrigation projects. last 5– 6 years, SRS a massive improvement in nation Bangladesh and it reflects the aura of the rustic individuals towards an elective source. Incredibly, essentialness yield in a SRS is low and is barely enough to meet the crucial nuclear family require like lighting, as the yield of SRS are not all that high. SRS isn't intended to give vitality bolster even too little scale industry. A choice is a microgrid framework where autonomous little size lattices are intended to give capacity to little country regions from a midway found power station. These power stations could be only sunoriented photovoltaics, or sun-oriented photovoltaics - Diesel half breed. There can be two choices so far, the plans of the of the smaller scale matrices are concerned 1) AC microgrid and 2) Dc miniaturized scale matrix [11]. Still initials cost might be high, yet it can keep running for quite a while. We find right now two kinds of electric vehicles are running in our nation. One is privately called "simple bicycle". It looks carefully comparable conventional CNG based auto rickshaw with the exception of its keep running on battery. The second one is two situated rickshaws. The two are vitality efficient and condition cordial being basic on the planet and also Bangladesh. Ordinarily they continue running on 50Ahr, 80Ahr, 100Ahr and 120Ahr battery subject to the size and speed of the vehicle. At present there is no alluded to stimulating station for charging them as it expands heaps of intensity from the framework. So, a Solar PV based electric vehicle energizing station can be made. This methodology can continue running near to the Normal CNG filling station or petroleum, Pump, as the sun-based boards would be mounted over it. This strategy can work in basically all parts of BANGLADESH as the whole country stand up to generally same sun-based protection enough to convey required electrical vitality [11].

2.5 Solar cooking and its prospects in Bangladesh:

A sun-oriented cooker is a gadget that utilizes daylight to create warm with the end goal to cook sustenance. Sun-powered cooking is the clean and safe method of cooking. It uses sun-oriented vitality which is luxuriously accessible in nature to cook nourishment. It has three noteworthy kinds of sun-based cookers [11]. Provincial having power accessible to them, found there is fundamentally more that ought to be conceivable to improve their, welfare, training, horticultural production new vocations have been made where have been set up to give after-bargains organizations to the customer, and show the authorities customer on the most proficient method to work and keep up the SRSs. No less than 20,000 green occupations have been made with around 5000 women arranged as

sun-based specialists using this system and step by step people are getting drawn in with this program [12].

2.6 Economic development in rural area through solar PV micro utility:

One of the fundamental monetary exercises of country Bangladesh relies upon common markets called Haat. The trading continues until night. Generally, Kerosene lights called Kupa, Hurricane and Mantle lights called Hazzak are the huge mechanical assemblies used to edify the Haat shops. Directly Client shops are associated with sun-oriented PV smaller scale utility and using lights to edify their shops which are protected and terrible. The principal sun-based PV smaller scale utility was set up in September 1999 in Manikgonj. Contribution from customers of a sunlight-based PV smaller scale utility in Manikgonj Bazaar demonstrated that customers were extraordinarily content with this advancement. [12]. Sun oriented vitality may give clients' comfort to some degree and can add to the national economy if it's sold inside and outside of the country; the examination expects to explore whether sustainable power source business industry executes a run of the mill philosophy to position itself in wherever all through the country.

2.7 Significance of solar energy for rural electrification in Bangladesh:

In 1971, the season of opportunity of Bangladesh, only 250 out of 87,928 towns approached power (BARAKAT, 2004). Administration of Bangladesh (GOB) subscribed to build up a program for giving power to rustic regions. Article 16 of the Constitution of Bangladesh states: “The State shall adopt effective measures to bring about a radical transformation in the rural areas through the promotion of an agricultural revolution, the provision of rural electrification, the development of cottage and other industries and the improvement of education, communications and public health, in those areas, so as progressively to remove the disparity in the standards of living between the urban and the rural areas” (GOB, 2004) [13]. Bangladesh Power Development Board (BPDB) was framed to work and extend the electricity network, which essentially focused on electrification of urban centers. To increment rural electrification National Rural Electric Cooperative Association (NRECA) was authorized to conduct an extensive study.

NRECA built up master plan emphasizing on the provision of electricity for agricultural mechanization, irrigation and rural industries. The master plan was adopted in 1977, closely followed by the establishment of the Rural Electrification Board (REB) in the following year (BARNES 2005: 84) [14]. By January 2014, in excess of 50,194 villages had been electrified through the REB program serving more than 84, 22, 246 domestic line (REB, website) and 53.34% people get access to electricity service and the rest 46.66% depends on kerosene and other sources (BBS, 2008)[14].The REB has set a goal to bring all villages of Bangladesh under electrification by 2020. However, it must be noticed that the electrification of a village does not necessarily mean that all households will instantly get a connection, as affordability of the underlying association cost makes an issue for certain number of families. Subsequently, just a little minority (10%) of rural Bangladesh is have access to electric power. Moreover, the nature of supply is regularly inadmissible because of successive load shedding and voltage fluctuation (MIYAN 2004: 42) [16]. In more remote zones, dissemination line set-up is all the more exorbitant because of its landscape dominated by extensive areas of water, regular flooding, hilly and certain regions of river islands. In this circumstance, decentralized power supply with RETs might represent a viable and cost-effective alternative to conventional grid-based electrification. Natural gas reserves assessed to be depleted soon and Bangladesh 's petroleum consumption being absolutely import-based, increased use of renewable energy sources seems to be a reasonable step for the development of a sustainable long-term energy scenario (ISLAM 2004: 9) [17]. Despite the fact that Bangladesh's physical scene is molded by tremendous measures of water, the potential for hydroelectric power generation is quite limited. Country's only hydroelectric plant, Karnafuli power plant, has a total generating capacity of 230MW, representing about 5% of the total installed capacity of electricity in the country. The development of the dam and the reservoir for the Karnafuli power plant prompted extreme negative ecological and social influences making long drawn social distress among the nearby populace. Again, electricity generation from wind power is likewise more constrained in Bangladesh for scarcity of usable wind speed. Besides, generation of electricity from biomass for example, animal waste or deposits are still in the beginning period of improvement and testing. Bangladesh is geologically situated in an ideal position for outfitting sunlight accessible plentifully for a large portion of the year. Normal everyday radiation of sunlightbased vitality is about 4.5 kWh per square meter making it in fact very practical to utilize photovoltaic energy for electrification purposes (ISLAM 2005: 79) [18]. Experience has revealed that Photovoltaic (PV) electricity seems to be more appropriate for isolated rural areas away from conventional gridlines (ISLAM 2005: 79) [18]. He also states for the future that with enough political help it is conceivable to 'Plug even the remotest

rural areas of Bangladesh to the sun' (ISLAM 2005: 76) [18]. From the above conditions, the use of solar energy (Solar Home System) is the most achievable choice for rural electrification in Bangladesh.



