Renewable Energy Technology (RET) for Micro-Enterprise (ME): A Study of Solar Home System (SHS) in Durgapur Upazila, Bangladesh

By

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Dedicated to

Freedom Fighters of Bangladesh

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Abstract

"Micro-Enterprises (MEs)" provide the necessary foundations for sustained growth and rising incomes in the less developed and transitional economies. However, in the current state of changing times, MEs need to adapt themselves to new realities and challenges and to stay competitive. In Bangladesh, SHS becomes a popular electrification tool in rural off grid areas. This study was conducted to find the role of SHS uses for ME development in rural off grid areas, and to study the changes brought to rural ME by up taking SHS. Mixed method (both quantitative and qualitative methods) has been adopted for this study. This study has examined the role of SHS on trade and service related rural MEs in off grid area of Durgapur Upazila, Bangladesh. The data were gathered from primary and secondary sources. Primary data were collected through questionnaire survey, in-depth interviews and observations.

From the study it has found that rural entrepreneurs are using SHS mostly for lighting, charging mobile phone and powering small DC fan. Productive use of SHS is seen by this study but the numbers are low. Some of the entrepreneurs are using SHS as a development tool. SHS is not equally helping to all the entrepreneurs for bringing change in their MEs. As a whole, the role of SHS to bring change in the investment and profit of the MEs were a little; to bring change in the working hour, working condition, product and service quality, customer service delivery, number of customer of the MEs were moderate. No role of SHS was found for brining change in the employment and employee wages by this study. Change in the energy expenditure and medium of entertainment highly influence by the use of SHS. The number of entrepreneurs observed change in the medium of entertainment is small but the role of SHS is for bringing the change is high. Not only the role of SHS for changing investment and profit is a little but also the average change is quite low in monetary value. Those who have used SHS for business purpose (productive use of SHS), they observed high level of change in all change indicators. This study conclude that SHS can enhance the capability to bring change in the MEs by the entrepreneurs but due to the limitation of the SHS and lack of business aptitude of the entrepreneurs, the desired level of change is not happening for the MEs.

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List of Abbreviations

7FYP	Seventh Five Year Plan
AC	Alternating Current
ADB	Asian Development Bank
APCL	Ashuganj Power Station Company Limited
BBS	Bangladesh Bureau of Statistics
BCCTF	Bangladesh Climate Change Trust Fund
BPDB	Bangladesh power Development Board
CPGCL	Coal Power Generation Company Bangladesh Limited
DC	Direct Current
DFID	Department for International Development
EGCB	Electricity Generation Company Bangladesh
FY	Fiscal Year
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Bangladesh
GPOBA	Global Partnership of Output-Based Aid
GS	Grameen Shakti
IDB	Islamic Development Bank
IDCOL	Infrastructure Development Company Limited
IFC	International Finance Corporation
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IRR	Internal rate of return
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
kWh	Kilowatt-hour
LED	Light-emitting Diode
ME	Micro-Enterprise
MSME	Micro, Small and Medium Scale Enterprise
MW	Mega Watt
NGO	Non Governmental Organization

NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NWPGCL	North West Power Generation Company Limited
PO	Partner Organizations
PRA	Participatory Rural Appraisals
PV	Photovoltaic
RE	Renewable Energy
REN21	Renewable Energy Policy Network for the 21st Century
REP	Renewable Energy Policy
RET	Renewable Energy Technology
SFYP	Sixth Five Year Plan
SHS	Solar Home System
SME	Small and Medium Enterprises
SREDA	Sustainable and Renewable Energy Development Authority
TV	Television
UN	United Nations
USAID	United States Agency for International Development
VAT	Value Added Tax
Wp	Watt-peak

