STUDY ON FUTURE PROSPECT OF SOLAR HOME SYSTEM IN BANGLADESH AND COST ANALYSIS

Thesis report submitted in partial fulfillment of the requirements For the degree of Bachelor of Science In the Department of Electrical and Electronic Engineering

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CERTIFICATION

This is to certify that this thesis entitled "**Study on Future Prospect of Solar Home System in Bangladesh and Cost Analysis**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held in October 2020.

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MY PARENTS
And
TEACHER
With Love & Respect

APPROVAL LETTER

This thesis report titled "**Study on Future Prospect of Solar Home System in Bangladesh and Cost Analysis ''**. Submitted by Al-Amin Mia & Md. Omar Halim ID: 171-33-408 & 171-33-404 to the Department of Electrical and Electronic Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor Science in Electrical and Electronic Engineering and approved as to its style and contents. The presentation has been held on October 2020.

DECLARATION

I hereby declare that this thesis is based on the result found by my selves. This thesis is submitted to Daffodil International University for partial fulfillment of the requirements of the degree of B.Sc in Electrical and Electronics Engineering. This thesis neither in enters nor in part has been previously submitted for any degree.

ACKNOWLEDGEMENT

I would remain forever obliged to The Department of Electrical Engineering, Daffodil International University, Bangladesh for giving me the scope to carry out this thesis. I would like to express my cordial gratitude to my thesis guide, Md. Mahbub-Ud-Jaman Department of Electrical and Electronic Engineering. Daffodil International University for his sincere efforts to make this thesis report a successful one. It was his guidance and incessant motivation during any doubts that have helped me immensely to go ahead with this thesis. I would like to express my heartfelt thankfulness to Md. Mahbub-Ud-Jaman Lecturer of the Department of

Electrical and Electronic Engineering for his guidance and support. I am also grateful to the faculties of the Electrical Engineering Department for offering his helpful hands during my thesis.

Lastly, I want to acknowledge the contribution of my parents, family members, and my friends for their constant and never-ending motivation.

ABSTRACT

Bangladesh is a country which is suffering from power generation for many years and the demand for the generation of electricity is increasing day by day, especially in the off-grid area. The government of Bangladesh takes initiative for the Solar Home system for off-grid as the energy demand is increasing with an increase in the world's population. This thesis intends to investigate Solar Home System's prospect in Bangladesh cost analysis current market price of import solar panel and production cost of local manufacturers like the top two Rahimafrooz Renewable Energy Ltd. (RRE) and Radiant Alliance Ltd.(RAL). This thesis is also trying to explore whether there is any prospect of solar energy in Bangladesh. Moreover, some specific this exploratory thesis is to overview of the present power system in Bangladesh, to evaluate the impact of further growth in the solar energy sector on the present power distribution system of Bangladesh, to understand the socio-economic impact of solar energy in rural Bangladesh, to overview of the prospect of solar energy in Bangladesh and analysis current pricing situation for a local manufacturer of the solar PV module in Bangladesh and also analysis cost-minimizing for a local manufacturer of the solar PV module in Bangladesh to stable the solar energy available to a rural area in Bangladesh. If both RRE and RAL revise their BOM and cost they will earn profit and compete in our local market here RRE can reduce about 9 takas from panel per wt. and RAL can reduce about 7.6 takas from panel per wt. which will directly earn some profit for their companies and RRE in case 300 wt., panel price will be at 12% profit 11341.35Tk where it is now at 11801.99 Taka and the difference is 460.64 Taka which will produce by the same employees of RRE and also in case of RAL for 300 wt., panel price will be at 15% =38.8171X 300wp = 11645.16 Taka where it is now at 12118.11 Taka and the difference is 472.95 Taka which will produce by the same employees of RAL. Hereby analyzing two companies' production costs and monthly operation expenses want to show in which areas they have to reduce cost and finally recommended a BOM for their raw materials for cost minimization by which they can earn some profit.

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Introduction

1.0 Introduction:

Bangladesh is a nation that is experiencing power generation for a long time and the interest for the generation of power is expanding step by step, particularly in the off-grid area. Starting in 2015, 92% of the metropolitan populace and 67% of the provincial populace approached power. A normal of 77.9% of the populace approached power in Bangladesh for that administration of Bangladesh steps up for Solar Home system for the off-grid area not just that as the energy request is expanding with an expansion in the total populace from various companies to little family units, yet individuals likewise need the energy to perform day by day errands. As science and innovation are creating, individuals' lives are additionally getting more intricate to fulfill energy needs, renewable energies, for example, solar is utilized other than different sources. This theory expects to explore Renewable Energy's (Solar Home System) prospect in Bangladesh and break down the current circumstance of nearby producers of the solar home system in Bangladesh.

1.01 Objectives:

The objectives of this thesis are to explore whether there is any prospect of solar energy In Bangladesh. Moreover, some specific purposes of this exploratory thesis are:

- To the overview of the present power system in Bangladesh
- To evaluate the impact of further growth in the solar energy sector on the present power distribution system of Bangladesh.
- To understand the socio-economic impact of solar energy in rural Bangladesh.
- To the overview of the prospect of solar energy in Bangladesh

- Analysis of the current pricing situation for a local manufacturer of the solar PV module in Bangladesh.
- Analysis cost-minimizing for a local manufacturer of the solar PV module in Bangladesh to stable the solar energy available to the rural area in Bangladesh.

1.02 Literature:

The utilization of power by individuals in provincial areas through solar Home System is turning out to be increasingly more famous in Bangladesh. Solar home systems use PV boards to create power by changing the utilization of Kerosene for laps and the utilization of diesel to charge batteries. The solar home system program has been begun to guarantee the utilization of clean energy in the rustic areas of Bangladesh where is no power.

This program supplements the administration's vision to create power for all by 2021. About 4.5 million Solar Home systems have just been introduced in the off-grid provincial areas of power. Under this program, more than 65,000 solar home systems are being introduced each month, which is developing at a normal pace of 56% Per year. The program is supplanting 160,000 tons of lamp fuel worth 225 million every year. Also, around 60,000 individuals are straightforwardly and by implication engaged with this program. The program has earned overall notoriety as one of the biggest and quickest developing off-grid renewable projects.

1.03 Components of the solar system

The off-grid solar system implies you produce this energy on your own home and utilize this system energy/power just at home. It doesn't have to flexibly on the grid system. For off-grid solar system there are four essential segments:

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

(a) Solar panel

Photovoltaic modules utilize the light energy of the sun to create power through the photovoltaic impact. Basic modules utilize glasslike silicon cells dependent on wafers or slight film cells. The basic individual from a module can be the top layer or the back layer. Cells should likewise be secured against mechanical harm and dampness. Most modules are inflexible, yet semi-adaptable cells dependent on flimsy film cells are additionally accessible. The phones must be associated electrically in arrangement, one to the next. A photovoltaic association box is associated with the rear of the solar board and is its yield interface. Most photovoltaic modules use MC4 type connectors to encourage weatherproof associations with the remainder of the system. In addition, a USB power interface can be utilized. The electrical associations of the module are made in arrangement to arrive at the ideal yield voltage or in corresponding to give an ideal flow limit. Lead wires that eliminate the current from the modules may contain silver, copper, or other non-attractive conductive progress metals. The detour diodes can be fused or utilized remotely, in the event of halfway concealing of the module, to boost the yield of the still lit up module segments. Some exceptional photovoltaic solar modules incorporate concentrators in which light is engaged by focal points or mirrors in littler cells [9].

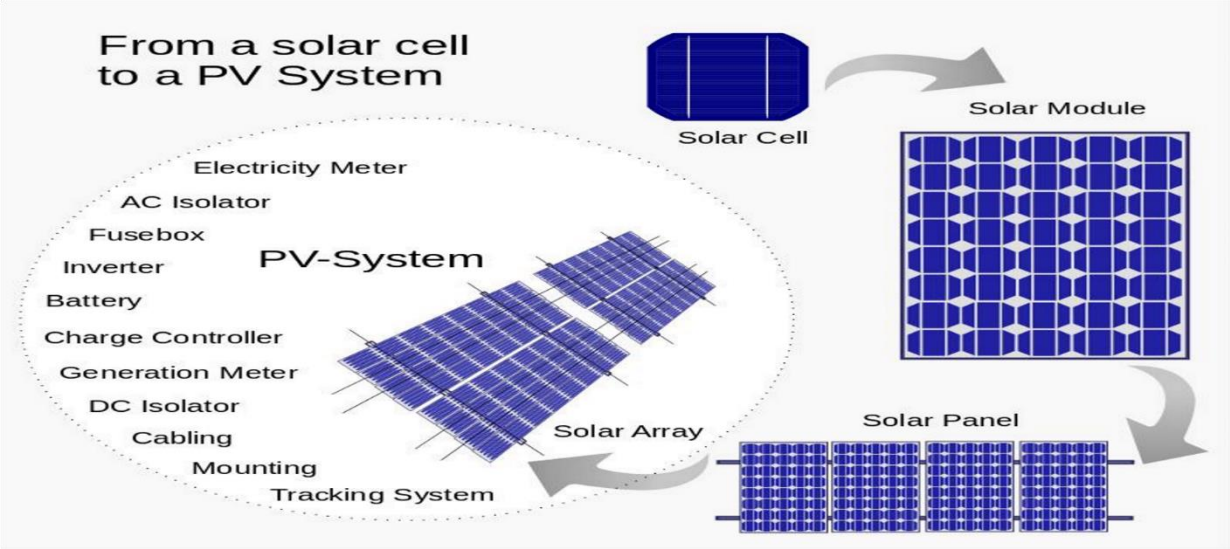


Fig 1.1: Solar Panel

(b) Charge Controller

A charge regulator or charge controller is a voltage and current regulator to rest batteries from cheating. It controls the voltage and current starting from the solar board embarking to the battery. Charge regulator for the most part two sorts:

i. PWM controller (Pulse Width Modulation)
ii. MPPT controller (Maximum Power Point Tracking)