Fig-2.14: Solar based school in rural area

2.8 Movement of overall SRS dissemination:

The utilization of solar electricity expanded at the revelation of photovoltaic cell in 1839 by French physicist Edmond Becquerel. Progressive specialists have created cells with more productivity. The primary enthusiasm for solar technologies for rural stand-alone electrification arose in the 1970s. An economic breakthrough happened when Dr. Elliot Berman could plan a more sun-based cell bringing the cost down from \$100 per watt to \$20 per watt. This huge cost savings opened up a large number of applications that were not considered before because of high costs. The 1973 oil embargo and 1979 energy crisis caused a reorganization of energy policies around the world conveyed reestablished thoughtfulness regarding creating solar technologies. Between 1970 and 1983 photovoltaic installations grew rapidly, yet falling oil costs in the mid-1980s directed the development of solar photo volt from 1984 to 1996. By the mid-90s, different activities were

launched to scale up into expansive SRS commercialization and government-supported scattering program. Since 1997, solar electrification has accelerated due to supply issues with oil and natural gas, global warming concerns and the improving economic position of PV relative to other energy technologies. Before the finish of 2005, 2.4 million SRSs had been introduced worldwide with an expected yearly establishment of in excess of 2,70,000 frameworks (REN 21 2006: 12) [19] . Dissemination of SRS depends on affordability. According to F. D. J. Nieuwenhout adequate service infrastructure is required to make projects viable. Household choice in system sizes is often too restricted in donor-funded projects. Smaller frameworks sold for money can be a decent choice to credit frameworks by offering to expanded moderateness (F.D. J. Nieuwenhout, et al, 200; 9: 455-474) [20]. Contingent upon their size, costs of SRSs can shift between US\$ 100 and US\$ 1,100. There are also significant price variations for different countries observable. Local costs rely upon variables, for example duties, taxes, and subsidies, the scale of manufacturing and assembly processes, the scale and cost of marketing and other services, the degree of competition, capacity utilization in manufacture, sales & servicing and the cost of funds for working capital and capital costs. The other real issues to be considered are the high starting costs, the foundation of a responsive and practical framework and the ensuring of value items and administrations. Reducing the market prices of SRS by impacting the above components is an imperative methodology of numerous SRS spread projects (CABRAAL et al. 1996: 8-9) [21]. In recent years most of the global growth in SRS deals has focused on a couple of Asian nations, to be specific India, Sri Lanka, Nepal, Bangladesh, Thailand, and China. In these the problem of affordability has been overcome either with micro-credit or by selling small systems for cash.

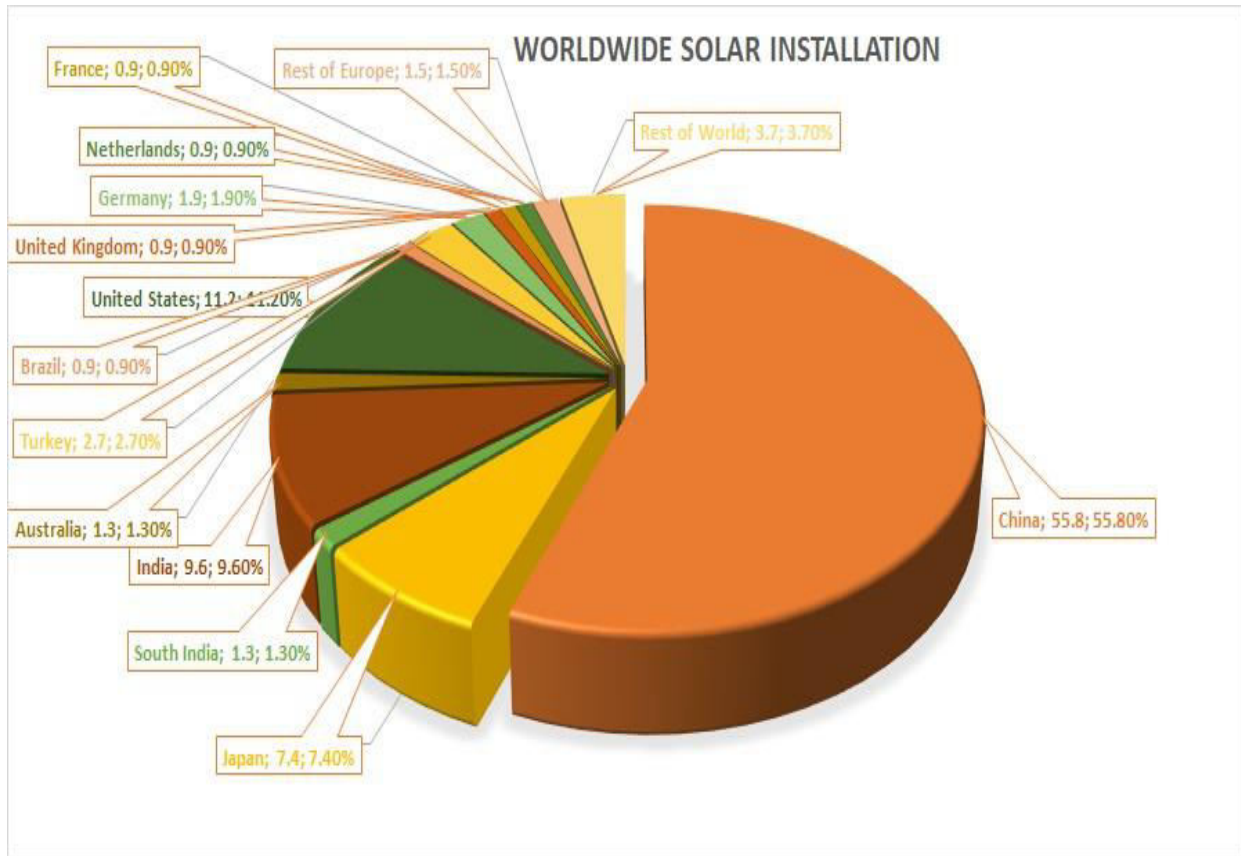


Fig-2.15: Worldwide solar installation.

2.9 SRS and socio-economic development framework:

Figure-2.16 is a structure of SRS and socio-economic development. It is a delineation of the multisectoral linkages of SRS impact on personal satisfaction in off-grid networks. It demonstrates social and monetary advantages that might be accomplished to rustic recipients by utilizing SRS. The framework focuses on specific area of education, health, agriculture information, environment and micro enterprise linkages with several sectors through solar electrification in rural area. It depends on a mix of models and discoveries from pertinent writing.