Chapter 1
Introduction

1.1 Introduction

Micro, small and medium scale enterprise (MSME)[1] which is usually called small and medium scale enterprises (SME), occupy an important and strategic place in economic growth and equitable development in all countries, especially in the developing countries. A healthy MSME/SME sector contributes prominently to the economy through creating more employment opportunities, generating high production volumes and introducing innovation and entrepreneurship skills (ESCAP 2011). Micro, small and medium scale enterprises are playing increasingly important role as engines of economic growth in most of the developing countries. There are around 90 million micro, small and medium scale enterprises (MSMEs) in developing countries and emerging markets, and the density of formal MSMEs in low and middle income countries is rising (Kushnir et al. 2010). SMEs all over the world have played a fundamental role in promoting economic and industrial production. MSMEs especially the "micro-enterprises" provide the necessary foundations for sustained growth and rising incomes in the less developed and transitional economies. SMEs together make up over 90% of the businesses in the world and account for 50 – 60% of worldwide employment. According to IFC MSME Country Indicators 2013 formal MSMEs generate 35% of employment in upper middle-income countries, 42% in lower middle-income and 34% in low-income countries (Scott et al. 2014). In developing countries, encouragement of an expanded private sector and the creation of local business opportunities is a crucial aspect of economic and industrial growth and the key to successful poverty alleviation activities. However, in the current state of changing times, MSMEs need to adapt themselves to new realities and challenges and to stay competitive. Not only they must add new features to their products, improve performance and reduce prices to remain competitive, but must also innovate to create new products and markets (ESCAP 2011).

Access to energy is widely considered to be vital to the operations of most Micro, Small and Medium Enterprises (usually called MSMEs/SMEs).

[1] There is no universal definition of MSMEs. Most Common definition of micro, small and medium enterprises as follows: micro (1-10 employees), small (10-49 employees), and medium (50-250 employees). But the capital among them defer from country to country.

> *"Energy inputs such as electricity and fuels are essential to generate jobs, industrial activities, transportation, commerce, micro-enterprises and agriculture outputs"* and resolving the energy challenge is recognized as critical for achieving the UN Millennium Development Goals (UN-Energy 2005).

It is well established that there is a close relation between expanding rural energy access and socio-economic development (Srivastava & Rehman 2006; Kanagawa and Nakata 2008). An unreliable electricity supply – electricity insecurity – can affect several aspects of business operations. Inadequate electricity services can constrain business operations because a supply of electricity may simply be unavailable and, if it is available, securing a connection may be difficult and the supply unreliable, even before its cost is considered. High quality and accessible infrastructure encourages productivity, business growth and investment, but when it is poor and unreliable, businesses' productivity and growth suffer. Electricity access and insecurity, as well as cost, are perceived to be significant problems in developing countries, considerably more so than in high income countries. There are several observations that it is a prerequisite for doing business, alongside capital and skills and market access (Scott et al. 2014). So the MSMEs need reliable supply of electricity at a reasonable cost and affordable price. But due to low population density and insufficient number of potential customers, lack of government funds and private investment, it is quite difficult to provide electricity in the un-electrified rural area. Therefore, reliable electrification at low cost through the extension of the central electricity grid will most likely is not feasible to achieve future energy security, so that Renewable Energy Technology (RET) is the most economical option for providing energy to the rural areas (REN21 2008). The role of RETs is crucial to providing reliable, affordable and appropriate energy solution to MSMEs. For developing countries, providing and maintaining energy access is an important driver for off-grid renewable energy systems (IRENA 2013). Answer to the question what is RET, it is defined by Renewable Energy Association (2009) as "'Renewable Energy Technologies (RETs) are energy-providing technologies that utilize energy sources in ways that do not deplete the Earth's natural resources and are as environmentally benign as possible. These sources are sustainable in that they can be managed to ensure they can be used indefinitely without degrading the environment" (cited in Rena 2012). The lack of access to energy services as mentioned has a negative impact on development

especially for business development, as the rural enterprises have limited access to modern energy services. Given the continuously rising energy and commodity demand, prices and security, it is expected that the use of RET to meet the energy security will be more convenient in the future particularly to meet the rural enterprises energy demand as in most of the cases electricity is used for consumptive power by the MSMEs in the rural areas.

