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**An assignment
on**

Module No-02

**Solar Energy- Potentiality and Challenges: Bangladesh
Perspective**

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Abbreviations and Acronyms

BPATC	: Bangladesh Public Administration Centre
BERC	: Bangladesh Energy Regulatory Commission
NEP	: National Energy Policy
GSB	: Geological Survey of Bangladesh
SREDA	: Sustainable and Renewable Energy Development Authority
IRENA	: International Renewable Energy Agency
SHS	: Solar Home Systems
BPDB	: Bangladesh Power Development Board
ADB	: Asian Development Bank
ADP	: Annual Development Program
BAEC	: Bangladesh Atomic Energy Commission
BAPEX	: Bangladesh Petroleum Exploration Co. Ltd.
BMEDC	: Bangladesh Mineral Exploration and Development Corporation
BOGMC	: Bangladesh Oil, Gas and Mineral Corporation (Short name of Petro Bangla)
BPC	: Bangladesh Petroleum Corporation
BUET	: Bangladesh University of Engineering and Technology
CNG	: Compressed Natural Gas
DESA	: Dhaka Electricity Supply Authority
EIA	: Environmental Impact Assessment
GOB	: Government of Bangladesh
GW	: Giga Watt
KWH	: Kilo Watt Hour
LPG	: Liquefied Petroleum Gas
MJ	: Mega Joule
MOEMR	: Ministry of Energy and Mineral Resources
MW	: Mega Watt
NEPFC	: National Energy Policy Formulation Committee
NGL	: Natural Gas Liquid
PBS	: Palli Biddyt Samity (Rural Electric Co-operative)
REB	: Rural Electrification Board
REDA	: Renewable Energy Development Agency
WB	: World Bank
SED	: Sustainable Energy Development Agency
RET	: Renewable Energy Technology
IDCOL	: Infrastructure Development Company Limited
NGO	: Non Govt. Organization
LGED	: Local Govt. Engg. Department
AEC	: Atomic Energy Commission
BRAC	: Bangladesh Rural Advancement Committee
PV	: Photo Voltaic

Executive Summary

Energy Policy:

The first National Energy Policy (NEP) of Bangladesh was formulated in 1996 by the Ministry of Power, Energy and Mineral resources to ensure proper exploration, production, distribution and rational use of energy resources to meet the growing energy demands of different zones, consuming sectors and consumers groups on a sustainable basis. With rapid change of global as well as domestic situation, the policy was updated in 2004. The updated policy included three additional objectives namely to bring the entire country under electrification by the year 2020, to ensure reliable supply of energy to the people at reasonable and affordable price and to develop a regional energy market for rational exchange of commercial energy to ensure energy security.

Vision 2021 also emphasize on providing energy security for development and welfare. It also aims at developing an integrated and developed energy sector in Bangladesh that will be the key driver of a sustainable national economy by 2021.

Broad objective of the Renewable energy policy:

To bring the entire country under electrification by the year 2020 encouraging public and private sector participation in the development of renewable energy and ensure energy security through reliable supply of energy to the people at reasonable and affordable price. Share of generation of power from renewable energy sources will be at least 5% of total demand by 2010 and 10% by 2020.

Specific objectives of the study:

Solar energy sector from among the renewable energy sources was selected for the study or policy evaluation. The specific objectives of the study are:

1. To identify the potentiality of solar energy in Bangladesh.
2. To critically analyze the reasons of less use of solar energy in Bangladesh.
3. To recommend necessary suggestions to overcome the problems.

Rationale of the Study:

The supply of natural resources is not sufficient to meet the demand for energy. The existing reserve of oil and gas will be exhausted if more sources are not explored further. Conventional coal fired power plants are a major cause of acid rain and contribute to global warming. Nuclear power involves huge capital costs, unresolved waste-disposal problem and growing public opposition. Hydroelectric power is also creates controversy because of relocation of indigenous population and ecological damage. So, solar energy can be the best option as a complement to commercial energy to ensure energy security.

Major Findings:

- The high costs of investment are associated with the import of solar systems from international market as Bangladesh has no capacity to develop new solar energy equipment based on its own production and imposition of government taxes.
- In Bangladesh, the number of solar-powered homes is expanding. Now many people have electricity due to SHS. This may help to secure energy and solve the existing energy crisis.
- Solar energy provides high quality, clean and environment friendly energy services. It produces zero emissions, causes no pollution & global warming.
- The price of solar PV is decreasing over the years and hence it is slowly becoming more cost effective. It provides a huge positive externality on the lives of the rural people in Bangladesh by providing them with numerous direct and indirect socio-economic benefits.
- The commercial energy sources (fossil fuels) are finite. The existing reserve of oil, gas & coal will be exhausted. Huge cost involves in establishing conventional power station. Solar energy is infinite and is able to meet family energy need.
- Conventional energy sources specially coal fired power plants cause harmful acid rain & contribute to global warming. Nuclear power involves huge capital cost. Hydroelectric power also creates controversy because of relocation of indigenous population & ecological damage. Hydro sources are limited. Biomass fuels have high potential but yet to be established as a viable power source. Solar energy has no such disadvantages.