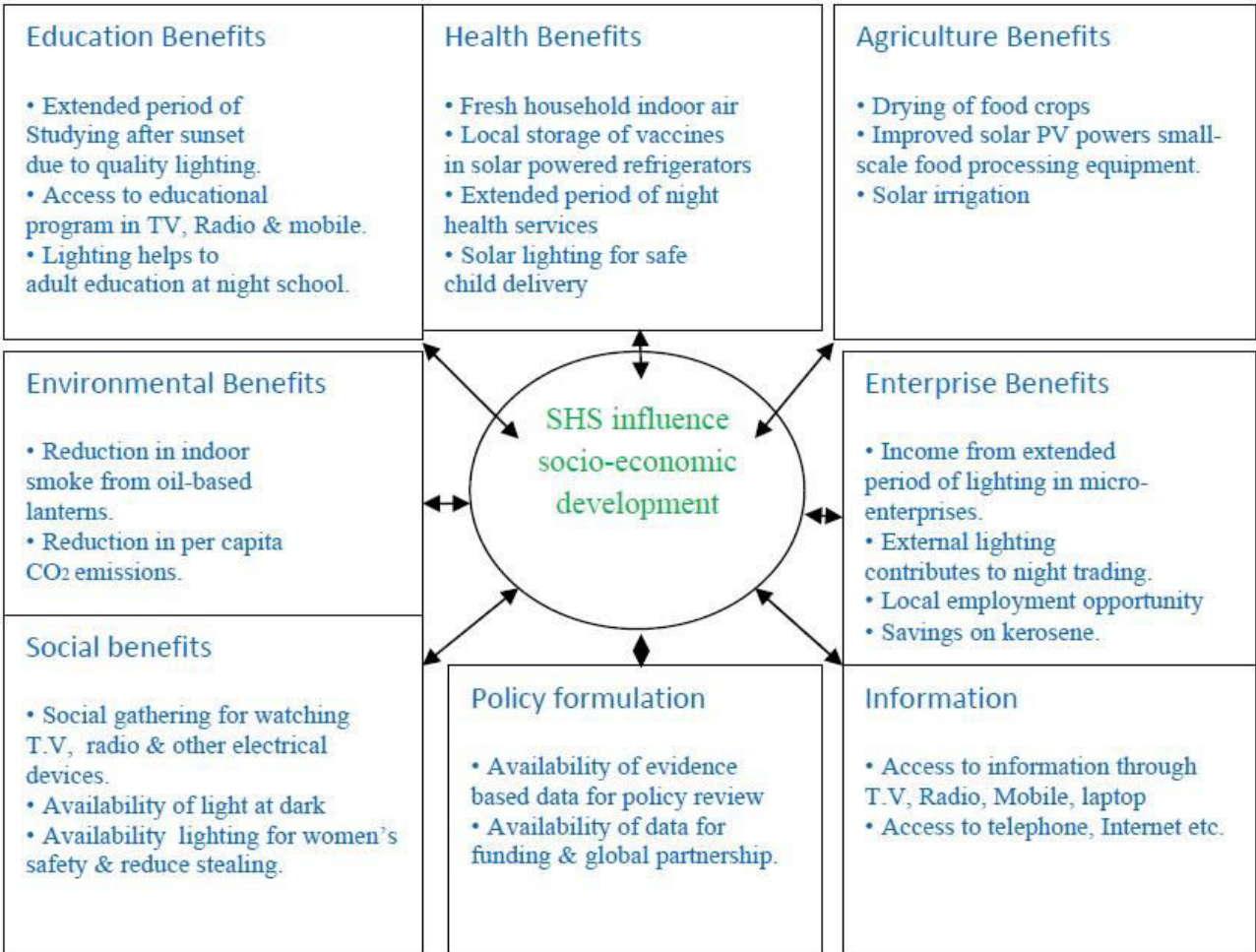


Figure-2.16: SRS and socio-economic development framework

2.10 Summary:

The article takes a look at the basic factors to be considered to build up a solar rooftop system. The system comes out of the solar energy. Solar energy uses the sun as the source of energy and helps it to turn the energy into electricity for home or business. Various Classifications of energy are analyzed within this review. The main procedures that help the system to run are also serially discussed here additionally with the explanation of different examples of the energy.

Chapter Three

Research Methodology

3.1 Introduction:

As it is pointed out within the title, this section comprises the analysis methodology of the theory. In additional details, during this half, the originator outlines the analysis strategy, the analysis methodology, the analysis approach, and the strategies of information collection, the choice of the sample, the analysis method, the sort of information analysis, the moral issues and therefore the analysis limitations of the scheme. This inspection was intended to research the socio-economic effects of 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. Finally, we gain basic data about the impacts of solar electricity and its effectiveness are Collected through an intensive unit survey technique victimization form. Primary knowledge of the survey is actually collected from the users of solar roof system. A systematic attempt was thrown to find the opinions about the appropriateness of the system and the way people are taking the service. Opinions are taken by the owners or the users of this system.

3.2 Flow chat of our working procedure:

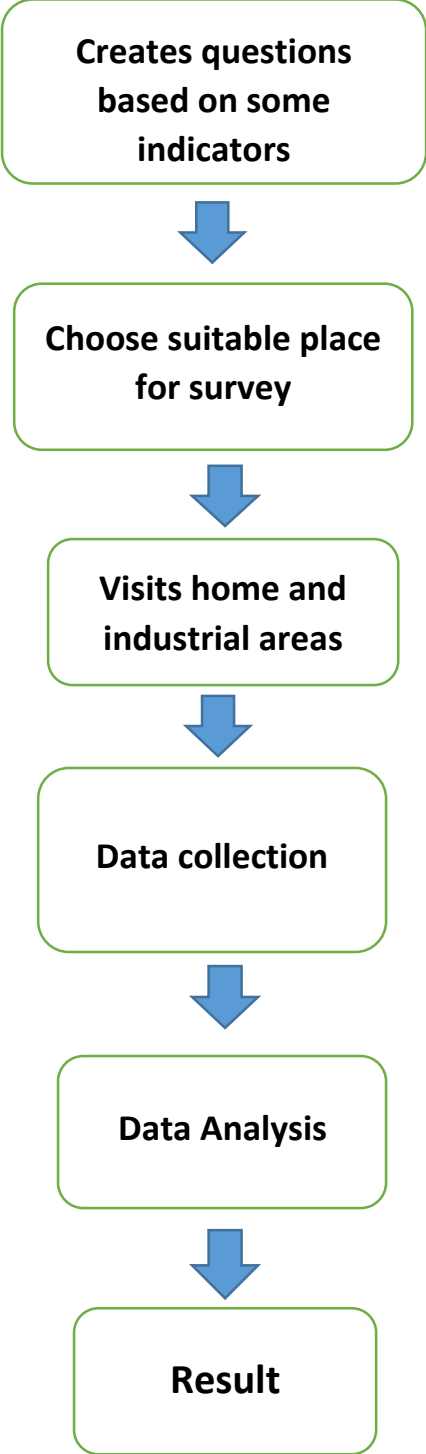


Fig. 3.1: Flow chart of working procedure.