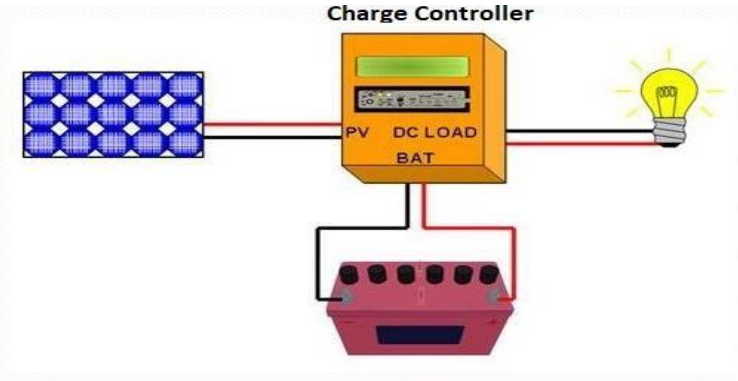


Fig 1.2: Charge controller

(I) PWM controller (Pulse Width Modulation)

PWM regulators make a straight association between the solar cluster and the battery bank. PWM regulators use Pulse Width Modulation to charge the battery. A PWM regulator doesn't send a firm yield but instead an arrangement of short charging heartbeats to the battery. Contingent upon the battery's present status of charge, the regulator chooses how frequently to send such heartbeats and how long every last one of them ought to be. For an almost completely energized battery, the beats will be short and seldom sent, while for a released battery they will be long and continually sent. PWM regulators are reasonable for little off-grid solar board systems, of low powers and low voltages – that is, were less to use as power and productivity. PWM solar charge regulators are more affordable than their further developed MPPT partners however they have a particular disadvantage – they make obstruction to radio and TV hardware because of the sharp heartbeats produced for the battery bank charging. In the daytime, when the battery is being charged by the

solar boards, the PWM regulator cuts down the solar exhibit produced voltage down to the battery voltage, for general run of the mill off-grid systems are as less as 12V DC.

Fig 1.3: PWM Solar Charge Controller

(II) MPPT controller (Maximum Power Point Tracking)

The MPPT regulator Tracking highlight empowers the information power of an MPPT regulator to be equivalent to its yield power. Thusly, if the yield voltage of the solar cluster is higher than the battery bank voltage the MPPT regulator brings it down to 12V yet repays the 'drop' by expanding the current with the goal that the power continues as before. The assessment of the MPPT regulator is pressing the greatest conceivable solar-created power from a solar board by causing it to work at the best mix of the voltage and current, otherwise called 'most extreme PowerPoint'. An MPPT charge regulator changes over the solar-created voltage into the ideal voltage to give the greatest charging current to the battery. The primary motivation behind the MPPT solar charge regulator isn't just to keep your solar power system from losing from the solar-produced power yet, besides, to get the greatest power from the solar cluster. An MPPT charge regulator powers a solar board to work at a voltage near its greatest PowerPoint. Another advantage of an MPPT regulator is that it diminishes the wire size (measure) required for the wires associating the solar exhibit to the regulator. MPPT regulators are more restrictive than PWM ones yet besides more productive as far as adding extra misfortunes to the system.

Fig 1.4: MPPT solar charge controller.

Which solar charge controller is the best?

Choosing the 'right' kind of charge regulator doesn't intend to choose which charge regulator innovation is better – the PWM one of the MPPT one – but instead to gauge which sort of these future more reasonable for your solar system. The thought isn't just to abstain from building a system that won't perform well yet additionally to get a good deal on purchasing an exorbitant gadget that you needn't bother with.

(c) Inverter

Sun arranged Inverter is a contraption prepared for changing over DC into AC power. Inverters are regular fragments of sun based power structures since sun based sheets make DC power and most devices used in homes or working environments deal with AC voltage. There are two key sorts of the close by planetary gathering related to the system (related to the system) and disconnected from the system (outside the system). Although the essential limit of the inverter is constantly proportional: the difference in DC into AC power, these two kinds of systems use unmistakable sorts of inverters [10]. An inverter related with the system ought to completely adjust to the essentials and headings of the power mastermind. The examiners outside the system are not equivalent to the inverters related to the system. It is possible that a close-by planetary gathering outside the system doesn't contain an inverter if simply the DC loads must be supported. Since the structures not related to the system are separated from the power network, the budgetary masters outside the system don't have to agree to the essentials and the guidelines of the electrical system.

Fig 1.5: Inverter

(d) Solar Battery

In any event, two electrochemical cells are related in a course of action which stores substance essentialness and makes it available as electrical imperativeness. Batteries can be restored when the blend reactions are reversible; they are stimulated by running a charging current through the battery anyway the other method of the delivery current. There are various kinds of electrochemical cells; the standard wet lead-destructive, the seriously fixed lead-destructive, and the dry-cell like lithium-ion(Li-molecule) are the most broadly perceived. Further ascribes move due to various components including inward science, current exhaust, and temperature. The battery choice relies earnestly upon its application, condition, and prize.

Fig 1.6: Solar Battery

CHAPTER-2

Overview of the Present Power System

2.1 Overview of the Present Power System:

Since energy assumes a significant part in the financial turn of events, the Government of Bangladesh is offering a need to the general advancement of the energy segment he utility power area in Bangladesh has one public grid with an introduced limit of 21,419 MW as of September 2019. The all-out introduced limit is 20,000 MW (joining solar power). Bangladesh's energy part is blasting. As of late Bangladesh began development of the 2.4gigawatt (GW) Ruppur expected to go into activity in 2023. As indicated by the Bangladesh Power Development Board in July 2018, 90 percent of the populace approached power. Nonetheless, per capita, energy utilization in Bangladesh is viewed as low.

Power is the significant wellspring of power for the majority of the nation's monetary exercises. Bangladesh's absolute introduced power generation limit (counting hostage power) was 15,351 megawatts (MW) as of January 2017and 20,000 megawatts in 2018.

The biggest energy customers in Bangladesh are businesses and the private part, followed by the business and farming parts.

Starting in 2015, 92% of the metropolitan populace and 67% of the country populace approached power. A normal of 77.9% of the populace approached power in Bangladesh. Bangladesh will require an expected 34,000 MW of power by 2030 to continue its financial development of more than 7 percent.

Issues in Bangladesh's electric power division incorporate high system misfortunes, delays in the culmination of new plants, low plant proficiency, unpredictable power gracefully, power burglary, power outages, and deficiencies of assets for power plant support. By and large, the nation's generation plants have been not able to fulfill system need over the previous decade.

On 2 November 2019, power was reestablished following a day-long cross country power outage. A transmission line from India had fizzled, which "prompted a course of disappointments all through the public power grid," and analysis of "old grid foundation and helpless administration." However, in an ongoing underlying driver examination report, the exploring group has explained that the shortcoming was in reality because of the absence of coordination and chronic weakness of the transmission and dissemination framework that caused the power outage.

The month to month solar radiation in various areas of Bangladesh is given in table 1.

Month	Dhaka	Rajshahi	Sylhet	Bogra	Barisal	Jessore
January	4.50	4.20	4.30	4.01	4.17	4.10
February	4.78	4.47	4.44	4.69	4.50	4.55
March	5.50	5.00	4.90	5.00	5.00	4.70
April	5.71	5.30	5.20	5.50	5.94	5.5
May	5.80	5.50	5.50	6.00	5.75	6.05
June	5.1	5.70	5.90	5.26	4.39	5.60
July	4.60	5.40	5.5	4.34	4.2	5.00
August	4.50	5.16	5.00	4.84	4.42	4.50
September	4.41	4.96	4.50	4.67	4.20	4.30
October	4.20	4.88	4.61	4.65	4.10	4.00
November	4.27	4.42	4.32	4.35	3.90	3.90
December	3.92	3.82	3.85	3.87	3.80	3.77
Average	**5.10**	**4.90**	**5.21**	**4.52**	**4.53**	**4.99**

Table 1: Monthly Solar Insulation at different locations of Bangladesh (in kWh/m²/day) from the above table it is seen that maximum solar radiation is available from March to May whereas minimum solar radiation is available during December and January.

2.1.1Common Application of PV technology for Rural Electrification:

Bangladesh has a lack of power generation and about 70% of the complete populace doesn't approach power. For a creating nation like Bangladesh, it is absurd to expect to bring the entire nation under a typical grid organization and monetarily, and actually**,** that isn't possible. To diminish the destructive ecological impacts of customary power generation distinctive government associations, NGOs, and instructive organizations are locked in to advance the differentiated use of renewable energy for **the** country charge. Business utilization of PV began in Bangladesh in the last part of the eighties. The Solar Home System (SHS) is a demonstrated innovation for **an** off-grid charge in rustic areas in Bangladesh while the brought together PV system is a nearly new idea of **a** provincial jolt.

2.1.2 Organizations Engaged in Dissemination of PV Technology:

The core of the solar PV system is the solar board and in Bangladesh, the solar boards for PV applications are imported from different nations. Anyway, customary capacity batteries for SHSs are created by nearby makers. In any case, for enormous PV applications like the brought together system, stockpiling batteries and inverters are imported from far off nations. The majority of the CCUs for SHS

Are privately created and not many of them are imported from outside Bangladesh. Distinctive government, non-government associations, and instructive organizations are occupied with the scattering of PV innovation in Bangladesh. In this part, some of them assume a significant function in the dispersal of PV innovation in Bangladesh will be examined.