- No infrastructure (grid, transmission & distribution line etc.) exists in remote, hilly, coastal & islands area. In off-grid area, solar energy may be the viable source of power
- Solar energy enhance sustainability and keeps commercial fuels (fossil fuels) price lower. No billing cost per month is involved for power consumption (self-installed) from solar energy.
- There is very minimum risk of fatal accident or threat to lives & property. Maintenance is easy and no hazard of load shedding.
- Efficiency is high as input (solar energy) cost amounts to zero except primary installation & maintenance cost.
- Use of solar energy has positive socio-economic impact on the users.

As regards to specific objective no 1 of the study, it can obviously be said that there is huge potentiality of solar energy in Bangladesh

Potential barriers or challenges:

- One of the major issues is the primary cost associated with solar energy systems. Due to high cost of solar systems, solar energy is unaffordable for most of the poorer community in Bangladesh
- Another major issue is the lack of available information about solar technology and very limited knowledge regarding costs and benefits of solar energy systems.
- Lack of awareness is also one of the major issues. Rural people in Bangladesh are not aware of the solar energy technology.
- Service providers and users are not properly trained in the management of solar energy systems. The lack of maintenance skills of the users is a factor.
- Public and private investment to this sector is too meager to have any impact. Weak regulatory incentives have been unsuccessful in encouraging private sector investments in renewable energy.

Aforementioned Potential barriers or challenges clearly substantiate the reasons of less use of solar energy in Bangladesh regarding the set objective no 2 of the study.

Recommendations:

The following recommendations are suggested:

- Solar home system (SHS) should be made affordable to the rural people.
- Components/accessories of solar systems should be locally available so that the users can buy them easily when required. This can increase acceptability of the technology to the users.
- An alternative to reach large number of rural households could have been developed with an easy and appropriate financing system so that the buyers can pay the system price over a longer period of time.
- Fiscal incentive policies are needed to encourage and support the private sectors for investment purposes. A suitable marketing mechanism is always required.
- Information about the benefits of solar system should be disseminated to the rural people through print and electronic media by the Govt. and the private enterprises as well.
- To promote solar technology at the root level, it is essential to introduce awareness programs about its effects on environment and encourage rural people to reduce carbon emissions. Therefore demonstration is necessary to reach the information to this group.
- Users training has great impact as the users can do trouble shooting of problems like replacing fuse, adding distilled water, replacing bulbs etc. This may avoid technician call and increase system reliability. Women also should be invited for training, as they are the main users of the systems. They can also pay attention for maintenance. Technician training is essential for ensuring the local technical support.
- Solar systems with different options should be available to the consumers so that they can choose themselves according to their demand.
- By installing roof top solar systems urban households can escape from load-shedding and reduce the over load on our grid system
- The government initiatives such as solar irrigation pumps, solar mini/micro-grids, solar park, and solar roof-tops should be boosted up.

In compliance with the objective no 3 of the study, the above mentioned recommendations are suggested.

Solar energy resources are quite high in Bangladesh. Hence, higher usage of solar energy in the national energy context will develop the sustainability and socio-economic development of Bangladesh.

Bangladesh has adopted a renewable energy policy to generate 10% of its energy from renewable sources by 2020. This is no doubt a very ambitious target, attaining even 50% of the set target can be considered an applauding achievement and can make a very big difference so far the rural economy and quality of living standard of the country is concerned.

Lessons learnt:

For off-grid and remote rural areas, solar energy may be the best complement to the conventional energy to meet the objectives of NEP for ensuring energy security for all.

CHAPTER- 1

Introduction

1.1 Background:

To meet the current energy demand there is no alternative to renewable energies such as solar, wind, biomass etc besides other existing sources. Using solar energy, simply, is a process which can provide energy from the sun. In this process, energy of the sun in the shape of photons reaches the earth and meets the world energy demand. Photovoltaic panel (PV panels-made of silicon) is the tool to harness solar energy.

Bangladesh is one of the densely populated countries which have not sufficient supply of energy. The present crisis in power supply hints at the troublesome time to come ahead. In Bangladesh, almost 80% of the people live in the village and only 62% of total population is connected to grid electricity at present. In light of the present demand for electricity; by 2020 the energy mix will be changed considerably from what it is today. The possibilities of using solar power are already being tested and will mostly increase. But still, most households meet their daily needs with biomass fuel. The country's electricity distribution board is failing to cope with the exponential growth in demand for power in the capital and all over the country. Therefore, the researchers intend to investigate whether there is any future prospect for solar energy in Bangladesh.

1.2 Statement of Problem:

Bangladesh has a large unsatisfied demand for energy, which is growing by 10 percent annually. Currently, it has the lowest per capita consumption of commercial energy in South Asia (321 kWh annually). While the current installed capacity is 12,780 MW, because of reduced efficiency of the old generating units. The derated (effective) capacity stands at 8890 MW maximum as of October, 2016. As a result, the country has been unable to meet the growing demand for electricity. A research conducted by Akter (1997) reveals that, though different organizations such as rural electrification Board (REB), Atomic Energy Commission (AEC), Local Government Engineering Department (LGED), and Grameen Shakti (GS) have installed a number of solar PV systems in different parts of the country, these are not widely

used in rural and urban areas in Bangladesh. As Bangladesh is still very centralized to its capital, many locations outside the capital do not get the attention they need.