3.3 Site Selection:

It is mentioned earlier that the survey based on the industrial areas of Bangladesh. The survey is mainly covered in one of the busiest cities of the country, Narayanganj regarding a 24 kilometers far away from Dhaka. It is known as a town in central Bangladesh. It's within the Narayanganj district, close to the capital town of Dhaka and features a population of concerning a pair of 2.2 million. The town is on the bank of the Shitalakshya stream. The area of the city is 33.57 km² (12.96 square meters).



Fig 3.2: Map of the survey location

The area of Narayanganj is a very important shipping and industrial center of the country. It's conjointly a middle of business and trade, particularly the jute trade and process plants, and also the textile sector of the country. It's nicknamed the Dundee of Bangladesh because of the presence of its several jute mills. According to the basis of the analysis, this city was chosen for this study. About 40 fields regarding industries and buildings are infrequently visited for the analysis of the thesis. These fields are circulated under the assistance of DPDC. Some areas regarding new chasara, Allama Iqbal Road, north chasara, Chandpura Adarsha Chasara, Nag road are given for the survey. More than 40 The queries are asked in Bengali for well understanding and it was taken as simple as it is possible as no one gets hesitated. At most of the buildings where the survey was covered, owners of the buildings are not found there. So,

the queries are actually asked to the person who operates the system. A few fields couldn't provide us with the proper data and information. So, the information's taken from the owners of the system or the person who looks after the system through a phone call as they are not present over there. The noticeable thing is that most of the operators or the owners of the system are very helpful to the survey activity which makes the project go thoroughly. To make the survey easier, couple of assistance is provided from the DPDC. It obviously makes the process easier and to find the places of SRS-owned area.

3.4 Working Sheet:

Through information collection and observation of the prevailing SRS, a transparent plan was developed concerning the current standing of solar roof system within the households, the difficulties faced by them, maintenance facilities and therefore the time of rectification needed during fault condition was noted in several cases. Normally, it takes some of days if the fault develops within the SRS. There's a good impact of solar power on our country additionally as on our rural folks. It is intended to try to figure out however the life-style is stricken by solar power. We got an outline from the questions sheet.

3.4.1 Questionnaires':

Serial No.	Items	Questions	Description
01	Consumer information	i) Name of the owner ii)Name of the NOCS iii)Mobile No., Address. iv) Consumer No.	In this method we just we just collected the consumers information.
02	Installment Information	i)Date of installment ii)Total capacity iii)Bought SRS from where.	In this part we asked and tried to find out the information of installment.
03	Operation	i)SRS are in operation or not ii)Is consumer use it	In this part we checked the present situation of SRS and taken reading from the meter.

		iii)In which purpose they use it. iv) Electricity generation	
04	Maintenances	i)Do the clean the panel ii)How often it is done iii)Do they get any training about SRS.	In this part we wanted to know about maintenance and training.
05	Consumer satisfaction	i)Do they want to increase SRS capacity ii)SRS is useful or not iii)Is it the waste of money	The part we tried to know that consumers are satisfied or not.
06	Cost analysis	i)Total cost for SRS ii)How much electricity generated.	In this section we calculated the electricity generation from a solar system and per unit cost of solar power.

Table 3.1: Tables of questionaries'

Most of the solar rooftop systems were found on grid and in operation. In addition, some of the systems were found uninstalled as well. There's a query about whether the people find it useful or not. Generally, a major number of people find it useful and satisfied to use the electricity from the system for their various purposes. The total costs of the system were approximately found in between eighty thousand and six lakhs. Many interviewed people showed their keen interest to increase the capacity of the system as well which is a good sign of the appropriateness of the solar rooftop system on our country. There's a matter to find out that how many of them actually clean the system and repair it and what's the actual duration to clean it. As it is found that most of the people are not well trained to operate the system, a few numbers of people were found who cleans the system within certain duration and test the system in a regular basis. Alongside with all the queries, there's a very limited support from the government to increase the crews of users of the solar rooftop system.

3.5 Summary:

As mentioned earlier home, tiny business and academic institutions were surveyed. It's clear that solar rooftop system is largely used for social unit use as fuel value is reduced to a good extent by using SRS. The noticeable thing from the study is that a number of people are coming to know the usefulness of the system. Due to lack of knowledge about it, some people also find itself just a waste of money. According to the study, there's no hesitation to say that majority opinion finds the system appropriate for reducing the value of electricity. If the government gives proper support, crew of the users will grow up gradually and many of the present users will be intended to increase the capacity of solar rooftop system.

Chapter Four

RESULT

4.1. Introduction:

Background, concept, and given scenario of solar electrification dissemination for transfer socio economic development in numerous areas are mentioned. It is observed from the previous discussion that energy plays the key role for development. Due to rise of fuel value and increasing carbon emission worldwide, there's a worldwide shift towards renewable energy like solar, wind etc. Being in tropical region, Bangladesh could be an alternative energy wealthy country. alternative energy will play a significant and secure energy supply for property development. the most objective of this study is to assess the impacts of alternative energy on socio-economic development in rural areas of Bangladesh. To verify the target through empirical observation, a cross-sectional of twenty-five haphazardly elect households and industries in Narayanganj space are surveyed with a structured form. The survey results are analyzed as follows within the following sections.

4.2 Data Analysis:

In data analysis part we showing the results through the questionnaire segment part. In this part we tried to show the results of the each items of the quiestionary segmet. We also tried to find out the solution from bellow results.

4.2.1 Consumer informaton:

In this section we showing one chart. The chart indicates the total number of consumers.

□ Number of consumers:

Figure 4.1 indicates the survey area divided into four different region. These four regions are Killarpul, Fatulla, Nitaiganj and Chasara. From the pie chart, we see that 10 consumers are

Chasara, 5 consumers are Killarpul, 6 consumers are in Fotulla and 4 consumers are in Nitaiganj Area.