2.1.2.1 Grameen Shakti:

Grameen Shakti is one of the pioneer private associations in the renewable energy part in Bangladesh. It was set up in 1996 and its primary adage is to advance, advocate and disperse renewable energy innovation at a reasonable cost to the country area of Bangladesh. To advance renewable energy in provincial areas, the Grameen Shakti has set up unit offices in various pieces of Bangladesh thus far it has 189 unit offices 50. Till May 2019 it has introduced 2, 65,000 SHS with roughly 8, 00,000 recipients thus far secured 88,000 towns and 11 distant islands in

Bangladesh since SHS is a relatively costly innovation hence Grameen Shakti has presented delicate advance credit offices for provincial shoppers.

2.1.2.2 Infrastructure Development Company Limited (IDCOL):

IDCOL is a non-bank money related organization that was joined as a public restricted organization on fourteenth May 1997 with help from the World Bank under the Private Sector Infrastructure Development Project. The essential goal of the organization is to advance the noteworthy support of the private part in venture and activity, possession, and upkeep of new framework offices. IDCOL approaches assets gave by the WB, GTZ, KfW, SNV Netherlands Development, and the Government of Bangladesh (in the same place). It advances renewable energy programs through 15 accomplice associations (PO) and gives specialized, strategic limited time, and preparing help to the POs. These POs are private associations that are occupied with the scattering of solar innovation in Bangladesh. It underpins The rural electrification using SHS under the Rural Electrification and Renewable Energy Development Project (REREDP) (on the same page). The REP is together financed by the IDA, GEF, and KfW and it has set an objective of financing the establishment of 200,000 SHSs by 2019 (in the same place). The SHSs are sold (generally through miniature credit) by POs to the family units and business elements in the far off and rural areas of Bangladesh (on the same page). The IDCOL gives a renegotiating office to the POs and channel awards to decrease the SHSs costs (in the same place). For the establishment of SHS, it advances standard specialized particulars and affirmed gear list for POs.

2.1.2.3 Rahim Afrooz:

Rahim Afrooz solar is a sister association of the Rahim Afroz gathering. It takes part in projects identified with SHS establishments and an incorporated PV system in Bangladesh. It gives gear identified with the PV system to various associations in Bangladesh. Although it imports solar boards from outside nations yet the Rahim Afrooz battery, another sister association produces batteries for solar PV applications and different purposes. It went about as a nearby specialist for the establishment of the incorporated PV projects of the BPDB and LGED. It is so far the biggest profound cycle battery supplier for SHS in

Bangladesh. It adds to the dispersal of SHS in association with neighborhood NGOs. As of late, the Rahim Afrooz Battery has presented the battery reusing unit alongside its battery fabricating plant. Accordingly, the batteries of the SHS establishments can be reused after a lifetime and this is the main battery reusing unit in Bangladesh.

2.1.2.4 Bangladesh Advancement Committee (BRAC):

BRAC is one of the pioneer associations in the dispersal of PV innovation in Bangladesh. It was set up in 1972 and it dispatched a solar energy program for feasible development in December 1997. Until June 2019, the BRAC has introduced SHSs of a sum of 363.545 kW limits. The future objectives of the BRAC are to build the quantity of SHS establishments, execute solar energy intricate and solar energy foundation.

2.1.2.5 Rural Electrification Board (REB):

The Rural Electrification Board has begun its activity with the vision of rural electrification in 1978. It has effectively actualized the rural electrification program in Bangladesh through a purchaser agreeable society called Palli Bidyut Samiti (PBS). Because of the activities of REB alongside help from BPDB, individuals in rural areas can appreciate the offices of power now. Notwithstanding, to give power to far off towns, islands, seaside areas, uneven landscapes, and other out of reach portions of the nation, REB has executed a decentralized method of power dispersion like standalone SHS. So far the REB has taken the accompanying solar electrification projects in Bangladesh: Diffusion of Renewable Energy Technologies (Pilot Project) – This project gave electrification to Karimpur and Nazarpur associations of the Narshingdi area by standalone and focal charging station based solar systems. The absolute system limit of this project was 62 Wtp and different burdens like homegrown, business, social organizations, and wellbeing focuses were associated with the system. Although after the augmentation of the grid power network the vast majority of the purchasers of that solar system took grid power and restored their systems which are migrated to various PBS. This project was financed by the GOB and French Government. Dispersion of Renewable Energy Technologies (second Phase) – This project will give solar electrification to Austogram, Shingra, Kotalipara, Moheshkhali, and Kutubdia Upzilla and St. Martin islands. This is a progressing project and is subsidized by the GOB and German Government. Rural Electrification through Solar Energy – This project has taken to give power to

customers of 6 PBS areas of REB. The purchaser target has been fixed to around 16,000. It's a progressing project and it is supported by World Bank, IDA, and GOB. So far under the second and third projects, REB has introduced 14,500 SHSs separately up to April 2019.

2.1.2.6 Local Government and Engineering Department (LGED):

The Local Government and Engineering Department (LGED) began solar PV electrification through UNDP upheld Sustainable Environment Management Program (SEMP) and Japan International Cooperation Agency (JICA) upheld the tornado cover project. The LGED began Sustainable Rural Energy (SRE) project as a part of the SEMP of the Ministry of Environment and Forest Under the twister cover project the LGED introduced a sum of 15.28 KWP limits SHS in 1859 typhoon covers in various waterfront areas of Bangladesh. Under the SRE project, the LGED introduced an aggregate of 2.625 KWP limits solar home lighting systems and two incorporated PV systems (in the same place). Other than that, the LGED actualized the solar light program for poor rural families under that project. To jolt the distant islands like St. Martin, the LGED actualized 10 kW limit solar-wind half breed establishments under the SRE project.

2.1.2.7 Bangladesh Power Development Board (BPDB):

Bangladesh Power Development Board is the public association occupied with the generation, transmission, and appropriation of power all through Bangladesh and it was set up in 1972. It adds to the usage of PV innovation for off-grid rural electrification, particularly in the Chittagong slope lots area. It has PV establishments of around 150 kW under the solar electrification development program. This introduced limit incorporates SHS and a unified PV system. It has an arrangement of jolting far off-grid towns and islands through PV innovation to improve electrification inclusion in Bangladesh.

2.2 Analysis of Slow growth of Solar Energy System in Bangladesh:

Solar power isn't new to Bangladesh, since 1996 distinct organizations have attempted to showcase solar energy systems to people in general. However, in a mechanically in the reverse nation like Bangladesh, the thought took a reasonable while to gestate. Grameen Shakti likes to consider itself one of the solar pioneers in Bangladesh, having begun tasks in 1996 they found the truth of solar

energy hard to manage. The fundamental obstacle behind the moderate development of the PV program is the extremely significant expense of the systems.

2.2.1 Obstacles of Expansion of PV Technology in Rural Areas:

The significant snags to the quick development of PV systems are as per the following:

a) The issue with this innovation is that the desires quite often exceed what the systems could accomplish. In most ideas, a basic system could power a whole family unit without any problem. Yet, in the wake of everything was clarified completely the principle issue of solar energy was its cost.
b) The absence of mindfulness about PV innovation requires quite a while, exertion, and cash to acclimate the PV innovation to the rural areas.
c) Private area organizations and NGOs may think that it is exceptionally hard to take care of the underlying expense of the spread of the innovation, the fundamental obstruction brings the significant expense of the system because of the excessive cost of the PV module in the worldwide market and the inconvenience of government charges.
d) A choice to arrive at countless rural family units might have been created with a simple financing system so the purchasers can follow through on the system cost over a more drawn out period (for instance, 5 to 7 years). The actualizing organization consequently requires the delicate reserve to back the clients, yet the wellspring of delicate account is so far nonexistent.

As a rule, individuals show a ton of eagerness for this innovation and a craving to watch it all the more intently for a more extended period. Numerous people approach to arrange terms under which they can acquire a system for themselves. There was a tremendous hole between the money related moderateness of rural individuals and the cost of the solar system. Thus, an appropriate advertising component is constantly needed to lessen the hole. Directly Grameen Shakti is offering four sorts of solar systems for family use. The short depictions of these are given in Table 2.

Table 3: Brief description of solar systems Types of Solar System (Wtp = Watt peak.)

Types of SHS	Usable Items	Package Price (Tk.)
75 Wp	6 lamp (8 Watt each) and 1 B&W TV	34,500
50 Wp	4 lamp (8 Watt each) and 1 B&W TV	22,000
40 Wp	3 lamp (8 Watt each) and 1 B&W TV	17,300
30 Wp	2 lamp (8 Watt each) and 1 B&W TV	12,500

Source: Secondary, Documents provided by Grameen Shakti

The Grameen Shakti program made a cost analysis of the SHS taking the price of the system, possible repairs, replacements, maintenance, and depreciation. This led to several possible marketing strategies to be piloted by the program. Table 4 indicates the pricing options of SHS.