The above situation is also supported by a research where it is mentioned, for the near future, it is impossible to connect every remote village and offshore island to the national grid system. Since expanding the national grid in those isolated areas is very expensive and not cost effective, solar PV could be an effective alternative to fulfill the electricity demand in these off-grid areas.

Under this situation, this study intends to evaluate the feasibility of the future of solar energy in Bangladesh.

1.3 Specific objectives of the study:

Solar energy sector from among the renewable energy sources has been selected for the study or policy evaluation. The specific objectives of the study are:

1. To identify the potentiality of solar energy in Bangladesh.
2. To critically analyze the less use of solar energy in Bangladesh.
3. To recommend necessary suggestions to overcome the problems.

1.4 Scope:

This research is conducted from operational point of view. Other aspects such as technical, financial and social aspects of the subject are considered as secondary concern for the report.

From statement of problem section, it is already mentioned that, rural areas are not properly electrified though city areas have already come under the circulation of electricity. Moreover there is no real time line when remote rural areas are going to come under the supply of electricity. So, rural areas are the primary concern of this study.

Another reason of choosing rural area is that, the concept of solar energy is yet new and most of the people in electrified areas will not be interested in using solar energy in alternate to their main source of power. Now a days, some discussions are going on to consider solar PV in urban areas also.

1.5 Methodology:

Both primary and secondary sources are used for collecting information. The basis for primary information was interview of Grameen Shakti personnel in implementing the solar energy system in Bangladesh at present. BPDB, PBS and BRAC personnel were also interviewed. Among the beneficiaries or users of solar energy 04 persons were interviewed, For secondary data collection, websites, journals, articles and other statistical sources are used.

1.6 Limitations:

There are three limitations in carrying out this research.

1. One of the obstructions of the study is accessibility. A very few persons of Grameen Shakti were available. They seemed to be not much interested in providing information.
2. The sample organization of interview for this research may be too small to represent the expert organizations.
3. Physical visit to rural areas (where solar energy program in already implemented) was very much limited because of inconvenient location and time constraint.

CHAPTER- 2

Literature Review

National Energy Policy 1996 and Updated version of Policy 2004 :

This document is the main paper to review. It gives us insight and broad guideline of effective use of energy and management of power in the country. Using renewable energy will reduce the pressure on the demand of commercial power supply and will help to avoid costly grid expansion and also keep environment pollution free.

The major objectives of the renewable energy policy are:

1. Promotion of renewable energy attracting private capital investment.
2. To accelerate electrification program using renewable energy resources.
3. To reduce pressure on commercial fuels.
4. Generation of power utilizing renewable energy to share at least 5% of total demand by 2010 and 10% by 2020.
5. To ensure optimum development of all renewable energy sources.
6. To ensure environmentally sound sustainable energy development programs causing minimum damage to environment.
7. To encourage public and private sector participation in the development of renewable energy.
8. To promote competition among the entrepreneurs.

Concerned articles:

Only 62% of the total population has got access to the electricity. Moreover, the rural and remote sector of Bangladesh economy, where 85% of the population live, is characterized by an abundance of disguised unemployment, high man-land ratio, alarmingly large numbers of landless farmers, extremely inadequate economic and social facilities, low standard of living and a general environment of poverty and deprivation. Larger energy supplies and greater efficiency of energy use are thus necessary to meet the basic needs of a growing population. It will therefore, be necessary to tap all sources of renewable energy and to use these in an efficient converted form for benefit of the people.

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For remote, coastal and island areas where there exists no infrastructure for conventional energy supply, solar energy system will be well suited and can be utilized to save imported fuel cost. Over the years, significant technological advances have been made in the area of renewable energies, especially in the field of solar photovoltaics (PV), wind energy and bio-gas technology. In recognition to the importance and necessity of using renewable energy efficiently, Government of Bangladesh (GOB) has already adopted a broad policy measures in the recently approved Energy Policy.

Generation of electricity using solar power is environmentally feasible. Development of solar power should be a top priority for Bangladesh in the 21st century. At present the national grid is serving only 50% of the nearly 10,000 rural markets and commercial centers in the country which are excellent market for centralized solar photovoltaic plants. Currently private diesel generator sets are serving in most of the off-grid rural markets and it has been found that 82% of them are also interested in marketing SHS in surrounding areas if some sorts of favorable financing arrangements are available.

To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency. Those endeavors manifest Bangladesh's commitment towards development of renewable energy.

Bangladesh is endowed with ample supply of renewable sources of energy. Solar energy is plentiful in Bangladesh. Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m². Maximum amount of radiation is available on the month of March-April and minimum on December-January. There is bright prospect for applications of solar thermal and photovoltaic systems in the country. Encouraged by the availability of solar radiation, Power Division has initiated a program to generate 500 MW of solar-based electricity. Under this program, projects for electrification of rural health centers, educational institutions are under consideration. Private sector is expected to implement commercial projects like Solar Irrigation, Solar Mini Grid, Solar Park and Solar Rooftop applications.

The government is gradually meeting part of the lighting and cooling load of public offices by installing solar panels. The national capacity of solar power development currently exceeds 150 MW. Most of the capacity addition is from Solar Home Systems (SHS) implemented by Infrastructure Development Company Limited (IDCOL), a government-owned financial institution. Until recently, more than 3 million SHSs have been installed with aggregated capacity of about 135 MW. The international community recognizes Bangladesh's SHSs as the fastest growing solar power dissemination program in the world.