Renewable energy technology or RETs need to be effectively tapped by MSMEs, so that they can enhance their competitiveness. The deployment of RETs need to be seen as a process which compliments and is customized to the local requirements of the users such as micro and SMEs, with a view to enhance their competitiveness aspect especially those related to quality, convenience, flexibility, delivery and cost of the product. The technology innovation in the context of MSMEs has to be deployed in a way that enables its business activity to operate efficiently and profitably, while providing equitable opportunities for jobs, and due consideration to gender issues such as inclusive role of women. The technology transfers of RETs to Micro-Enterprises (MEs) will modernized their production system and make them more efficient, make them more profitable and economically competitive (ESCAP 2011).

1.2 Background and Context

Accelerating growth and reducing poverty, income inequality and regional disparity are the overarching goals of the current development paradigm in Bangladesh. The main strategy for achieving these goals include creation of productive employment in the manufacturing and organized service sector and withdrawal of labor force out of the low skilled and low return agricultural sector and informal activities (Bakht & Basher 2015). Because of 131.5 million people of Bangladesh live in rural areas, where almost one third of the total population lives below the poverty line and a significant proportion of them live in extreme poverty, micro-entrepreneurship has been a popular poverty alleviation strategy in Bangladesh for many years (Tushar & Akter 2013).

Since small and micro enterprises make up more than 90 per cent of the number of enterprises and employ about three-fourth of its labor force, including manufacturing, trade and service sectors, this sector can play the pivotal role in achieving targets set in Vision 2021 of Bangladesh (BBS 2013). The Sixth Five Year Plan (SFYP) of Bangladesh lays out the roadmap of small and medium enterprise (SME) sector to achieve higher

equitable growth to fulfill the vision of elevating the country to the middle-income group by the end of 2021. Development of MSME is envisaged as a key element in this development strategy. For achieving double digit growth, matching development of MSMEs is considered critical. Enhanced MSME activities in the rural and backward regions constitute a key component of the strategy for rural development and reduction of poverty and regional disparity (GoB 2011). In Bangladesh, the nature and growth of MSMEs over the last two decades indicate a horizontal expansion of enterprises in terms of increasing the number of establishments without major change in the pyramid-like structure. In 1986, total number of enterprises was 2.6 million of which 2.5 million were MEs (98 per cent); whereas SMEs were 49,000 (1.9 per cent) and large enterprises were 2300 (0.08 per cent). In 2002, the structure and composition of enterprises were remained almost the same - out of 3.5 million enterprises, 97 per cent were micro, 2.2 per cent were SMEs and 0.16 were large enterprises (Moazzem 2011).

The major sources of rural income are agricultural production and wage, retail/whole trade, rural transport, microenterprises of various types, and remittances (domestic and international). In Bangladesh a country wide survey [by ICG/MIDAS in 2003] of micro, small and medium enterprises (MSMEs), including those with up to 100 workers, shows there are a total of approx six million such enterprises and about three-quarters of all MSMEs contribute half or more of the household income in both urban and rural areas and over three-quarters of all MSMEs are located in rural areas (Alamgir 2010).

Bangladesh Bureau of Statistics (BBS) carried out the third Economic Census of the country during March – May 2013. Like the previous two censuses in 1986 and in 2001 & 2003, the Economic Census 2013 attempted a 100% count of all economic units in the country outside household based agriculture. The full set of data collected through the Census is yet to be processed and published. Preliminary results from the Economic Census 2013 are presented in Table 1.1. Based on the Preliminary result of the Economic Census 2013, it can be affirmed that the nonfarm economic units are dominated. Thus, nearly 97% of all nonfarm economic units in 2013 had less than 10 workers, compared to manufacturing, *trade and service* activities have a higher incidence of units with less than 10 workers (BBS 2013). Similarly, rural units as opposed to urban units have higher incidence of units with less than 10 workers (Bakht & Basher 2015).

Table 1.1: Number of Nonfarm Economic Units in the Three Economic Censuses

Description	*1986*	*2001/03*	*2013*
Total number of economic units (000)	2169	3708	7950
Inter-census yearly compound growth in total number of economic units (%)	-	3.4	7.2
Number of trade and other service units (000)	1638	3218	7081
Share of trade and other service units in total number of units (%)	75.5	86.8	89.1
Inter-census yearly compound growth in the number of trade and other service units (%)	-	4.0	7.4
Number of rural units (000)	1379	2369	5742
Share of rural in total number of units (%)	63.6	63.9	72.2
Inter-census yearly compound growth in the number of rural units (%)	-	3.4	8.4
Number of urban units (000)	790	1339	2208
Share of urban units in total number of units (%)	36.4	36.1	27.8

(Source: Bakht & Basher 2015).