Sl No.	Type s of SHS	Cashback price (Tk.)	Down payment (TK.)	Loan amount (TK.)	Monthly installment amount (36 installment)	Monthly installment amount (24 installment)	Monthly installment amount (12 installments)
01	75 Wp	34,500	5,865	28,635	1,034	1,432	2,625
02	50 Wp	22,000	3,740	18,260	660	913	1674
03	40 Wp	17,300	2,941	14,359	519	718	1317
04	30 Wp	12,500	2,125	10,375	375	519	951

Table 4: Pricing Options for solar system

Source: Secondary, Documents provided by Grameen Shakti

2.2.2 Experience of Rural Electrification Board (REB) Project:

a) Clients lean toward standalone system essentially because of the higher amount of energy accessible from the system and for accommodation; batteries need not be brought to the charging station;
b) Clients favor generally bigger system (40 Wtp and above);

c) Charging stations might be considered a disappointment. Clients don't prefer to often charge batteries from charging stations. It is awkward to bring batteries from **a** distan**ce**. Numerous batteries have been harmed due to over-release.

2.3 Socio-Economic Impact of Solar Energy:

Socio-economic development is the cycle of social and economic development in a general public, which is estimated with markers, for example, GDP, future, education, and levels of work. Power has a critical effect on the rural network from a socio-economic point of view. Among various parts of the socio-economic effects of rural electrification, a few viewpoints are featured in this investigation. Other than electrification other fundamental framework development is important for a positive socio-economic effect on the rural network. The level of effect fluctuates with the area of the examination area, accessibility of essential foundation, and method of electrification in the neighborhood network. For this situation, the creators needed to measure the socio-economic effect that solar energy use has on Bangladeshi society, particularly the rural one.

2.4 Advantages and Disadvantages of Solar Power:

Advantages of Solar Energy:

1. **Renewable Energy Source**

   Among all the advantages of solar boards, the most significant thing is that solar energy is a renewable energy source. It tends to be an outfit in all areas of the world and is accessible consistently. We can't run out of solar energy, in contrast to a portion of different wellsprings of energy. Solar energy will be open as long as we have the sun, along these lines daylight will be accessible to us for in any event 5 billion years when as indicated by researchers the sun will bite the dust.

2. **Reduces Electricity Bills**

   Since you will meet a portion of your energy needs with the power your solar system has created, your energy bills will drop. The amount you save money on your bill will be reliant on the size of the solar system and your power or warmth use. Besides, not exclusively will you be saving money on the power bill, yet there is likewise a likelihood to get installments for the overflow energy that you send out back to the grid. On the off chance that you create

more power than you use (taking into account that your solar board system is associated with the grid).

3. **Diverse Applications**

   Solar energy can be utilized for assorted purposes. You can create power (photovoltaics) or heat (solar warm). Solar energy can be utilized to deliver power in areas without admittance to the energy grid, to distill water in districts with restricted clean water supplies, and to power satellites in space. Solar energy can likewise be coordinated into the materials utilized for structures. In the relatively recent past, Sharp presented straightforward solar energy windows.

4. **Low Maintenance Costs**

   Solar energy systems generally don't require a lot of maintenance. You only need to keep them relatively clean, so cleaning them a couple of times per year will do the job. Most reliable solar panel manufacturers offer 20-25 years warranty. Also, as there are no moving parts, there is no wear and tear. The inverter is usually the only part that needs to be changed after 5-10 years because it is continuously working to convert solar energy into electricity and heat (solar PV vs. solar thermal). Apart from the inverter, the cables also need maintenance to ensure your solar power system runs at maximum efficiency. So, after covering the initial cost of the solar system, you can expect very little spending on maintenance and repair work.

5. **Technology Development**

   Innovation in the solar power industry is continually progressing and enhancements will heighten later on. Developments in quantum material science and nanotechnology can conceivably build the adequacy of solar boards and twofold, or even triple, the electrical contribution of the solar power systems.

Disadvantages of Solar Energy:

1. **Cost**

   The underlying expense of buying a solar system is genuinely high. This incorporates paying for solar boards, inverter, batteries, wiring, and the establishment. In any case, solar innovations are continually growing, so it is protected to expect that costs will go down later on.

2. **Weather Dependent**

   Albeit solar energy can even now be gathered during overcast and blustery days, the productivity of the solar system drops. Solar boards are reliant on daylight to adequately assemble solar energy. In this way, a couple of overcast, blustery days can noticeably affect the energy system. You ought to likewise consider that solar energy can't be gathered during the night. Then again, if you additionally require your water warming answer for work around evening time or during wintertime, thermodynamic boards are a choice to consider.

3. **Solar Energy Storage Is Expensive**

   Solar energy has to be used right away, or it can be stored in large batteries. These batteries, used in off-the-grid solar systems, can be charged during the day so that the energy is used at night. This is a good solution for using solar energy all day long but it is also quite expensive. In most cases, it is smarter to just use solar energy during the day and take energy from the grid during the night (you can only do this if your system is connected to the grid). Luckily your energy demand is usually higher during the day so you can meet most of it with solar energy.

4. **Uses a Lot of Space**

   The greater power you need to create, the more solar boards you will require, as you need to gather however much daylight as could reasonably be expected. Solar PV boards require a ton of room and a few rooftops are not large enough to fit the number of solar boards that you might want to have. An option is to introduce a portion of the boards in your yard however they have to approach daylight. If you don't have the space for all the boards that

you needed, you can pick introducing less to at present fulfill a portion of your energy needs.

5. **Associated with Pollution**

   In spite of the fact that contamination identified with solar energy systems is far less contrasted with different wellsprings of energy, solar energy can be related to contamination. Transportation and establishment of solar systems have been related to the discharge of ozone harming substances. There are likewise some harmful materials and risky items utilized during the assembling cycle of solar photovoltaic systems, which can buy implication influence the environment. By the by, solar energy dirties far not exactly other elective energy sources.

CHAPTER-3

Prospect of Solar System in Bangladesh:

3.1 Government Initiative:

Government methodology underlines advancing off-grid choices in areas that are unacceptable for grid development. It has made a decent beginning by killing import obligation on SHS in April 2000. The methodology stresses the vital part of well working rural systems for the Government's off-grid advancement procedure and underwrites the way to deal with utilizing well-working rural network-based associations (CBOs) to use the grass-roots reach and build up believability to improve power arrangement essentially.

The goal of this Clean Development Mechanism (CDM) project is to add to sustainable development through the arrangement of renewable solar power to families not associated with the power grid and accordingly diminish Greenhouse Gas (GHG) emanations by uprooting lamp oil and diesel use for lighting and off-grid power generation. The project will add to the sustainable development of Bangladesh with specific accentuation on the rural populace, which is commonly more unfortunate. Notwithstanding lessening GHG discharges, the project would have critical other social, economic, and environmental advantages. Bank's association in supporting this project is consequently considered exceptionally proper. The project conceives introducing 929,169 SHSs the whole way across Bangladesh somewhere in the range of 2007 and 2015. The SHS will give offices to lighting, TV, and radio and involve: (an) a Solar Module (10 to 120wp); (b) battery (47 Ah to 130 Ah); (c) Charge Controller; (d) fluorescent cylinder lights with unique electronic weights; (e) mounting structure; (f) establishment pack; and (g) links and associating gadgets. The limit of individual SHS will differ as per shopper decision and demand. The expense

of SHS would be recuperated through regularly scheduled payments for as long as 4 years which will be inside the moderate limit of the focused on shoppers.

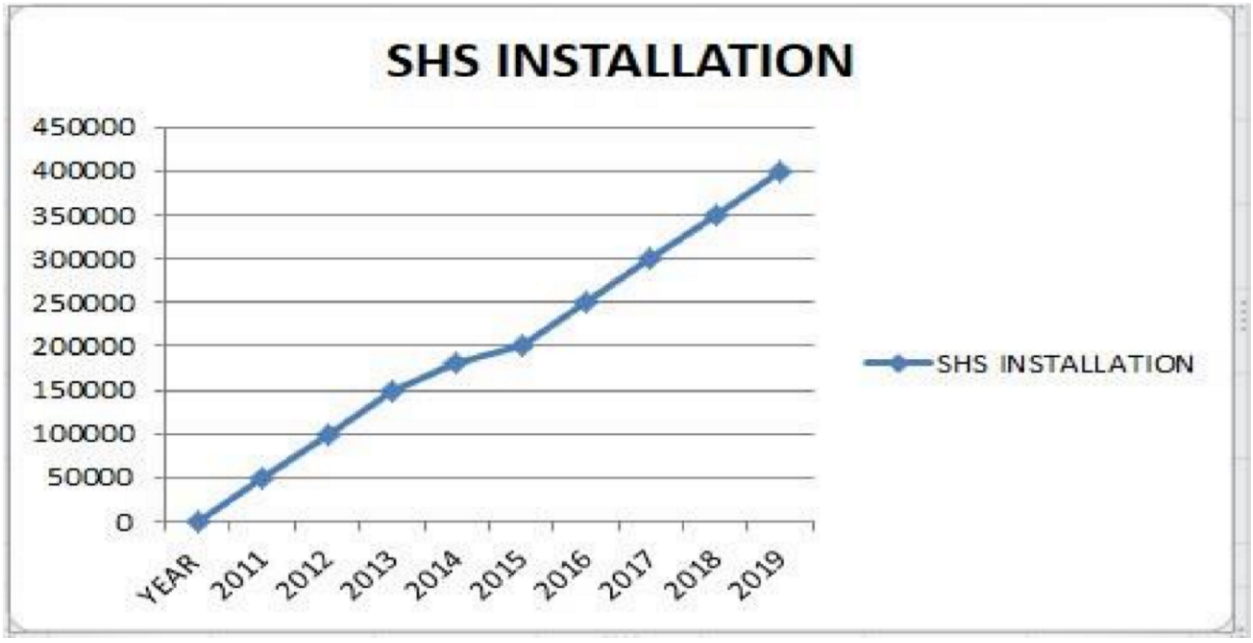
Upon full execution in the year 2015, the project activities will supplant 20,075 kilolitres for each annum of lamp oil use, equal to a discharges decrease of 48,380.75 tones CO2 per annum and 16,600,500 KWh/year of power generation utilizing diesel generators. The project will be actualized by Grameen Shakti (GS) which creates, presents, and advocates renewable energy advances for sustainable energy arrangements, especially Solar PV systems, meaning to decrease neediness, improve expectations for everyday comforts and ensure the environment.