Islam and Islam (2005) said to their research that, throughout the country, different government administrative offices, NGO offices, health centers, schools, banks, police stations etc are functioning. In the off-grid locations, these offices are either using traditional means (lantern, candles, kerosene wick lamps etc.) or operating their own diesel gensets. These offices have separate budgets for electricity and they can be easily served with solar photovoltaic applications. A solar PV system is an important emerging option to supply electricity with quality light, reliable service, and long-term sustainability (Ibrahim, Anisuzzaman, and Kumar, 2002).

Bangladesh is highly dependent on fossil fuels which are estimated to run out of stock by the end of 2020 (Sharif, 2009). The country can meet the energy demand by depending more on renewable energy rather than fossil fuels.

Bangladesh is still far behind than its expected growth of renewable energy, i.e. target 1000-1200 MW to ensure the electrification for all (Ahmed et al., 2013). According to the paper by Bhuiyan et al. (2002), renewable energy is essential for economic growth, sustainable development of the country, and for socioeconomic development. More usage of renewable energy and Renewable Energy Technologies (RET) could increase the availability of electricity leading to an improvement in the standard of living of the people (Uddin and Taplin, 2008). However, the cost of renewable energy is very expensive especially for the ones who are already in poverty. Solar pumps, mini grids and biogas plants could be promoted through introduction of village based small and medium entrepreneurs who can then invest in the technology and earn a profit by renting it to others. The government can also create village based women entrepreneurs and encourage them to promote improved

cooking stoves which help to reduce household smoke levels and would also be responsible for assembling, repairing solar accessories and providing after sales service (Islam et al., 2011).

According to Monju and Ullah (2014), the Government of Bangladesh will need to attain and effective power generation capacity of 17000 MW to reach the very ambitious national goal of providing electricity to every citizen by 2020. They also mentions that this goal seems quite impossible since there had been an increase of only 500 MW of electricity from 2001 to 2008. Ahmed et al. (2013) mentions in their study that the initial investment cost of RET, lack of infrastructure and lack of awareness are the main reasons behind why Bangladesh is still lagging behind from using renewable energy as the main contributor. The major constraints of renewable energy mentioned in their paper are economic, financial, political and technological. In order to overcome the barriers of using renewable energy, proper investment on RET is essential along with policies that favors renewable energy. This will help to reduce the country's energy crisis. The current issues regarding renewable energy policies can be solved with the creation of a comprehensive energy strategy which would include expert and unbiased policies (Monju and Ullah, 2014).

There is an absence of skilled engineers who can construct cost effective and efficient Solar Home System (SHS) models particularly for productive utilization. This system not only provides reliable, clean, and eco-friendly energy but it could also create new employment opportunities. Workers should be trained on how to handle and maintain solar equipments and also installation of photo voltaic (Islam et al., 2011). Amin, Islam, Kamal & Mithila Asaduzzaman et al. (2008) states various private agencies, such as Grameen Shakti, have more practical knowledge in providing micro-finance and in reaching at the community level than the public sector. In particular, Grameen Shakti has played an important role in the spreading of SHS in rural Bangladesh and its credit program has reached many low-income households.

Government of Bangladesh should also try to attract foreign investment. The renewable energy sector should be provided with incentives so that they get the opportunity to create a steady environment for production of renewable sources and materials.

CHAPTER- 3

Overview and Analysis

3.1 Overview

Present energy situation in Bangladesh:

Bangladesh's energy infrastructure is quite small, insufficient and poorly managed. The per capita energy consumption in Bangladesh is one of the lowest (321 kWh annually) in the world. Noncommercial energy sources, such as wood fuel, animal waste, and crop residues, are estimated to account for over half of the country's energy consumption. Bangladesh has small reserves of oil and coal, but very large natural gas resources. Commercial energy consumption is mostly natural gas (around 66%), followed by oil, hydropower and coal. Electricity is the major source of power for most of the country's economic activities. Bangladesh's installed electric generation capacity was 12780 MW as in October, 2016; only three-fourth of which is considered to be available. Maximum Generation as on 08/09/2016 is 8890 MW. Total demand is 9036 MW as on 30/06/2016. Only 62% of the population has access to electricity with a per capita availability of 321 kWh per annum which is interrupted by power cut. Vision 2021 focuses on electricity generation to **11,959 MW by 2013, 15,357 MW by 2015 and 20,000 MW by 2021**. It also focuses on per capita per annum energy consumption to be increased from **321 to 600 KWH**.

Current solar energy situation in Bangladesh:

Solar energy is the most easily available renewable source of energy in Bangladesh which can be implemented at comparatively low cost in a huge amount. The long term average sunshine data indicates that the period of bright sunshine hours in the coastal regions of Bangladesh varies from 3 to 11 hours daily. The insolation in Bangladesh varies from 3.8kwh/m²/day to 6.4 kwh/m²/day at an average of 5 kwh/m²/day (**Annexure -5**). These indicate that there are good prospects for solar thermal and photovoltaic application in the country.