Deficient physical infrastructure and utility services constitutes one of the major impediments to MSME development in Bangladesh. It is widely acknowledged that greater investment and/or better performance from existing infrastructure facilities and utility services would have high returns in terms of reduced costs of doing business. In an earlier perception survey of sample entrepreneurs by ICG/MIDAS in 2003, it was found that the respondents considered electricity to be the most serious structural bottleneck encountered by them and lack of access to gas and electricity constitute the binding constraint to decentralized growth of private investment, particularly of MSMEs (Bakht & Basher 2015). The key challenges in rural non-farm activities include lack of access to credit, market and electricity and lack of education and training of entrepreneurs (NSDS, 2013). The quality of Bangladesh's electricity supply ranks 124th out of 144 countries in the World Economic Forum's Global Competitiveness Report 2014-2015 (Sala-I-Martín et al. 2015), and 125th out of 129 countries for energy security in the World Energy Council's Energy Sustainability Index (Oliver 2014).

In developing countries like Bangladesh solar power offers an effective solution to the problem of energy access. To meet the power demand, both the developed and

developing countries take grid extension as the mean but the rapid reduction of the cost of photovoltaic solar power generation and increasing technology development, solar photovoltaic power generating system (e.g. Solar Home System (SHS), Solar thermal etc.) is now becoming popular all over the world especially in the developing countries like Bangladesh. There is tremendous potential for renewable energy technologies to provide energy services in off-grid areas of Bangladesh (Eusuf (ed.) 2005; A.K.M. Islam et al. 2005; M.R. Islam et al. 2006; M.A.H. Mondal et al. 2010). Sadeque et al. (2014) have thoroughly documented the Solar Photovoltaic (PV) program in Bangladesh, considered to be the largest off-grid program in the world, and have highlighted that the program has achieved success due to leveraging of an extensive micro-finance institution network, high population density thereby ensuring economics of scale, a competent and passionate local champion (Infrastructure Development Company of Bangladesh) as the nodal implementing agency, affordable financing and strong emphasis on quality of the systems.

Bangladesh Government has a vision to electrify entire country by the end of year 2020. SHS is an alternative to grid connection for supply of energy in rural and isolated areas. Solar PV based electricity generation systems provide a good prospect to supply electricity for rural areas in Bangladesh. Solar PV systems can contribute to poverty alleviation and socio-economic development of remote rural areas (Chakrabarty & Islam 2011). The last 14 years of data shows that both rural and urban people prefer SHS as an effective alternative in providing energy for homes and businesses (Khan et al. 2012). The main use of SHS is to provide access to electricity for people in remote and rural areas, who are not usually connected to the national grid, replacing kerosene lighting and battery-supported electricity supply.

In Bangladesh, photovoltaic (PV) technology in the form of solar home systems (SHS) has been widely applied for rural electrification purposes (Sharif & Mithila 2013). In addition to lighting, SHS supply power for small electrical appliances such as radios, cassette players, mobile chargers and TVs. In Bangladesh, as SHS becomes a popular electrification tool in rural areas, several indicators have been used as evaluation tools for off-grid households and enterprises electrification with SHS, such as number of SHS installed, percentage of installed SHS currently operating, technological transfer to the enterprises involved, and the creation of markets for SHS and their accessories.

Moreover, user satisfaction is widely applied as an evaluation tool for those who have received electricity from SHS (Komatsu et al. 2013).