Throughout the most recent decade, GS has introduced around 77,000 SHS with consolidated limits of 15.8 MW and more than 1,650 SHSs are introduced every month. It has additionally set up 120 offices for administration conveyance and execution checking and has an examination unit for the development of the general effectiveness of the system and ancillaries. GS is as of now serving over 275,000 recipients through its 120 offices spread more than 58 locales of Bangladesh.

The assessment of market potential depends on the working experience of other creating nations like India, Sri Lanka where PV innovation is techno-economically alluring for various applications regardless of the high starting expense of solar establishments. This market potential is resolved on a short to midterm premise anyway the genuine market potential is reliant on the cost of the solar PV system. The commercialization and far and wide utilization of solar electrification rely upon the capability of the market with regards to socio-economic conditions, mentality, and inclination of individuals and overall the energy use designs in the rural area. Present Bangladesh is included with a heap shedding issue and now, individuals in Bangladesh are living with a portion of the most exceedingly terrible burden shedding recollections. As Bangladesh is a thickly populated nation, things ought to have been changed before any discouraging thing develops.

Although solar power isn't new in Bangladesh, individuals yet are not utilizing it as an unadulterated option in contrast to stacking shedding issues. In Bangladesh, Grameen Shakti is well known for its mindfulness and usage of solar power in some rural areas. In Bangladesh, power demand adds up to 5500 megawatts unofficially and 4600 megawatts officially. However, the

power plant under the Power Development Board (PDB) can create just around 3600 megawatts (MW). Presently, with the gas emergency, the PDB can't create 500 to 800 MW. Before April 2009, PDB had all the gas gracefully it required and it could create a record 4200 MW power only for one day. It has been demonstrated by numerous sorts of examinations that Bangladesh isn't reasonable for wind or coal power in light of the significant expense. Hence solar power is the main option as indicated by this it has been uncovered that, at first, individuals were inspired by how the sun could give power yet now, with various mindfulness program generation, from 1996 to work now, NGO has been effective to cause individuals to understand and accordingly is prevailing with regards to introducing solar power system in numerous rural areas of Bangladesh. From the auxiliary sources gave by NGO, the accompanying insights about the establishment of a solar home system have been found.



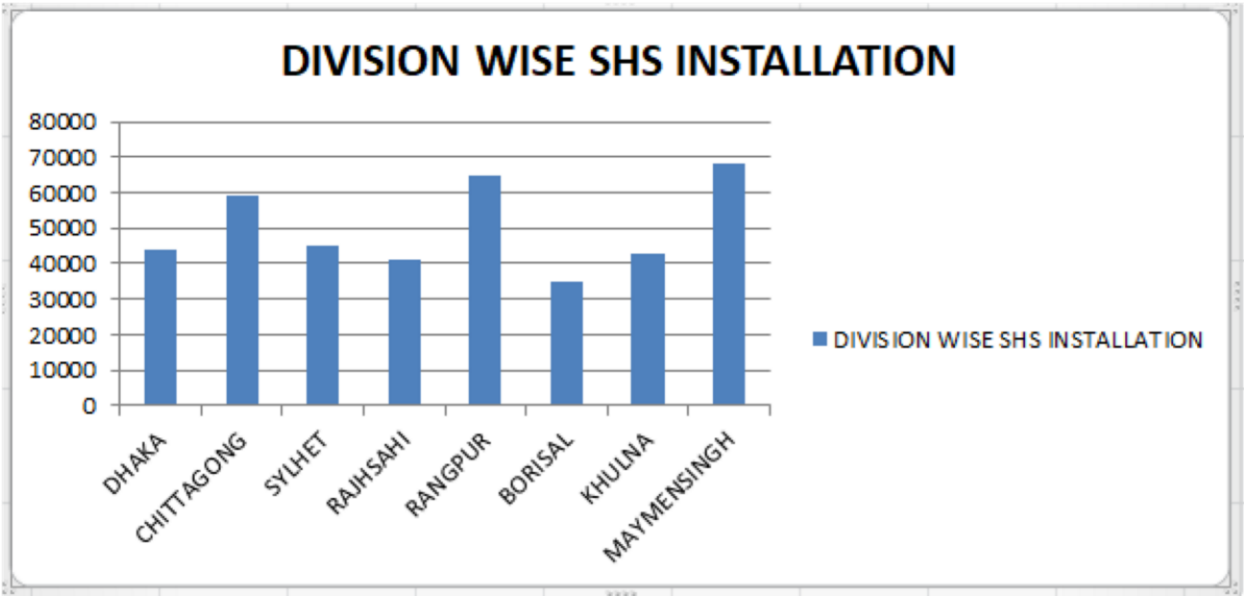
Graph 1: Graphical data presentation of SHS progress

As per the above diagram, up to June 2019, in total, more than 0.62 million solar-home systems have been introduced in rural areas of Bangladesh. As per NGO, the solar home system (SHS) is exceptionally famous in the commercial center as a miniature utility.50 Watt systems can lease lights to 3 additional shops. Additionally, SHS assists with supplanting lamp oil. A 40-watt system can supplant around 20 Tk. lamp oil costs every day. Normal portions are every month Tk 515.

To advance solar energy among rural individuals, an alternate association, for example, BRAC, Rahim Afrooz is approaching with the SHS program. The accompanying diagram shows the number and name of associations that introduced a solar system in various areas.

3.2 Market Share of Solar Energy Providers:

Proposing to create renewable energy assets to meet 10% of complete power demand by 2015 and 20% by 2020, the Bangladesh government has just proclaimed solar board as obligation free in the forthcoming financial plan of 2017-2018. The administration consistently has been giving offices with the goal that individuals can utilize solar energy. The accompanying chart shows the quantity of SHS introduced in various divisions of Bangladesh up to May 2019. Along these lines, however not millions or billions of SHS yet, the current number of SHS establishment is giving reinforcement to the current power demand as the nation's populace is expanding



Graph 2: Graphical data presentation of Division wise SHS progress

3.3 Analysis of the current situation of SHS in Bangladesh:

In the piece of examination here we can see the current circumstance of SHS estimating and watch the worldwide valuing of SHS and add contrast and the pie-diagram. There is plenty of organizations that are creating SHS and in Bangladesh, there are the main five organizations that

are delivering SHS for foundation development. Here I present the main 13 nos. of organizations and Bangladeshi Companies Solar Home System's evaluating.

3.4 Pricing of SHS analysis of the foreign market and Bangladesh market: In Foreign Market:

Solar Panel Brand	Wtp	Cost US$ per Solar Panel	Efficiency %	Price per Watt	Country of Manufacture.
Canadian Solar	270	$141.75	15.00%	$0.52	China
Sonali	240	$120	15.00%	$0.50	India
REC Solar	250	$131.25	14.30%	$0.52	Singapore
Conergy	260	$130	14.39%	$0.50	China
DM Solar	168	$79.8	15.00%	$0.47	China
Hyundai	260	$136.50	14.20%	$0.52	South Korea
EcoSolargy	240	$114	14.00%	$0.47	China
Schott Solar	250	$125	15.00%	$0.50	China
Sharp	280	$154	14.40%	$0.55	USA
Suniva	240	$117.00	16.20%	$0.50	USA
Suntech	220	$112.75	14.50%	$0.49	China
LG Solar	250	$118.75	15.80%	$0.47	South Korea
Helios Solar	260	$130.00	15.63%	$0.50	USA

Table no. 7: Price of Solar Panel in Foreign market

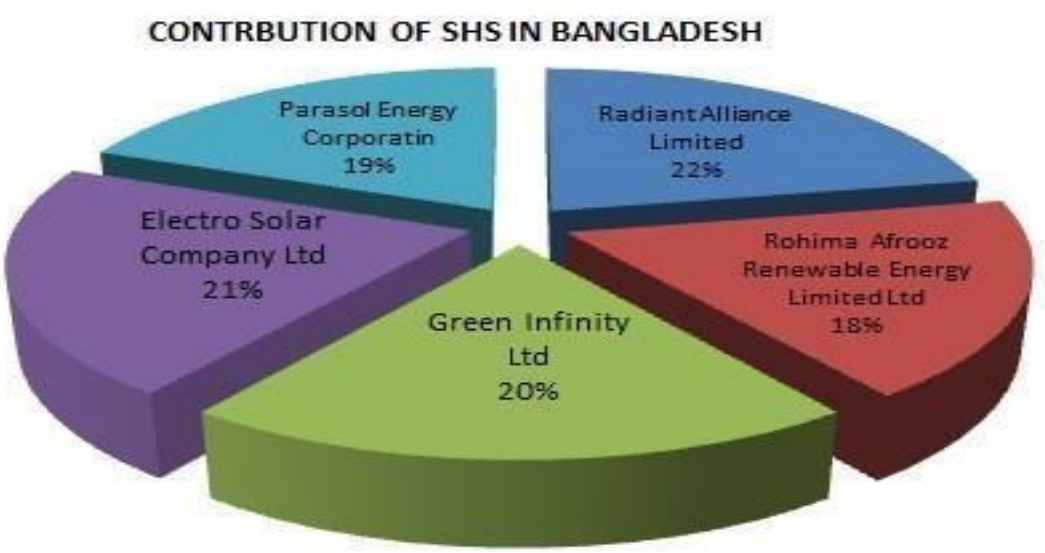
In Bangladesh Market:

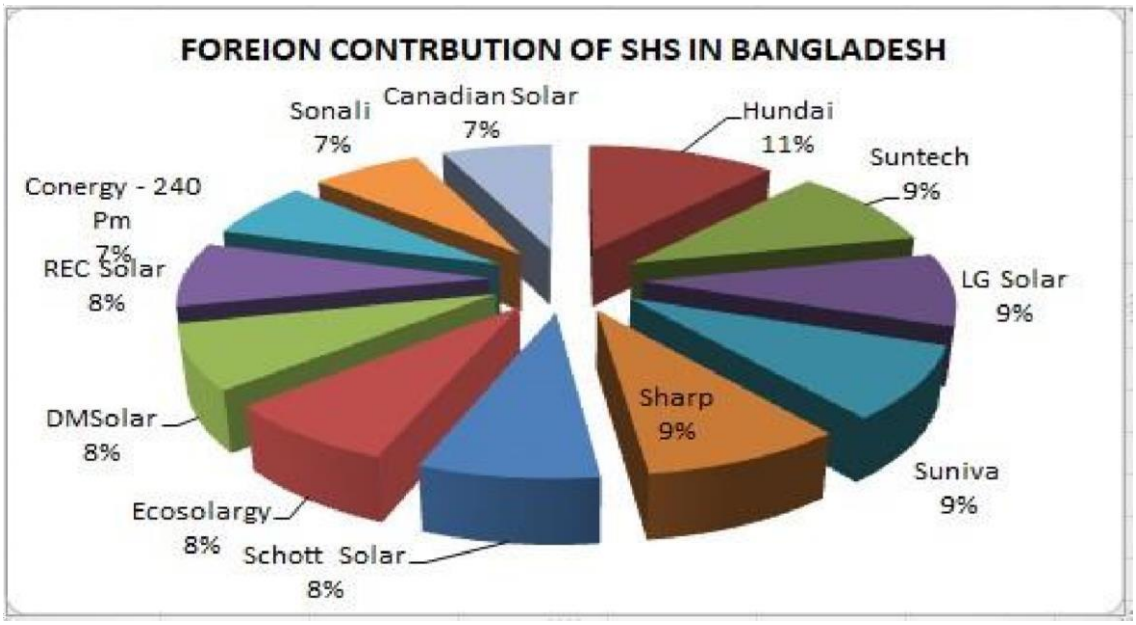
Solar Panel Brand	Wtp	Cost US$ per Solar Panel	Efficiency %	Price per Watt	Country of Manufacture.
Radiant Alliance Limited	250	$125.00	15.00 %	$0.50	Bangladesh
Rahim Afrooz Renewable Energy Ltd	250	$131.25	15.00%	$0.52	Bangladesh
Green Infinity Ltd	250	$118.75	14.20%	$0.47	Bangladesh
Electro Solar Company Ltd	250	$112.50	14.39%	$0.45	Bangladesh
Parasol Energy Corporation	250	$128.12	15.00%	$0.51	Bangladesh

Table no. 8: Price of Solar Panel in the Bangladesh market

We can see that our Solar Panel price is comparatively less than that of any SHS of Foreign countries.

3.5 Contribution of Solar PV Module in Bangladeshi and foreign manufacturer:





Pie chart no.01: Foreign contribution in Bangladesh

Pie chart no.01: Local manufacturer's contribution of SHS in Bangladesh

3.6 Local manufacturers of Solar PV Module (SPM) in Bangladesh:

As a part of the analysis here I take the top two manufactures of the Solar Home System in Bangladesh and try to figure out their current situation of manufacturing SPM. The top two companies are as below

a) Rahimafrooz Renewable Energy Ltd.

b) Radiant Alliance Ltd.

a) Rahimafrooz Renewable Energy Ltd:

Rahimafrooz Renewable Energy Ltd is set to collect solar boards to snatch the homegrown market for solar home systems that are on an upward bend on the rear of the administration strategy backing to help off-grid individuals get power. A worry of Tk 1,500-crore-Rahimafrooz Group, the organization has been occupied with dispersing solar systems throughout the previous barely any years. Development work of the production line at Shripur, Gazipur, Dhaka has just been finished with a limit of 5 MW. Rahimafrooz Renewable Energy expects that privately collected solar boards will be more serious than the imported ones. The organization, which asserts a piece of the pie of around 21 percent in SHS. They are creating 40-300wp SPM for serving our neighborhood market.

b)Radiant Alliance limited:

Brilliant Alliance Limited began its lady venture in October 2010. Its fundamental point is to give power at a reasonable cost to far-off areas of Bangladesh by utilizing Solar Power; a renewable and efficient power energy source. Brilliant Alliance Limited is in a key organization with one of the widely acclaimed's Solar Cell Manufacturers, Renewable Energy Corporation (REC) of Norway for its essential crude materials, the Photovoltaic (PV) Solar Cell. Brilliant Alliance Limited has set up a worldwide organization with Solar Module Manufacturers Surana Ventures, India to dispatch its own 10 MW Solar PV Modules gathering offices in Bangladesh. Notwithstanding, the organization intends to start its underlying activity with a yearly limit of 5 MW in the main stage. Development work of the manufacturing plant at Ashulia, Dhaka has just been finished. The plant is completely operational since the mid of January 2010. It merits referencing that a significant bit of the Radiant Alliance Limited was financed by IDCOL an advance at a sponsored rate. They are creating from 10wp to 300wp SHS to serve the neighborhood market.

3.7 Operation expenses (OPEX) of two companies:

By analyzing two companies' operation expenses per month can understand the manufacturing cost of SHS of the last six months and in which purposes they spend their capital and run their factory efficiently.

a) Rahimafrooz Renewable Energy Ltd:

Monthly Operational Expenses of the Factory

Jan 2019

Sl No.	Particulars	Monthly Estimate	Monthly Actual
01	Factory entertainment	15000	7406
02	Tiffin	21450	13550
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	550
05	Factory Miscellaneous communication Expense	5000	4500
06	Environment, Health & safety (EHS)	6167	5150
07	Carriage inward & outward (FG Transportation)	10000	18700
08	Diesel	222040	150000
09	Electricity	102960	32665
10	Drinking Water	400	400
11	RM Accessories	25500	4600
12	Maintenance spare	71542	5287
13	Repair & Maintenance : Machinery, Utility, Building	25500	2000
14	Factory Cleanliness	8300	1225

15	Office supplies & stationery	7000	1398
16	Postage, Internet & Telephone	10000	500
17	Books, News paper & periodical	1000	260
18	Factory conveyance	5000	8250
19	Gardening	2500	700
	Total	548691	258141

Monthly Operational Expense of the Factory

Feb-19

Sl No.	Particulars	Monthly Estimate	Monthly Actual
01	Factory entertainment	15000	14000
02	Tiffin	21450	11940
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	5000
05	Factory Miscellaneous communication Expense	5000	4580
06	Environment, Health & safety (EHS)	6167	4587
07	Carriage inward & outward (FG Transportation)	10000	10620
08	Diesel	222040	180000
09	Electricity	102960	41000
10	Drinking Water	400	400
11	RM Accessories	25500	35000
12	Maintenance spare	71542	65000
13	Repair & Maintenance : Machinery, Utility, Building	25500	24500

14	Factory Cleanliness	8300	600
15	Office supplies & stationery	7000	2098
16	Postage, Internet & Telephone	10000	500
17	Books, News paper & periodical	1000	246
18	Factory conveyance	5000	2555
19	Gardening	2500	250
	Total	548691	403876

Monthly Operational Expense of the Factory

Mar-19

Sl No.	Particulars	Monthly Estimate	Monthly Actual
01	Factory entertainment	15000	8000
02	Tiffin	21450	13000
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	0
05	Factory Miscellaneous communication Expense	5000	3500
06	Environment, Health & safety (EHS)	6167	4700
07	Carriage inward & outward (FG Transportation)	10000	21420
08	Diesel	222040	54600
09	Electricity	102960	99180
10	Drinking Water	400	400
11	RM Accessories	25500	23000
12	Maintenance spare	71542	35850

13	Repair & Maintenance : Machinery, Utility, Building	25500	12500
14	Factory Cleanliness	8300	535
15	Office supplies & stationery	7000	1637
16	Postage, Internet & Telephone	10000	500
17	Books, News paper & periodical	1000	245
18	Factory conveyance	5000	2247
19	Gardening	2500	1250
	Total	548691	283564

Monthly Operational Expense of the Factory

Apr-19

Sl No.	Particulars	Monthly Estimate	Monthly Actual
01	Factory entertainment	15000	5116
02	Tiffin	21450	12701
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	0
05	Factory Miscellaneous communication Expense	5000	4200
06	Environment, Health & safety (EHS)	6167	3500
07	Carriage inward & outward (FG Transportation)	10000	11840
08	Diesel	222040	73610
09	Electricity	102960	85650
10	Drinking Water	400	400

11	RM Accessories	25500	3704
12	Maintenance spare	71542	45707
13	Repair & Maintenance : Machinery, Utility, Building	25500	15670
14	Factory Cleanliness	8300	925
15	Office supplies & stationery	7000	613
16	Postage, Internet & Telephone	10000	4500
17	Books, News paper & periodical	1000	250
18	Factory conveyance	5000	1545
19	Gardening	2500	1505
	Total	548691	272436