Bangladesh is expected to have enormous potentiality in renewable energy development. Country is blessed by considerable solar radiation. Solar photovoltaic (PV) are gaining acceptance for providing electricity to households and small businesses in rural areas. Development of off-grid solar home solutions has achieved international benchmark. According to a survey, there is an existing market size of 06 million households for Solar Home Systems (SHS) on a fee-for-service basis in the off-grid areas of Bangladesh to be covered by 2017. Only 3.3 million households reached SHS having installation capacity of 150 MW which was implemented by NGOs and Private organizations (called Development Partners) through mainly IDCOL and other supporting organizations such as REB, LGED and BPDB by April, 2014 (**Annexure -1**). Vision 2021 focuses on renewable energy to be increased to 3168 MW by 2021 in which solar energy will be 1740 MW.

Infrastructure development company limited (IDCOL) has mainly supported NGOs and private organizations (called development partners) in installation of solar home systems (SHSs) and a total of 13,20,965 SHSs have been installed up to February 2012 (**Annexure-2**). Bangladesh power development board (BPDB) has implemented an excellent Solar PV electrification project in the Chittagong hill tracts region. The Solar PV electrification has emerged as the most appropriate technological option for the electrification of these areas. A 10 kW central AC solar PV system has been installed in one selected market in Rangamati district. With these systems, the shops of that market have been electrified with normal AC electricity. A 200 MW solar power project to be constructed by Sun Edison Energy Holding (Singapore) in the Tekhnaf, the largest solar power project in Bangladesh.

Annexure- 3 shows distribution of the SHSs (Solar Home System) in six divisions in Bangladesh up to Feb 2012.

Annexure- 4 shows the upward trend of the number of SHSs (Solar Home System) installations in the country.

Experiences of Solar power in India:

Solar power in India is a new industry that is taking off quickly. As of 31 July 2016, the country's solar grid has a cumulative capacity of 8,062 MW (8GW). In January 2015, the Indian government significantly expanded its solar plans, targeting US \$100 billion of investment and 100 GW of solar capacity (including 40 GW directly from rooftop solar) by 2022. Large scale solar power deployment began only as recently as 2010.

In addition to the ambitious large scale grid connected solar PV initiative, India is also continuing to develop the use of solar power for off grid and localized energy needs. By the end of 2015 only 55% of all rural households had access to electricity and 85% of rural households depended on solid fuel for cooking. Solar products have increasingly helped to meet rural needs, by the end of 2015 a cumulative total of just under 1 million solar lanterns had been sold. In addition a cumulative total of 30,256 solar powered water pumps for agriculture and drinking water had been installed. During 2015 alone 1,18,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national program. The same year just over 1.4 million solar cookers distributed or sold in India.

India is ranked number one in terms of solar electricity production. India saw a sudden rise in use of solar electricity in 2010 when 25.1 MW was added to the grid, and the trend accelerated when 468.3 MW was added in 2011. More recently growth has been over 3,000 MW per year and is set to increase yet further.

3.2 Analysis

Primary data analysis:

For primary data collection, sales and distribution (North), PDB, Mymensingh, Mymensingh Palley Biddut Samity-1, Muktagacha, BRAC Office, Mymensingh, Grameen Shakti, Mymensingh Regional office, Grameen shakti, Nandail Branch office, Mymensingh and finally four users of solar panels of Tarakanda were contacted and interviewed.

The executive engineer of PDB informed that present electrical generation capacity is around

8500-9000 MW but actual output only 75% of the capacity because of age- old generation plants. Current demand over the country for the existing distribution lines is around 8000 MW. PDB has no activities for solar panel installation. PBS officials informed that they also have no plan or activities regarding supply and installation of solar panels. In the past, BRAC was involved in solar system activities but presently they have stopped their activities regarding supply and installation of solar panels. Only Grameen Shakti is involved in solar activities such as sell, installation and maintenance. The capacity of the solar panels varies from 10 - 130 W available for sale. Grameen Shakti, Nandail Branch sold 1,800 packages and Regional office, Mymensingh sold 7,908 packages from starting. The prices of different capacities of solar panels sold by Grameen Shakti are as follows:

Capacity	Prices (Taka)
10 W	6000
20 W	10750
30 W	12500
40 W	17000
50 W	19500
130 W	39000

The solar panel sets are sold on installment basis for maximum three years with service charge which is stated below:

Installment	Down payment	Service Charge
03 years	15%	12%
02 years	20%	10%
01 year	25%	09%

Grameen Shakti also informed that 02 and 03 years installment has presently been suspended and only 01 year installment is running. The solar panel sets are foreign made and are imported through IDCOL from abroad. Consequently the panels are of high standard, costly and service is satisfactory. The price also differs. The price of a 50 W solar panel set sold by Grameen Shakti is Taka 19,500 whereas sold by other private organizations or persons cost Taka 12000 only. Solar panels are now being sold by private entrepreneurs alongside Grameen Shakti.

Grameen Shakti informed that people of off grid areas are the main customers. But because of high price, people are reluctant to buy and install solar panel sets though the price has been decreasing over the years. But it is still beyond the purchasing capacity of the general mass. Four consumers and users of solar panels of Tarakanda were interviewed to know about their experiences of benefits of solar panel, socio-economic impacts on their lives.

Socio-economic and environmental Impact:

Impact on literacy and education:

Solar energy in households like any other form of energy enhances opportunities for connecting to the world and education. The users informed me that their children feel much more comfortable and read long hour at night under the solar light than previous time. At present children could study additional two and half (2.5) hours with this facility. Three household respondents made their opinion that their children's performance of study was better than before.