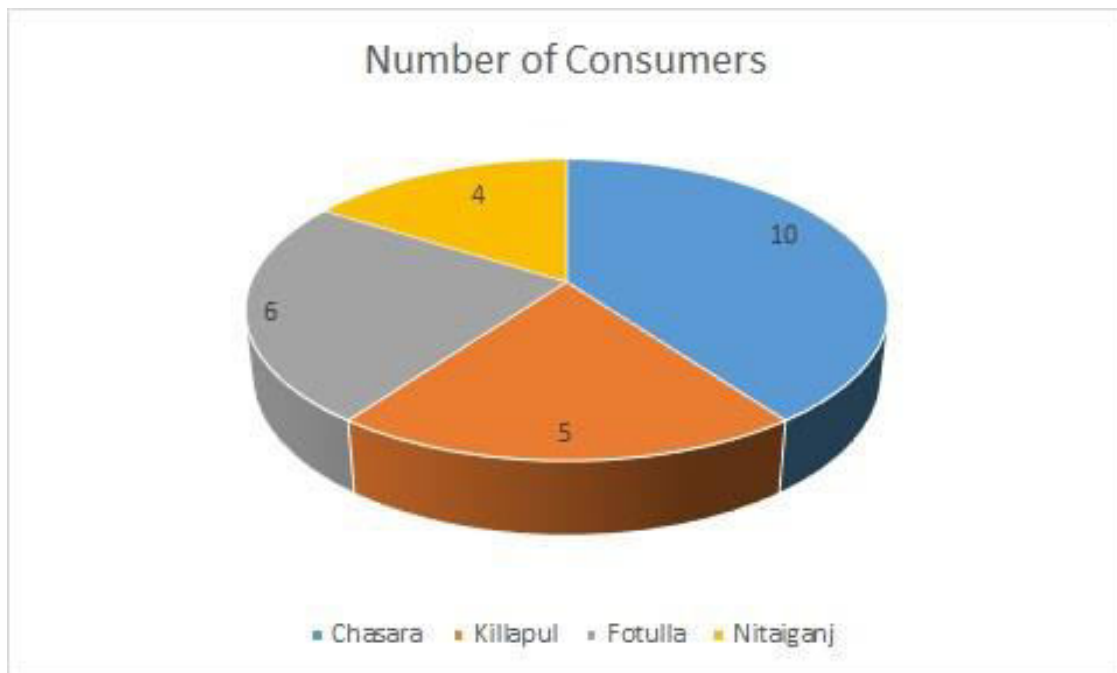


Figure 4.1: Total consumers

4.2.2 Installment Condition: In installment condition part, we are showing three different sections of installation system. These three are total capacity, installment condition and brought the solar system.

□ **Total capacity of SRS:**

After completing the survey we found the total capacity of the SRS of 25 consumers has 20KW. Figure 4.2 shows that, the 20KW electricity divided into basic two areas of Narayanganj. We see here west zone of Narayanganj area has 40% of the total capacity and the rest of 60% is in east zone of Narayanganj.

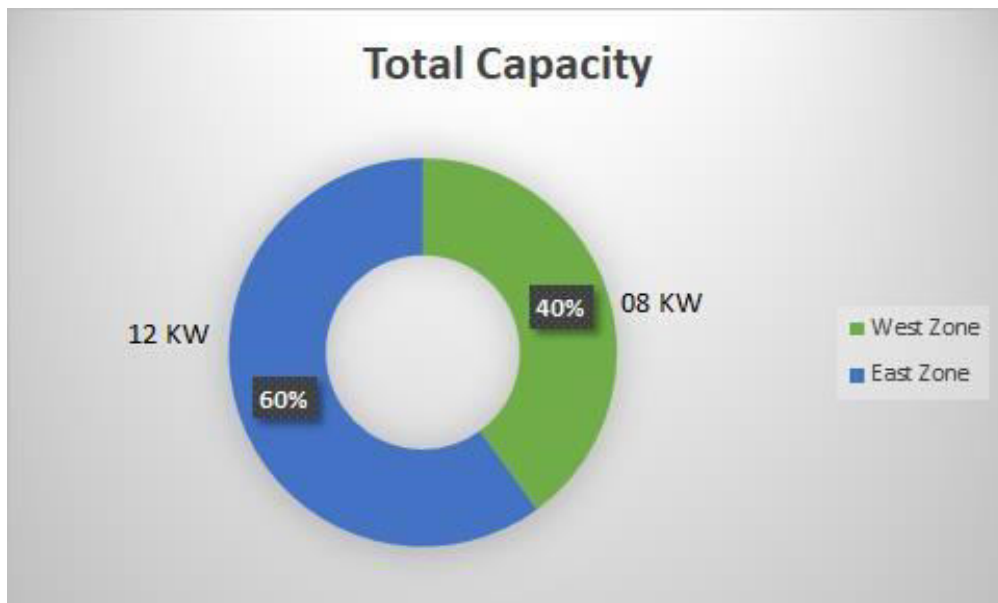


Figure 4.2: Total capacity

□ **Solar system provider:**

Under Narayananj NOCS, we collected 25 consumers data samples. Figure 4.3 indicates that, between those consumers, 18 consumers are brought SRS from market for installation of solar home system, 5 consumers are brought SRS from DPDC agency and rest 2 users are not wants to say anything about it. But the consumers those are brought SRS from the market cannot get

much electricity according to their capacity.

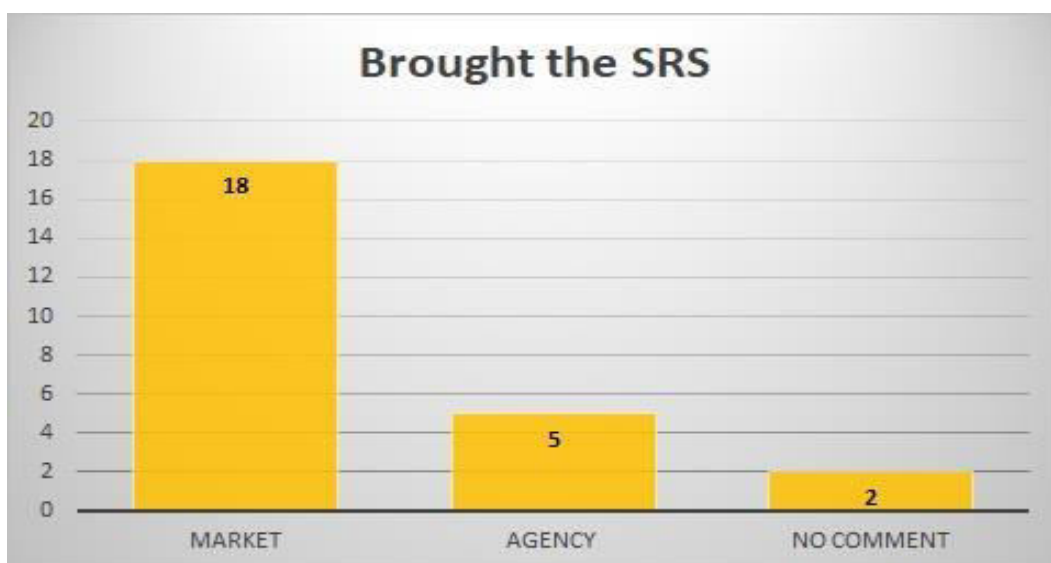


Fig-4.3: Brought the SRS.

□ Installation process:

Figure 4.4 provides information that 21 consumers are installed SRS for the policy obligation. That means they have no interest to install the solar system. Other 4 consumers are interested to install the SRS system. That's why they intalled SRS for their own choice.



Figure 4.4: Installment condition

4.2.3 Operation:

In operation part we are showing one chart, which is solar systems are in operation or not.