Barua (2001) claimed that Renewable Energy (RE), for example, SHS in Bangladesh, can benefit living, help to preserve fossil fuels and to alleviate poverty by providing income generation opportunities while women welfare, children's education and so on may also be improved. As a result, many NGOs and private organizations have emerged as a pioneer for providing SHS in rural Bangladesh with technical assistance from Infrastructure Development Company Limited (IDCOL). Every month on an average 30,000 SHSs are being installed in rural Bangladesh, enhancing the energy access at the rate of 3.5% (World Bank, 2011). With 52 partner organizations (POs), IDCOL has provided electricity to 200,000 people per month by installing 50,000 SHSs every month, adding 2.0 MW to national electricity generation (IDCOL 2015a). Up to September, 2015, IDCOL has installed a total of 3,840,593 SHSs all over Bangladesh. SHSs are becoming the most popular technology among the available renewable technologies practice in Bangladesh especially in rural and coastal areas. Most of the rural and coastal people in the country have no electricity access. Consequently, SHSs may be an effective option for off grid electrification of those areas (Halder et al. 2013).

1.3 Statement of the Problem

The dynamic role of micro and small-scale enterprises (MSEs) in developing countries as "necessary engines for achieving national development goals such as economic growth, poverty alleviation, employment and wealth creation, leading to a more equitable distribution of income and increased productivity is widely recognized' (William & Webster 1992). When treating end-users in the rural areas of developing countries with respect for their capacity to make their own investment choices and to define themselves what is best for them, the question is inherently answered.

The World Bank Enterprise Surveys show that firms in middle and lower income countries consider electricity access one of the biggest constraints to their business , with constraints stemming from inadequacies in aspects of electricity service (access to electricity, availability of electricity, and reliability of supply), as well as cost. Electricity insecurity has impacts on numerous aspects of business operations (Scott et al. 2014).

Moreover, there is a very little understanding of the linkages between uses and impact of electricity services and micro enterprises establishment, survival, expansion, growth, decline and closure in rural areas in developing countries in general. In addition, there are very few studies, which concretely assessed the actual impact of grid electricity services upon Micro-Enterprise (ME) development in the rural areas of the developing world.

It is argued that the key driver to the interest in disseminating PV technology in the developing world especially in Bangladesh is a preoccupation with electricity. For instance, a number of multilateral agencies, Government of Bangladesh (GoB) and non government organizations (NGOs) have actively supported various initiatives to promote the dissemination of PV technologies in rural communities of Bangladesh. The implementation measures for these initiatives and the question of whether they are having the desired effects on the rural populations in the developing world (especially solar PV) are issues worthy of detailed critical scrutiny. Electrification program are often justified by the socio-economic befit resulting from productive use of energy such as increase in income and creation of new employment (Attigah 2015).

Not all enterprises are able to use SHS for increasing productivity. So lacking reliable data and information about significant positive role of SHS on MEs may limit the room for entrepreneurs to choose this type of modern energy for productive activities. Furthermore, this lack of data and information on the linkages between SHS and MEs development may have effects on national policy strategies to combat poverty as most of poor people in the rural areas depend on MEs for their income generation beside agriculture.

Most of the previous study in this field is based on qualitative data. A mix of qualitative and quantitative method is highly needed to find the causal relation between the development of MEs and use of SHS. In Bangladesh, further research is needed in order to get insight of the changes brought within MEs and between different MEs by up taking SHS; who is affected by these changes and why that category of people; to identify barriers and constraints ME's are facing in accessing and using electricity services.

1.4 Research Objective

This research would examine whether the rural entrepreneurs in Bangladesh are observing any changes due to introduction of SHS in their enterprises and it will also try to find out whether SHS is enhancing their ability to bring about changes in their enterprise.

In line with the above stated circumstances this research has set the specific objectives to study the role of SHS uses for ME development in rural off grid areas in Bangladesh, and to study the changes brought to rural ME by up taking SHS, if any.

1.5 Research Questions

To address the research objectives, the study will attempt to find the answers of the following research questions.

1. What are the services that the MEs in Bangladesh are getting from SHS?
2. To what extent these services are helping to bring about changes in their business?

1.6 Scope and Limitations of the Study

This study has examined the role of SHS on trade and service related rural MEs in off grid area of Durgapur, Netrokona of Bangladesh only. Other renewable energy technologies (RET) and other types of micro-enterprises in the study area are kept out of the scope of this study.