Impact on Lifestyle:

The daily working activities changed after introducing of solar home systems in the stated study areas. Better quality of light provided opportunities for studying and refreshment as well as gossiping activities, for watching TV or listening to broadcast information and entertainment by the radio. On the other hand, all respondents remarked that their evening working hours were extended.

Impact on Household Assets:

Households acquire color television after the solar home system installation Mobile phone uses increased. Most popular item for the households is television. Mobile phone was another interesting item for communication. They use the solar facility for charging.

Impact on Income Generation Activities and Poverty:

There is a positive relation between the income generation and the exposure of people to sources of power in the rural areas. Income generation activities are created after acquiring the solar home systems in villages. The people engaged in doing business using traditional

fuel now switch to solar light that results in more development of their business than before. Medical pharmacies in and mobile phone service centers are established due to installation of solar home systems. Tailoring machines are bought to earn some money.

Women become involved with income generation activities. Grocery shop owners who were using kerosene lamps for their business get working hours extended due to SHS.

Impact on Environment:

In today's world more than 80% of the energy used comes from fossil fuel generating 33 billion metric tons of carbon dioxide every year- the main component of global warming. Trend in the energy demand is increasing causing emission of more green house gas. Solar energy is environmental-friendly and is a way to reduce or mitigate greenhouse gas emission.

Secondary data analysis:

Bangladesh power sector and primary energy resources:

Bangladesh is heavily dependent on fossil fuel for its power generation. As per Bangladesh Power Development Board data, out of total installed capacity of about 12780 MW, 64% of the energy comes from natural gas, 2.0% comes from coal, 33% comes from diesel/furnace oil, 2% comes from hydro and remaining approximately 1% is imported.

With dwindling supply of gas, the power sector of Bangladesh is facing a serious threat and the diversification of primary source has become a necessity.

Diversification of primary energy resources has its own fall out effects- coal is highly polluting, diesel and furnace oil is quite expensive and hydro resources are very limited.

Nuclear energy seems to be an alternative energy option, but it involves huge capital cost.

With the growth rate in GDP nearing to 7% in 2015, Bangladesh is one of the fastest developing world. Keeping pace with the global trend, Bangladesh has also attached its due importance to the development of renewable energy. Focus has been put on the development and usage of renewable energy by the government to mainly serve the purposes of reducing

poverty, aiding in energy shortage by diversification of energy sources and to mitigate the condition of environmental degradation. To this end, effective utilization of renewable energy resources has been adopted as a policy of the Government of Bangladesh. Presently renewable energy options have also been included in the Bangladesh National Building Code. Renewable Energy Policy of Bangladesh has been in force since 2009, which envisions having 5% power from renewable energy sources by 2010 and 10% by 2020. Different government, semi-government and organizations have been working separately or jointly to disseminate RET throughout the country over a significant period. All these endeavors manifest Bangladesh's commitment towards the development of renewable energy.

CHAPTER- 4

Evaluation Findings

4.1 Evaluation of the policy:

National Energy Policy formulated in 1996 and updated versions of National Energy Policy of 2004 were evaluated. Broad area of my study was Renewable Energy Policy part of the said policy. Specific area of my study was solar energy as one of the prolific components of Renewable Energy Policy. The topic selected was Solar Energy- Potentiality and Challenges: Bangladesh perspective. Three specific objectives of topic selected were taken into consideration. Concerned literature were reviewed, present situation of conventional and nonconventional (solar energy) energy were examined, primary and secondary data were collected and analyzed to come up with a concrete findings regarding the objects set.

4.2 Major Findings:

- The high costs of investment are associated with the import of solar systems from international market as Bangladesh has no capacity to develop new solar energy equipment based on its own production and imposition of government taxes.
- In Bangladesh, the number of solar-powered homes is expanding. Now many people have electricity due to SHS. This may help to secure energy and solve the existing energy crisis.
- Solar energy provides high quality, clean and environment friendly energy services. It produces zero emissions, causes no pollution & global warming.
- The price of solar PV is decreasing over the years and hence it is slowly becoming more cost effective. It provides a huge positive externality on the lives of the rural people in Bangladesh by providing them with numerous direct and indirect socio-economic benefits.
- The commercial energy sources (fossil fuels) are finite. The existing reserve of oil, gas & coal will be exhausted. Huge cost involves in establishing conventional power station. Solar energy is infinite and is able to meet family energy need.

- Conventional energy sources specially coal fired power plants cause harmful acid rain & contribute to global warming. Nuclear power involves huge capital cost. Hydroelectric power also creates controversy because of relocation of indigenous population & ecological damage. Hydro sources are limited. Biomass fuels have high potential but yet to be established as a viable power source. Solar energy has no such disadvantages.
- No infrastructure (grid, transmission & distribution line etc.) exists in remote, hoar, boar, coastal & islands area. In off-grid area, soar energy may be the viable source of power
- Solar energy enhance sustainability and keeps commercial fuels (fossil fuels) price lower. No billing cost per month is involved for power consumption (self-installed) from solar energy.
- There is very minimum risk of fatal accident or threat to lives & property. Maintenance is easy and no hazard of load shedding.
- Efficiency is high as input (solar energy) cost amounts to zero except primary installation & maintenance cost.
- Use of solar energy has positive socio-economic impact on the users.
- Solar energy has huge potentiality in Bangladesh out of all the renewable energy.