□ Operating status:

In figure 4.5 we used bar type chart. This bar shows that, in home unit 3 SRS sytems are in operation among 5 consumers, and in industrial sector, among 11 consumers, only 2 consumers are in operating modes and 9 consumers are not in operating modes. Its a very low numbers of SRS are in operating modes in industrial sector. Though there is highest numbers of SRS intalled in industrial sector. In commercial building, only 2 SRS is in operating modes among

6 consumers. At last we see in hospital there is 100% SRS system are in operation. That's are 3 out of 3 in opreation.

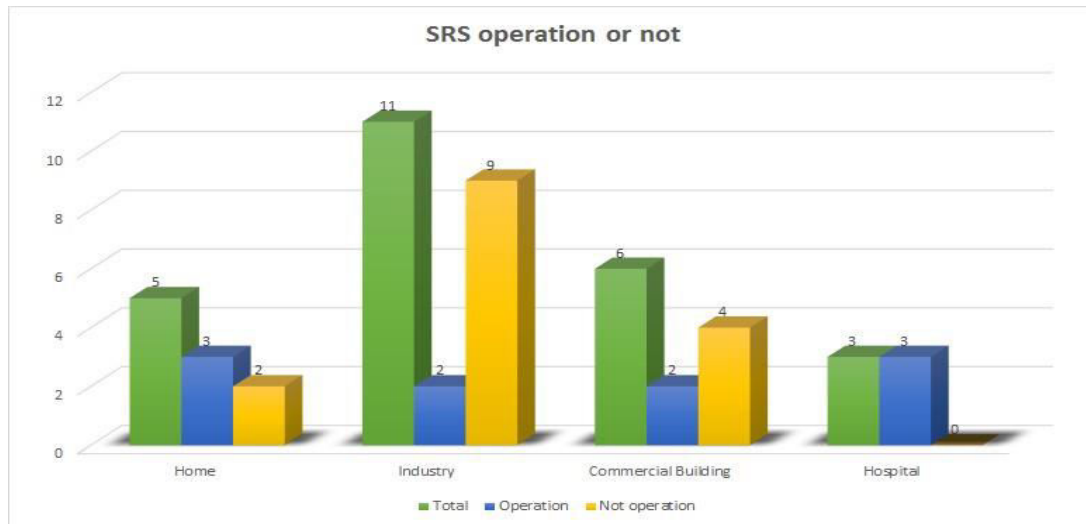


Figure 4.5: Operating condition

4.2.4 Maintenance:

In maintenance part we are showing different types of conditional charts which are important for maintenance. These include cleaning the solar panels, getting any kind of training, facing any kind of survey, and recording the solar electricity data.

□ Cleaning the solar panel:

Figure 4.6 indicates that we divided consumers into four different sectors: Home, Industrial, Commercial Building, and Hospital. In the Home sector, 20% of users clean their solar panels, while 80% do not. In the Industrial sector, 100% of users do not clean their solar panels. In the Commercial Building sector, 100% of users do not clean their solar panels. In the Hospital sector, 100% of users clean their solar panels.

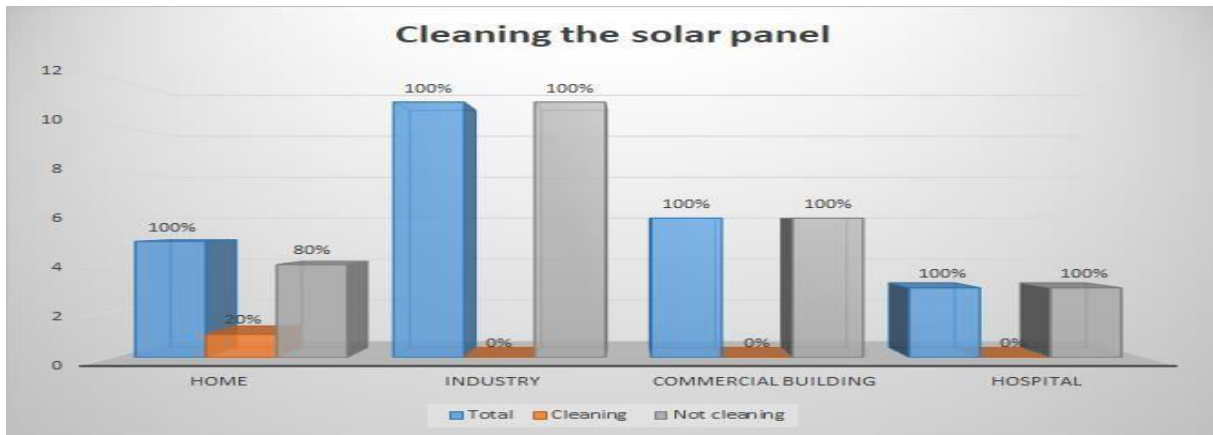


Figure 4.6: Cleaning the solar panel

Getting training for SRS operation:

In figure 4.7 there showing vertical bar type chart with percentage condition. From chart, we can say that, between 100 percent consumers are not interested to taking any kinds of traning for SRS operating. They are not interested to use solar energy and for this they don't agree to take any kind of training about it.



Figure 4.7: Training for SRS operation

□ Facing any kinds of survey:

Figure 4.8 showing the pie chart with percentage value of facing any kind of survey. The pie chart indicates that 16 percent users are facing survey one or more time. And 84% users are not

facing any kinds of survey. Some of them realise that there need to held such kind of survey.

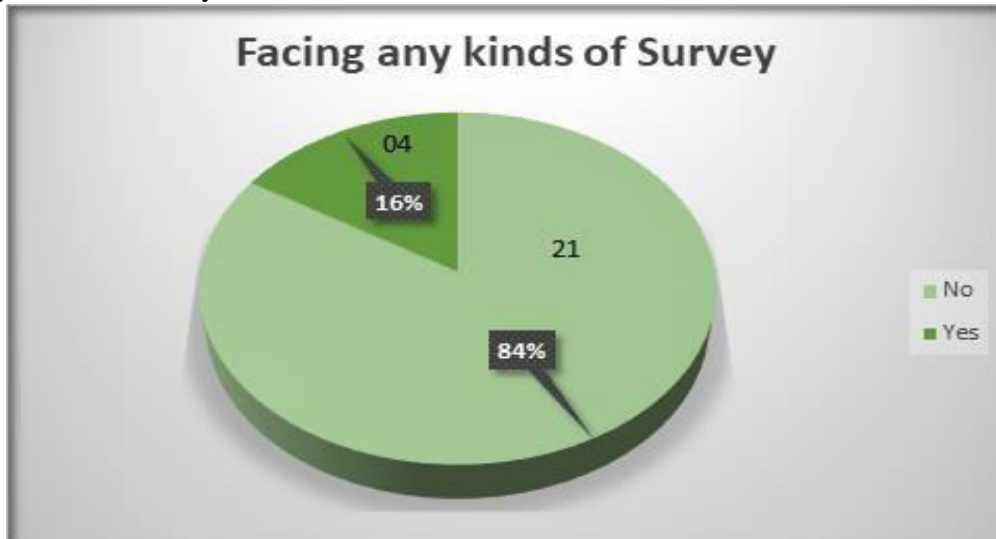


Figure 4.8: Facing any kinds of survey

□ Records of solar electricity:

Figure 4.9 provides that in hospital sectors all 3 consumers are recording the solar electricity. In commercial building there are 6 consumers we visited, from them 2 consumers are recording the solar electricity and the rest consumers are not recording the solar electricity. In industrial sectors, no one records the solar electricity. And last sector is home. In home sectors, among 5 consumers 2 consumers are recording the solar electricity and 3 consumers are not recording the solar electricity.