Monthly Operational Expense of the Factory

May-19

Sl No.	Particulars	Monthly Estimate	Monthly Actual
01	Factory entertainment	15000	3410
02	Tiffin	21450	17625
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	0
05	Factory Miscellaneous communication Expense	5000	4500
06	Environment, Health & safety (EHS)	6167	322
07	Carriage inward & outward (FG Transportation)	10000	15000
08	Diesel	222040	150000

09	Electricity	102960	55872
10	Drinking Water	400	400
11	RM Accessories	25500	5275
12	Maintenance spare	71542	45000
13	Repair & Maintenance : Machinery, Utility, Building	25500	37255
14	Factory Cleanliness	8300	874
15	Office supplies & stationery	7000	1960
16	Postage, Internet & Telephone	10000	500
17	Books, News paper & periodical	1000	250
18	Factory conveyance	5000	5330
19	Gardening	2500	1400
	Total	548691	345973

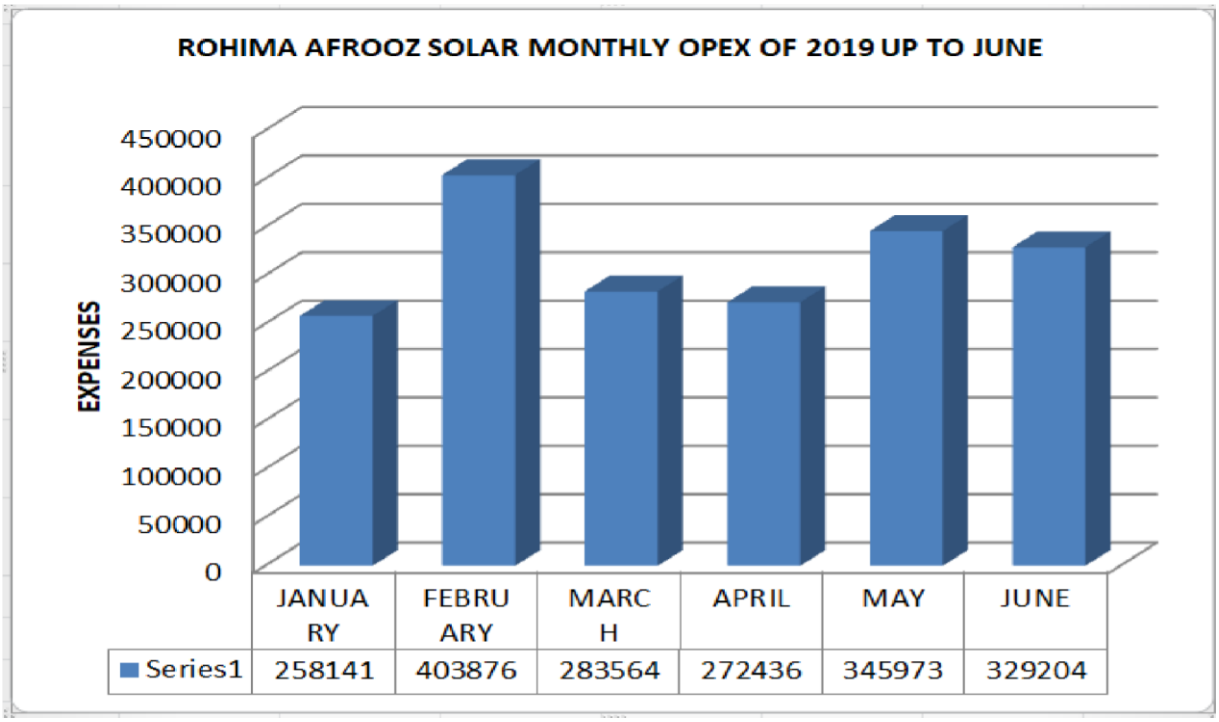
Monthly Operational Expense of the Factory

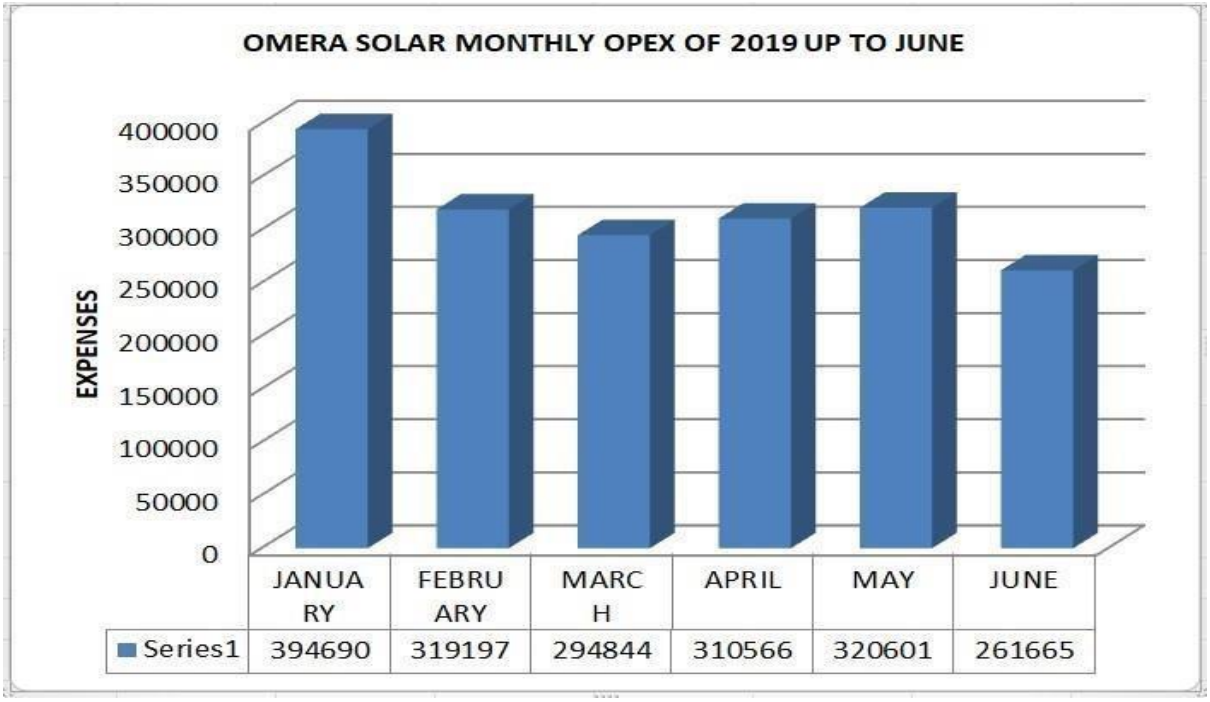
Jun-19

Sl No.	**Particulars**	**Monthly Estimate**	**Monthly Actual**
01	Factory entertainment	15000	4470
02	Tiffin	21450	18316
03	Reward expenses	1000	1000
04	Uniform & Sandal	8333	1075
05	Factory Miscellaneous communication Expense	5000	4200
06	Environment, Health & safety (EHS)	6167	870
07	Carriage inward & outward (FG Transportation)	10000	20880
08	Diesel	222040	74000
09	Electricity	102960	97850

10	Drinking Water	400	400
11	RM Accessories	25500	7884
12	Maintenance spare	71542	65000
13	Repair & Maintenance : Machinery, Utility, Building	25500	21560
14	Factory Cleanliness	8300	3550
15	Office supplies & stationery	7000	3534
16	Postage, Internet & Telephone	10000	500
17	Books, News paper & periodical	1000	250
18	Factory conveyance	5000	2615
19	Gardening	2500	1250
	Total	548691	329204

Comparison of OPEX Graph between RAL and RRE





Graph no 04: Comparing of OPEX between RAL and RRE

3.8 Analysis of manufacturing cost of the solar PV module:

In this part try to figure out the manufacturing cost of both two companies and also provide them where they can reduce the cost of manufacturing of the Pv module. As here take two types of module's BOM for analysis and this is 250wp and 300wp.

a) **Radiant Allaince Ltd (RAL):**

BOM of 250wp Solar PV Module

Sl. No.	Item Description	250 wp			
		Qty	Unit	CPU	Total Cost
01	Solar Cell (156mm*156mm)multi	61.5	pc-132*72	85.14	5236.11
02	Tempered Glass-mm	1655x985x3.2	pc	677	677
03	Encapsulation Material/EVA t= 0.35mm	3.4	sqm	124.38	422.892
04	Back Sheet/Tedlar, t =0.35mm	1.65	sqm	257.9	425.535
05	Al-Frame-mm	1660x990x35	set	810.7	810.7
06	Junction Box (4, rail)	1	pc	332.78	332.78
07	Connecting Link,w= 2 mm	0.2	kg	1331.11	266.222
08	Bus Bar, w= 5 mm	0.05	kg	1331.11	66.5555
09	Adhesive/ RTV Silicon (Tube)	0.6	pc	207.99	124.794
10	Fluxing Agent	0.15	ltr	1276.94	191.541
11	Soldering Material, t=1.5 mm	0.005	kg	1331.11	6.65555
12	Cleaning agent	0.03	kg	185	5.55
13	Scotch Tape (1/2")	0.65	pcs	6.67	4.3355
14	Nomeclature Sticker	1	pcs	128	128
15	Brand Logo	1	pcs		
16	Passed Sticker	1	pcs		
17	Barcode Sticker	1	pcs		
18	Packaging Material	1	pcs		
19	Travel Card	1	pcs		
20	**Module Cost**				8698.671
21	**Cost Per Watt**				34.79468
22	**Direct Labor Cost Per Watt**	Module Cost Final (All Cost include 1.5 %)			8829.151
23	Indirect Labor Cost Per Watt				
24	**Other Indirect Overhead Per Watt**				
25	Office & Administrative Overhead Per Watt				
26	**Selling & Distribution Overhead Per Watt**				
27	**Cost Per Watt (Final)**				35.3166