Potential barriers or challenges:

- One of the major issues is the primary cost associated with solar energy systems. Due to high cost of solar systems, solar energy is unaffordable for most of the poorer community in Bangladesh
- Another major issue is the lack of available information about solar technology and very limited knowledge regarding costs and benefits of solar energy systems.
- Lack of awareness is also one of the major issues. Rural people in Bangladesh are not aware of the solar energy technology.
- Service providers and users are not properly trained in the management of solar energy systems. The lack of maintenance skills of the users is a factor.
- Public and private investment to this sector is too meager to have any impact. Weak regulatory incentives have been unsuccessful in encouraging private sector investments in renewable energy.

CHAPTER- 5

Recommendations and Conclusion

5.1 Recommendations:

The following recommendations are suggested:

- Solar home system (SHS) should be made affordable to the rural people.
- Components/accessories of solar systems should be locally available so that the users can buy them easily when required. This can increase acceptability of the technology to the users.
- An alternative to reach large number of rural households could have been developed with an easy and appropriate financing system so that the buyers can pay the system price over a longer period of time.
- Fiscal incentive policies are needed to encourage and support the private sectors for investment purposes. A suitable marketing mechanism is always required.
- Information about the benefits of solar system should be disseminated to the rural people through print and electronic media by the Govt. and the private enterprises as well.
- To promote solar technology at the root level, it is essential to introduce awareness programs about its effects on environment and encourage rural people to reduce carbon emissions. Therefore demonstration is necessary to reach the information to this group.
- Users training has great impact as the users can do trouble shooting of problems like replacing fuse, adding distilled water, replacing bulbs etc. This may avoid technician call and increase system reliability. Women also should be invited for training, as they are the main users of the systems. They can also pay attention for maintenance.

Technician training is essential for ensuring the local technical support.

- Solar systems with different options should be available to the consumers so that they can choose themselves according to their demand.
- By installing roof top solar systems urban households can escape from load-shedding and reduce the over load on our grid system
- The government initiatives such as solar irrigation pumps, solar mini/micro-grids, solar park, and solar roof-tops should be boosted up.

5.2 Conclusion:

Energy crisis and possible alternative energy sources are considered two really big issues for Bangladesh. There is a high potential of renewable energy contributing to the society a security for energy. Shifting to renewable energy sources will not only increase the supply of energy, it will also cause less harm to the environment. Therefore, the government of Bangladesh must take sufficient level of initiatives to make this sector sustainable and prosperous for the creation of higher economic growth.

Even though there are some reserves of commercial energy but due to outdated technology and economic constraint, it cannot get the most out of these reserves. Also, over usage of fossil fuel can impose a negative impact on the environment. In order to overcome this barrier, renewable energy should be used significantly more than the current usage level. Solar energy resources are quite high in Bangladesh. Hence, higher usage of solar energy in the national energy context will develop the sustainability and socio-economic development of the country like Bangladesh.

Bangladesh has adopted a renewable energy policy to generate 10% of its energy from renewable sources by 2020. This is no doubt a very ambitious target, attaining even 50% of the set target can be considered an applauding achievement and can make a very big difference so far the rural economy and quality of living standard of the country is concerned.

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Annexes:

Sl. no	Category	Achievement (2014)
No.	System	Capacity
1.	Solar Home System (3.3 million)	150MW
2.	Solar System at roof top of Govt./non govt. building	03MW
3	Solar System at Commercial building and shoppingmall	01MW
4	Solar PV for new connection at roof top of buildings	11MW
5	Solar Irrigation (193)	01MW
6	Wind based power generation	02MW
7	Bio-mass based power generation	01MW
8	Bio-gas based power generation	05MW
9	Hydro Power	230MW
	Total	404 MW

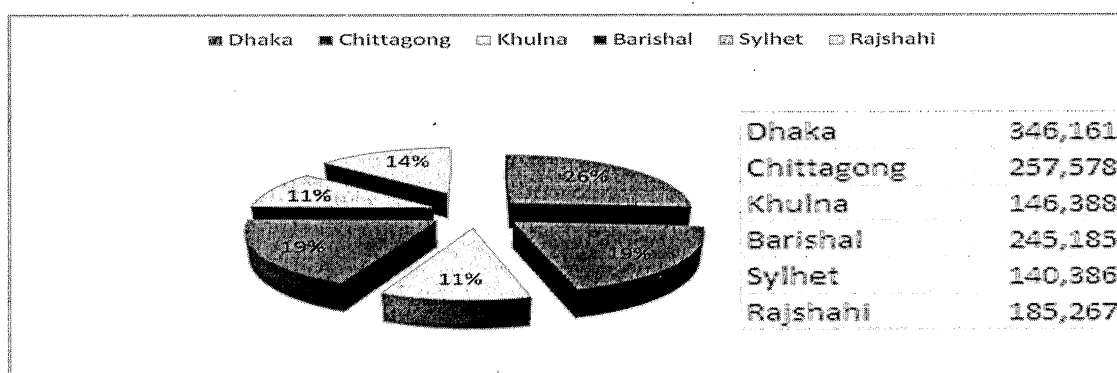
Source: Power Division, 2014

Annexure 1: The implemented Renewable Energy in Bangladesh

Partner Organization	Number of SHSs Installed
Grameen Shakti	7,50,657
RSF	1,99,209
BRAC	75,440
Srizony Bangladesh	54,011
Hilful Fuzul Samaj Kallyan Sangstha	32,630
UBOMUS	23,651
BRIDGE	19,148
Integrated Development Foundation	12,618
TMSS	11,787
PDBF	9,869
SEF	16,783