All the aspects of change in MEs of a particular area under any single technological intervention as such, quite impossible to determine and measure in a short period of time. The change usually has taken place for a long period of time under the influence of many interventions.

The reviewed literature was in line with the scope of the research. At the time of drawing of analytical framework, and when the data is presented and analyzed the scope and limitation is always kept in mind.

1.7 Significance and Rationale of the study

Rural electrification is a very important process to provide access to modern energy, especially to the poor people in developing countries like Bangladesh. Rural

electrification programs in Bangladesh focus on providing development assistance through the supply of electricity services to stimulate economic productivity and enhance the quality of life in rural areas. Energy for rural development in developing countries has been an issue of national interest for some time, receiving significant attention in most developing countries during the last three decades of the twentieth century. Three main options have been considered to steer the electrification drive for rural areas (Bawakyillenuo 2007). The first is centralized electrification, consisting of an extension of the domestic electricity network; another is the decentralized local grid powered for instance, by diesel or small hydro plants. The third is electrification without grids, which includes stand alone systems such as photovoltaic (PV) Solar Home Systems (SHSs).

In recent times, however, considerable advocacy has taken place in the academic and policy studies, and national agenda about solar PV energy technology serving as a panacea to the energy problems and rural electrification of rural populations of remote and isolated rural areas of Bangladesh. Notwithstanding this great advocacy, the literature on the dissemination of the SHS for rural ME is not well discussed and documented.

Most of the rural electrification with the help of SHS at present is confined to measure only quantifiable variables, such as the number of consumer electrified. Moreover impact of electrification on rural MSMEs especially on the ME operation also seldom evaluated, though there are many study regarding introduction of SHS in the household of Bangladesh. This study will mitigate that gap.

This study adopts mixed method to gauge the role of SHS uses in micro enterprise. The result of the study is expected to enhance policy and planning efforts of government and NGOs to use the SHS as a strong instrument for micro enterprise development.

The outcome of this research would lead to better understanding on the role of RET for rural empowerment, for income generating opportunities, and finally contribute to poverty reduction. This is possible because the linkages between electricity services from SHS and ME development in rural areas would has clearly stated and those could be used to understand the influence of SHS for ME development in the rural areas.

1.8 Operational Definition of the Two Core Concept

SMEs/MSMEs: There is no uniform definition of SMEs/MSMEs. This research has used the following definition which is given in Table 1.2.

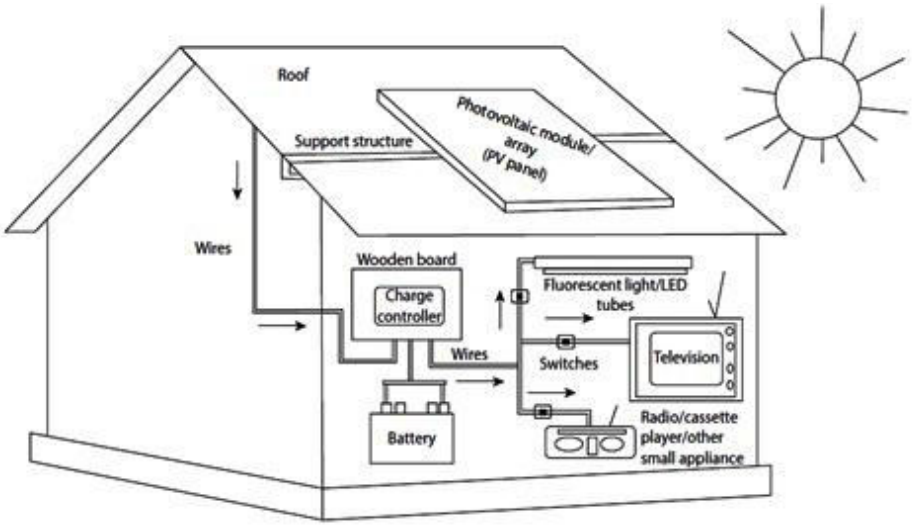
Table 1.2: Definition of SMEs/MSMEs

Sector	Total Fixed Assets excluding land and building (Tk million)	Labor Employment
Medium industry/ enterprise		
Manufacturing	100.0 - 300.0	100 - 250
Service/ Trading	10.0 - 150.0	50 - 100
Small enterprise		
Manufacturing	5.0 - 100.0	25 - 99
Service/ Trading	0.5 - 10.0	10 - 25
Micro enterprise		
Manufacturing	0.5 - 5.0	10 - 24
Service/ Trading	≤ 0.5	≤ 10