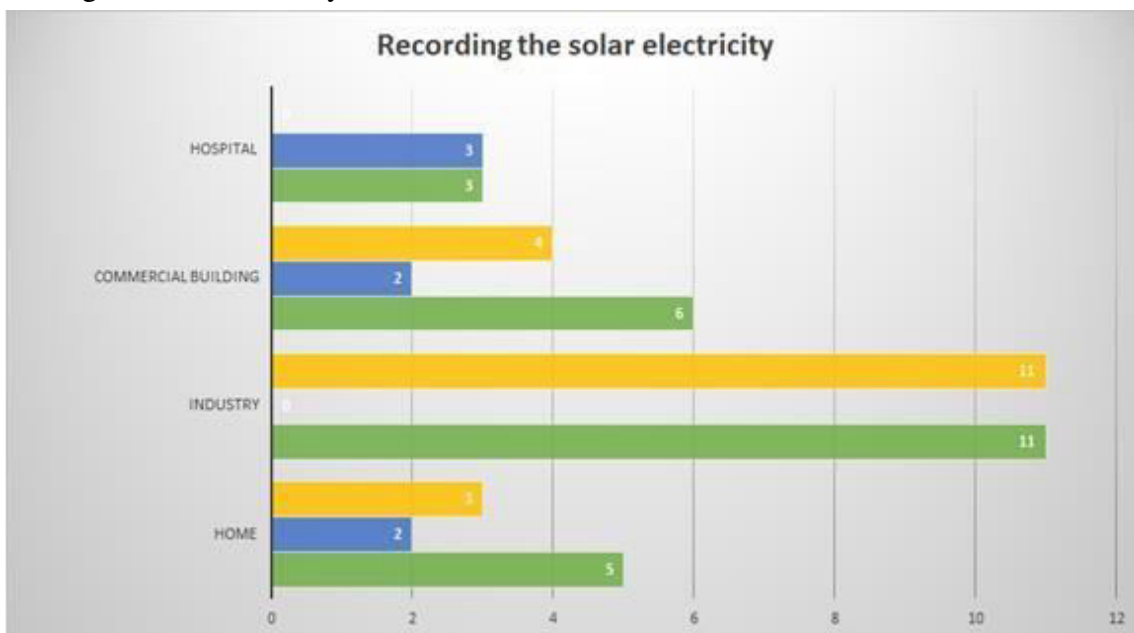


Figure 4.9: Records of solar electricity

4.2.5 Consumer Satisfaction :

In consumer satisfaction part, we get various types of questions or comments which is useful for making this report. These questions or comments are showing through charts. These charts are about increasing the capacity of the solar and it's usefulness □ **Increasing the capacity of the solar:**

Figure 4.10 gives us consumers interest about increasing the capacity of the solar system. It shows the information that all 25 users didn't want to increasing the capacity of the solar system. They thinks that the solar system is not useful and waste of money.

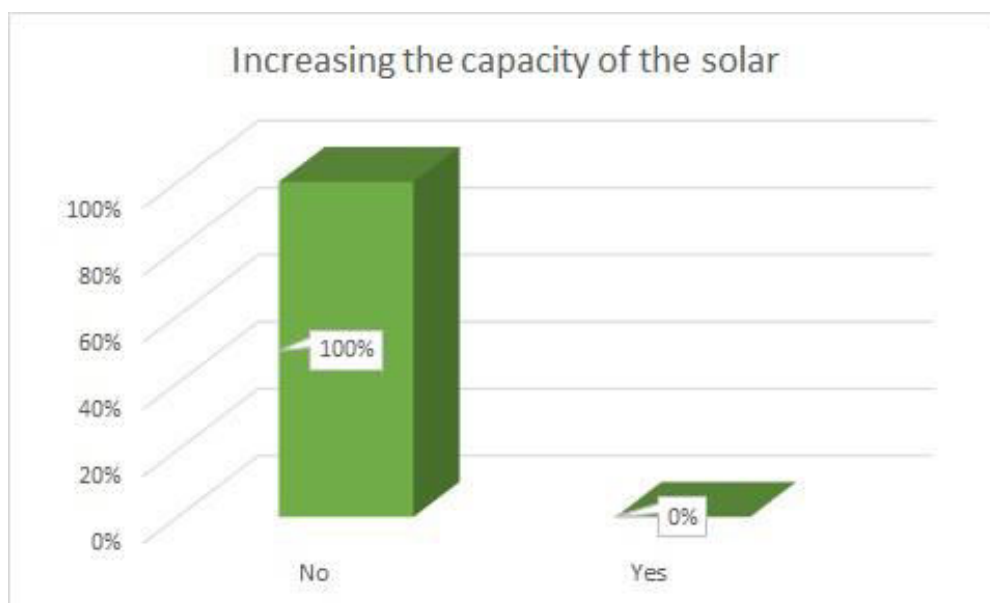


Figure 4.10: Increasing the capacity of the solar

□ Usefulness for solar:

The figure 4.11 concern us, only 8 percent users think solar is useful. And 92% are thinking that solar is not useful. Most of the consumers think SRS is waste of money.