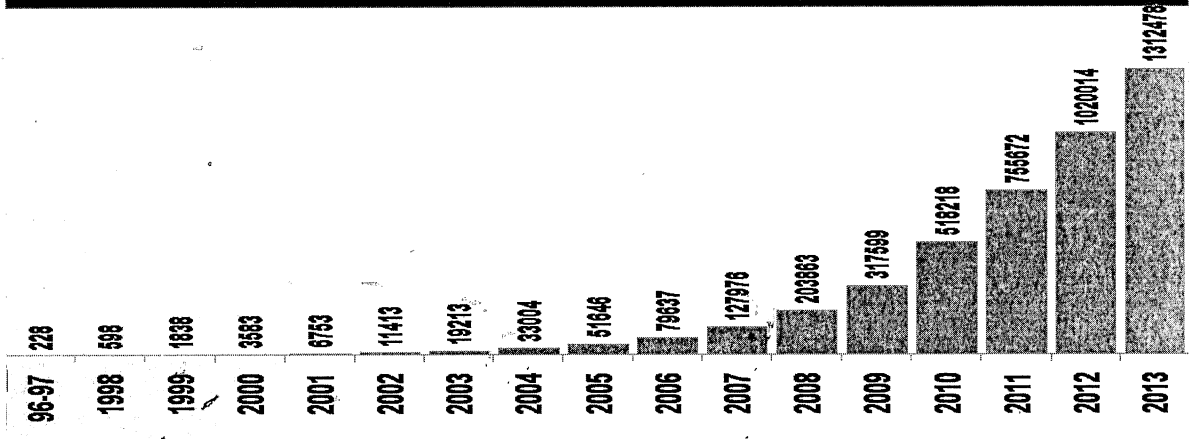
AVA	10,564
DESHA	9,593
BGEF	13,684
RDF	15,911
COAST	6,181
INGEN	8,487
CMES	5,543
NUSRA	7,651
RIMSO	6,798
Shubashati	4,933
REDI	5,209
GHEL	4,981
SFDW	7,417
PMUK	2,046
Ratakuri	2,087
ADAMS	2,433
AFAUS	1,003
Xenergeia	252
Other	389
Total	13,20,965

Annexure 2: SHS's installation up to February 2012

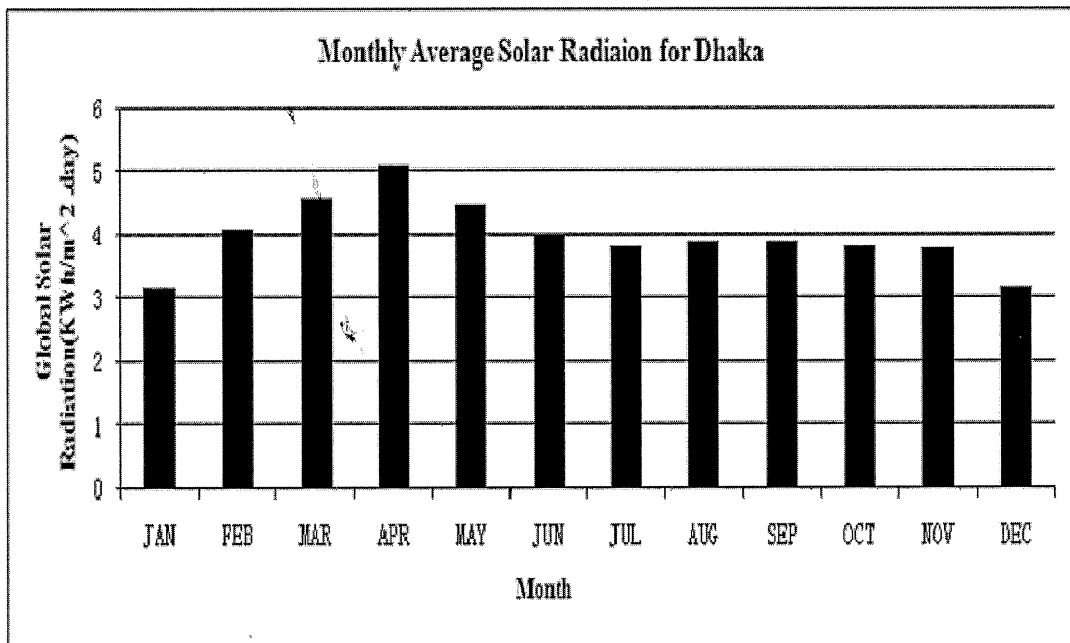


Annexure-3: Distribution of the SHSs (Solar Home System) in six divisions in Bangladesh up to Feb 2012

Installation of SHS (Cum.)



Annexure 4: Grameen Shakti solar home system installations by year.



Annexure 5: Monthly Average Solar Radiation for Dhaka