Source: (BB 2013)

Solar Home System: A SHS incorporates a photovoltaic solar panel, a rechargeable battery, a charge controller and in most cases electric lights and possibly other electronic devices. Solar panel converts sunlight into electricity through photovoltaic process and stored rechargeable battery. Finally, the electricity is supplied to the DC (Direct Current) load or AC (Alternating Current) load by converting as consumer's requirement (Lysen 2012). Figure 1.1 shows the picture of a typical solar home system. Owning an SHS enables users to produce their own electricity, and accessing requested services like electric lighting, mobile charging and other usage like to run Television (TV), fan etc.

Figure 1.1: Solar Home System



(Source: Khandker et al. 2014)

The power of the panel can range from 10 Wp to 130 Wp, where Wp [watt-peak] denotes the power generated under conditions equivalent to bright sun in the tropics. The use of these applications is considered to be an important solution to rural electrification and rural development (Khandker et al. 2014).

1.9 Outline of the Chapters

This thesis is composed of seven chapters which are presented below:

Chapter One: Introductory Discussion- It gives an overview of the discussion that deals with background, research problem, significance of the study, research questions, research objectives, scope and limitation of the study and structure of the thesis.

Chapter Two: Current State of Renewable Energy Development in Bangladesh- Overview of the current RE development in Bangladesh is discussed in this chapter. In addition, this chapter describes the current state of power generation in Bangladesh, Renewable Energy Policy 2008 of Bangladesh and the role of IDCOL for RE development in Bangladesh with latest data in contrast to solar technology (namely SHS and solar irrigation).

Chapter Three: Literature Review, Theoretical concept and Analytical Framework- In this chapter some relevant and available literatures has reviewed,

applicable theory has discussed, and identifies related variables from literature review and theory. This chapter explains the experience of SHS usage in MEs and provides logical arguments for identifying those variables, and finally draws an analytical framework for this study on the basis of the grounded reality of the issue.

Chapter Four: Methodology- It makes an attempt to employ various methodological approaches used in this study. It also discusses reasons for use of various methodological approaches, how such approaches were justified over others, and how these were incorporated in this study.

Chapter Five: Data Presentation, Analysis and Discussion - Data collected from the field through questionnaire survey, observation and in-depth interviews are briefly presented in first sections of this chapter. This chapter highlights the major findings of the study. It also establishes a link between primary data and information drawn from all sources to address the research questions to meet the research objectives in the study. In this connection it also discusses applicability of analytical framework compare with the previous relevant literature in explaining the research questions and objectives of the study and to what extent can findings are generalized.

Chapter Six: Conclusion- This chapter draws major findings of the research and makes concluding remarks of the study, policy consideration, recommendations and how this study can be implicated for further research.

Chapter 2

Current State of Renewable Energy Development in Bangladesh

2.1 Introduction

Energy is considered as one of the basic ingredients for alleviating poverty and expediting socioeconomic development. One of the main goals of the Government of Bangladesh (GoB) is to bring the entire country under electricity service by the year 2020, which is stated in VISION 2021. It is also a constitutional mandate as stated in the Article 16 in "The Constitution of the People's Republic of Bangladesh":

> "The State shall adopt effective measures to bring about a radical transformation in the rural areas through the promotion of an agricultural revolution, *the provision of rural electrification*, the development of cottage and other industries, and the improvement of education, communications and public health, in those areas, so as progressively to *remove the disparity in the standards of living between the urban and the rural areas*".