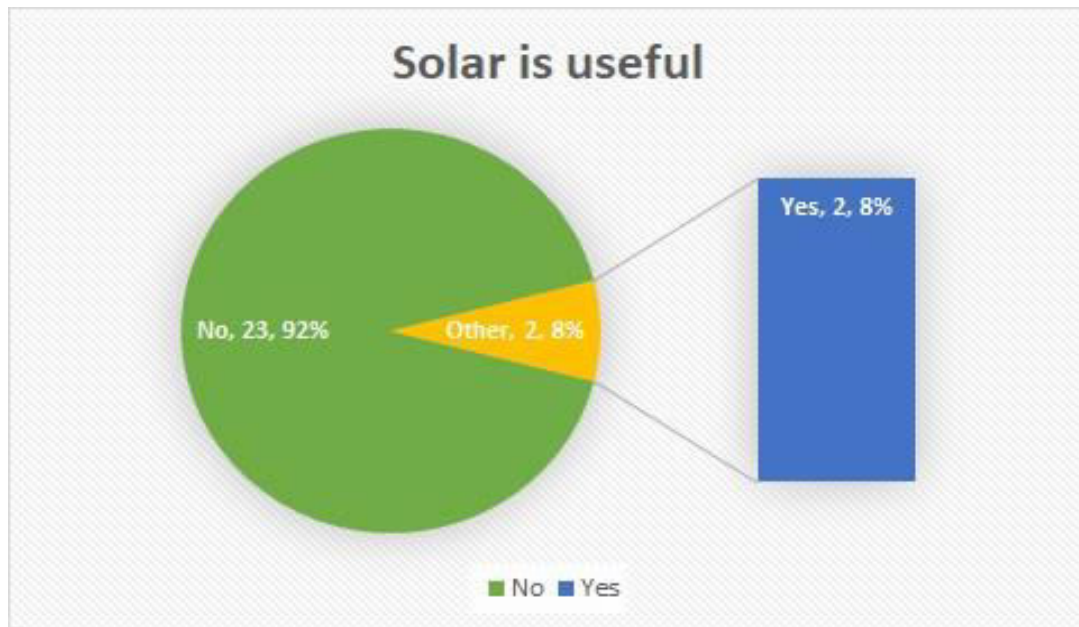


Figure 4.11: Solar is useful

4.3 Cost calculation of per kWh of solar electricity:

Sample calculation:

Lifetime of solar panel = 20 years

Total cost of solar system = 90000 taka

Date of installment of solar system = 2016/07

Date of survey = 2018/11

Time duration of starting generation = 2 years, 4 months

= 2.33 years

$$\text{Yearly generated} = \frac{873}{2.33} = 374.678 \text{ kwh/year}$$

$$\text{Total generation} = 374.678 \times 20 = 7493.56 \text{ kWh}$$

$$\text{Cost of per kWh of solar electricity} = \frac{90000}{7493.56} = 12.01 \text{ taka/kWh}$$

➤ In below we added a table, which is indicating the previous two-cost calculation and more:

SL No.	Total Cost	Capacity	Lifetime(years)	Cost of per kWh(taka/kWh)
01	90000	880 W	20	12.10
02	50000	500 W	20	19.72
03	100000	500 W	20	30.67
04	200000	1.92 kW	20	57.80
05	150000	1.20 kW	20	11.36
06	450000	8.4 kW	20	14.37
07	120000	1 kW	20	15

Table: 4.1 - Cost Calculation of per kWh of solar electricity

From this table we see that, five consumer's per unit cost of solar electricity is less than 20 taka. Those SRS are provided by DPDC agency. We gained this information from survey, there the DPDC providing SRS are more efficient than SRS from local market. We also see that the per unit cost of two consumers are more than 20 taka who are brought SRS from local market.

This is very high rate of per unit cost of solar electricity.

4.4 Thesis finding:

After completing the survey according to the indicators and analyzing the result we pointing out some important things,

- The main thing is there consumers are not concern about the SRS properly.

So, here need to counsel consumer when provide the SRS.

- Consumers do not have enough knowledge about how to clean it and the usefulness SRS system.

There should need to train the consumer so that they can clean it properly and should inform about the usefulness of the SRS system.

- Majority of the consumer do not know about the net metering system.

Government organization should inform the consumer how they will get profit by net metering system.

- About 98% consumer think that SRS system is waste money, they do not get much energy from SRS but its initial cost is very high.

Government should reduce the market price of instrument for the SRS system.

- From above analysis it can be roughly estimated the data in the respective areas.

To find out actual data we need time series data. Further studies are required in this line for better understanding of SRS in various area of Bangladesh.

Chapter 5

Conclusion

5.1 Introduction:

This paper discusses thoroughly about solar roof system with its usefulness and significance to the modern society. As the technology itself is growing days after days, human being are

getting used to this and using all of it for the betterment of future. The advantages and disadvantages, various limitations of solar rooftop system have been discussed here. Among all the advantages of solar panels, the foremost necessary factor is that solar power could be an actually renewable energy supply. It is often controlled all told areas of the globe and is on the market daily. We have a tendency to run out of solar power, in contrast to a number of opposite sources of energy. Solar power is going to be accessible as long as we've got the sun. Solar rooftop system, may be an electrical phenomenon plant that has its PV panels put in on the roof of a building. The urban atmosphere provides an oversized quantity of empty upper side areas and may inherently avoid the potential land use and environmental considerations. The maximum dimension of an upper side scheme depends on the world of the roof, therefore upper side solar systems area unit sometimes little compared to ground-mounted electrical phenomenon power stations. The typical dimensions of an electrical phenomenon panel (power from 280 to 340 Wp supported potency and range of cells of that it's composed) is concerning 1mx2m, therefore one kWh of PV panels covers concerning 6-7 money supply of roof. In addition to the scale of the quilt, the facility of an upper side scheme is additionally influenced by alternative factors like the position, orientation and inclination of the roof. Since you'll be meeting a number of your energy desires with the electricity your system has generated, your energy bills can drop. What proportion you save on your bill is going to be addicted to the dimensions of the system and your electricity or heat usage. Moreover, not solely can you be saving on the electricity bill, however if you generate additional electricity than you employ, the excess are going to be exported back to the grid and you'll receive bonus payments for that quantity (considering that your electrical device system is connected to the grid). Savings will any grow if you sell excess electricity at high rates throughout the day then obtain electricity from the grid throughout the evening once the rates square measure lower. To justify the statistics of the appropriateness of any project, gathering the people's thought is the best way to do the job. At the end of the time, public demand matters. Solar rooftop system is the simplest way to reduce the waste of electricity. In this study and survey period, this was the initial basis to research whether the users of the system are taking it within a positive way or not. In the research, it is found that majority of people don't know either the significance or the usefulness of the solar rooftop system. Being a developing country, the government should obviously be concerned to this system about how the system can be developed to the modern society. Some steps are to be taken as people gets query and come to know about the system. If this happens orderly, people will definitely be influenced to increase the capacity of the system.

From the survey we found that, various types of consumers information who are using SRS system. There we visited 25 consumers in Narayanganj area. We collected consumers name, contact numbers, addresses. Here we check those SRS are in operation or not. If those are in operation, we collect the meter readings and calculate per unit cost. If those are in not operation, trying to know the reason behind it. From 25 consumers we found 10 SRS system are in operation and rest 15 are not in operation and 5 of them are brought the SRS from the DPDC agency and others are from local market. We see here that 90% of consumers do not clean the solar panel. For this maximum SRS cannot generate proper electricity according to their capacity. There no consumers do not get any kind training about SRS. And mainly we found

92% consumers are not satisfied to use SRS. The per unit cost of solar electricity is about 1530 taka. This is very expensive.

5.2 Future work:

This survey was taken within various areas of Narayanganj throughout an inquiry form. A proposed discussion has been going on that another survey will be covered within Dhaka city under DPDC as well. After completing this survey both Dhaka and Narayanganj city we make a report on SRS system for DPDC which is help them to make decision about solar system. Next, we want to make a survey report on the whole country where SRS system are installed.

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