Manufacturing cost

250wp solar pv module /WTP	35.3166 (Tk)
Selling price at 15 % profit	40.6140 (Tk)

BOM of 300 wp Solar PV module

Sl. No.	Item Description	300 wp			
		Qty	Unit	CPU	Total Cost
01	Solar Cell (156mm*156mm)multi	72.1	pc-156*72	85.14	6138.594
02	Tempered Glass-mm	1949x 976x4	pc	953	953
03	Encapsulation Material/EVA t= 0.35mm	4.015	sqm	124.38	499.3857
04	Back Sheet/Tedlar, t =0.35mm	2	sqm	257.9	515.8
05	Al-Frame-mm	1954x981x35	mm	733	733
06	Junction Box (4, rail)	1	pc	332.78	332.78
07	Connecting Link,w= 2 mm	0.25	kg	1331.11	332.7775
08	Bus Bar, w= 5 mm	0.05	kg	1331.11	66.5555
09	Adhesive/ RTV Silicon (Tube)	0.85	pc	207.99	176.7915
10	Fluxing Agent	0.25	ltr	10	2.5
11	Soldering Material, t=1.5 mm	0.005	kg	1331.11	6.65555
12	Cleaning agent	0.04	kg	185	7.4
13	Scotch Tape (1/2")	0.8	pcs	6.67	5.336
14	Nomeclature Sticker	1	pcs	206	206
15	Brand Logo	1	pcs		
16	Passed Sticker	1	pcs		
17	Barcode Sticker	1	pcs		
18	Packaging Material	1	pcs		
19	Travel Card	1	pcs		
20	**Module Cost**				9976.576
21	**Cost Per Watt**				33.25525
22	**Direct Labor Cost Per Watt**	Module Cost Final (All Cost include 1.5 %)			10126.22
23	Indirect Labor Cost Per Watt				
24	**Other Indirect Overhead Per Watt**				
25	Office & Administrative Overhead Per Watt				
26	**Selling & Distribution Overhead Per Watt**				
27	**Cost Per Watt (Final)**				33.75408

Manufacturing cost

300 wp solar pv module /WTP	33.75408 (Tk)
Selling price at 15 % profit	38.8171 (Tk)

Here module cost of Radiant Alliance Ltd for 250 wp solar module is 35.3166Tk per watt and the total cost of the panel is 35.3166 X 250 wp = 8829.15 tk and sale price 10153.5Tk and also for 300 wp module cost is 33.75408 Tk and the total cost of the panel is 33.75408 X 300 wp =10126.224Tk and sale price 11645.13Tk which is higher than an existing market where the price of panel per watt at 40 tk for 250wp panel and 300 wp is 39 tk per watt.

b) Rahimafrooz Renewable Energy Ltd (RRE):

BOM of 250wp solar PV module

Sl. No.	Item Description	250 wp			
		Qty	Unit	CPU	Total Cost
01	Solar Cell (156mm*156mm)multi	61.5	pc-132*72	86.14	5297.61
02	Tempered Glass-mm	1655x985x3.2	pc	695	695
03	Encapsulation Material/EVA t= 0.35mm	3.6	sqm	124.38	447.768
04	Back Sheet/Tedlar, t =0.35mm	1.67	sqm	257.9	430.693
05	Al-Frame-mm	1660x990x35	set	812.564	812.564
06	Junction Box (4, rail)	1	pc	335.78	335.78
07	Connecting Link,w= 2 mm	0.3	kg	1331.11	399.333
08	Bus Bar, w= 5 mm	0.06	kg	1331.11	79.8666
09	Adhesive/ RTV Silicon (Tube)	0.65	pc	207.99	135.1935
10	Fluxing Agent	0.17	ltr	1276.94	217.0798
11	Soldering Material, t=1.5 mm	0.005	kg	1331.11	6.65555
12	Cleaning agent	0.03	kg	185	5.55
13	Scotch Tape (1/2")	0.65	pcs	6.67	4.3355
14	Nomeclature Sticker	1	pcs	133	133
15	Brand Logo	1	pcs		
16	Passed Sticker	1	pcs		
17	Barcode Sticker	1	pcs		
18	Packaging Material	1	pcs		
19	Travel Card	1	pcs		
20	**Module Cost**				9000.429
21	**Cost Per Watt**				36.00172
22	**Direct Labor Cost Per Watt**	Module Cost Final (All Cost include 3%)			9270.42
23	Indirect Labor Cost Per Watt				
24	**Other Indirect Overhead Per Watt**				
25	Office & Administrative Overhead Per Watt				
26	**Selling & Distribution Overhead Per Watt**				
27	**Cost Per Watt (Final)**				36.54174

Manufacturing cost

250 wp solar pv module /WTP	36.54174 (Tk)
Selling price at 22 % profit	44.58092 (Tk)

BOM of 300 wp solar pv module

Sl. No.	Item Description	300 wp			
		Qty	Unit	CPU	Total Cost
01	Solar Cell (156mm*156mm)multi	72.1	pc-156*72	86.14	6210.694
02	Tempered Glass-mm	1949x 976x4	pc	975	975
03	Encapsulation Material/EVA t= 0.35mm	4.2	sqm	124.38	522.396
04	Back Sheet/Tedlar, t =0.35mm	2	sqm	260	520
05	Al-Frame-mm	1954x981x35	mm	850	850
06	Junction Box (4, rail)	1	pc	335.78	335.78
07	Connecting Link,w= 2 mm	0.34	kg	1331.11	452.5774
08	Bus Bar, w= 5 mm	0.06	kg	1331.11	79.8666
09	Adhesive/ RTV Silicon (Tube)	0.9	pc	207.99	187.191
10	Fluxing Agent	0.28	ltr	10	2.8
11	Soldering Material, t=1.5 mm	0.006	kg	1331.11	7.98666
12	Cleaning agent	0.08	kg	185	14.8
13	Scotch Tape (1/2")	1	pcs	6.67	6.67
14	Nomeclature Sticker	1	pcs	216	216
15	Brand Logo	1	pcs		
16	Passed Sticker	1	pcs		
17	Barcode Sticker	1	pcs		
18	Packaging Material	1	pcs		
19	Travel Card	1	pcs		
20	**Module Cost**				10381.76
21	**Cost Per Watt**				34.60587
22	**Direct Labor Cost Per Watt**	Module Cost Final (All Cost include 3%)			10745.12
23	Indirect Labor Cost Per Watt				
24	**Other Indirect Overhead Per Watt**				
25	Office & Administrative Overhead Per Watt				
26	**Selling & Distribution Overhead Per Watt**				
27	**Cost Per Watt (Final)**				35.12496

Manufacturing cost

300 wp solar pv module /WTP	35.12496 (Tk)
Selling price at 22 % profit	42.85245 (Tk)

Here module cost of RRE for 250 wp solar module is 36.54174 Tk per watt and the total cost of the panel is 36.54174 X 250 wp = 9135.435 tk and the sale price 11145.23 Tk and also for 300 wp module cost is 35.12496 Tk and the total cost of the panel is 35.12496 X 300 wp = 10537.488 Tk and sale price 12855.735Tk.

By picking the data from the local market it has been observed that the price of some foreign panel as follows:

Sl No.	**Name of Foreign panel in Bangladesh**	**Price / WTP (Tk)**	
		250 wp	300 wp
01	Blue Carbon(China)	28	27
02	Southern Solar Co.(China)	31	29
03	ECO power Co.(China)	27	26
04	Haron Solar (China)	29	27
05	Power for you (China)	28	26

Table no 8: Price of existing market solar panel in Bangladesh

Here it has been seen that which is the price of a panel at 12.05 tk per watt for 250wp panel and 300 wp is 11.81 tk per watt. So our local manufacturers are suffering from their high pricing solar module though they have high quality than foreign panels. So in this our local manufacturers have to revise their cost of everything regarding the panel manufacturing So, from BOM they can reduce some cost and as well as overhead costs also.

From the BOM of modules we can see that the maximum contribution of cost is below materials:

Sl. No.	Item Description
01	Solar Cell
02	Low iron Tempered Glass
03	Encapsulation Material/EVA
04	Back Sheet/Tedler
05	Al-Frame

CHAPTER-4

Conclusion & Recommendations

4.1 Conclusion:

By studying and analyzing we can see that the prospect of solar energy and growth of this sector is increasing day by day for our rural areas as well as for providing electricity of lighting needs of households and several positive impacts including improvement of quality of life and increase in income and employment opportunities. Though the price of import panel is lower than our local manufacturers if they go through the cost-minimizing process of their raw materials then they will earn more profit and also can compete with importer and the existing market pricing situation in Bangladesh and the risk of the whole system has been avoided with the involvement of the local community in management.

4.2 Recommendation:

The following are the recommendations that might be applied for the smooth growth of rural electrification through solar energy:

a) Rural people in Bangladesh are not aware of solar energy technology. Therefore a demonstration is necessary to reach the information to this group.
b) The appropriate financial arrangement is necessary for rural people to afford the system. This may include payment in installment, a fee for services, and other suitable modes.
c) Solar systems with different options should be available to the consumers so that they can choose themselves according to their demand.

d) Components/accessories of solar systems should be locally available so that the users can buy them easily when required. This can increase the acceptability of the technology to the users.

CHAPTER-5

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