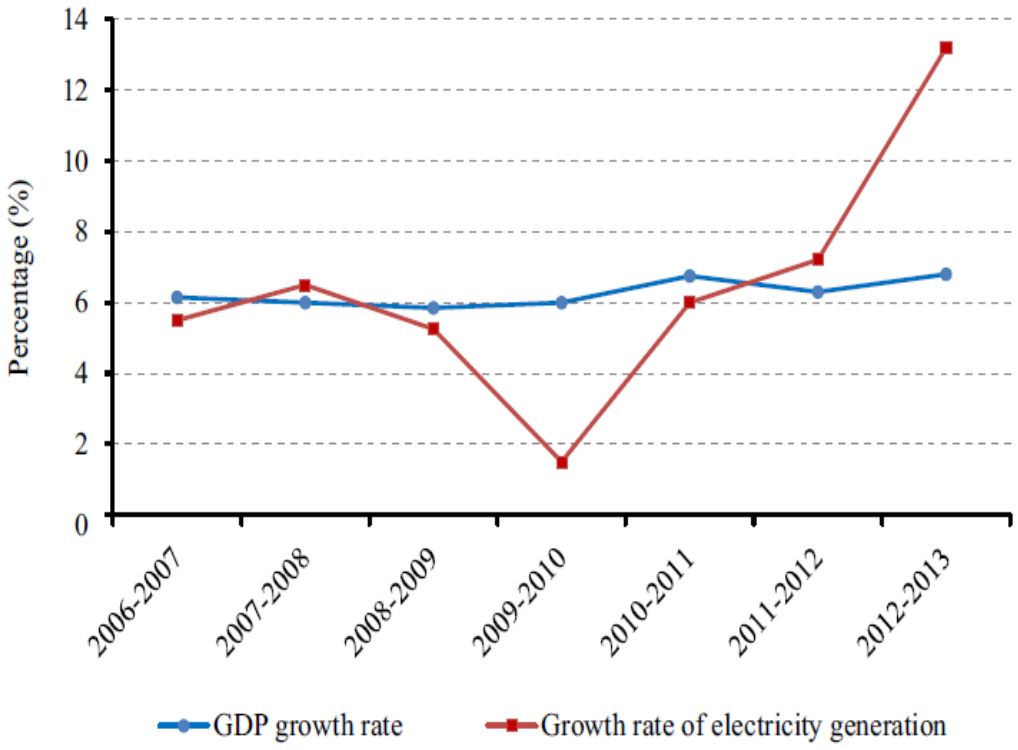
At present the national grid is serving 72 percent of Bangladesh total population and it is interrupted by power cut (7FYP 2015). The situation gets worse in the time of irrigation season. In comparison, only 62 percent of Bangladesh's population had access to electricity in 2013, with a wide disparity between urban areas (90 percent) and rural areas (43 percent), and about 13 million rural households without electricity (NSDSP 2013). Even those with access to electricity routinely experience supply disruptions. The dispersed nature of rural settlements, especially in the delta and hilly regions make the extension of the electricity grid to these areas difficult and expensive. Moreover, the existing sources of power are non-renewable. Bangladesh's energy infrastructure is quite small, insufficient and poorly managed (Uddin et al. 2014). The energy prospect is generally assessed on the basis of available commercial sources of energy i.e., fossil fuel-like gas, coal, oil etc.

2.2 Current State of Power Generation of Bangladesh

Electricity is a typical form of energy and considered as the most critical input for the technological, industrial, and economic development. Almost 41.1million people live

below the poverty line in the country. In a typical developing economy a one percent increase in GDP leads to 1.5 percent increase in electricity demand (NSDP 2013). This implies an average 6 percent growth would require more than 9 percent growth in electricity supply. In Figure 2.1 the GDP growth rate and electricity generation growth of Bangladesh is presented. From Figure 2.1, it can be shown that the growth rate of electricity generation has increased to 13.2% in the fiscal year 2012-2013, which was 5.5% in the fiscal year 2006–2007. On the other hand, the GDP growth rate was 6.15% in the fiscal year 2006–2007 which has increased to 6.8% in the fiscal year 2012–2013 (Halder et al. 2015).

Figure 2.1: GDP growth rate and electricity generation growth of Bangladesh



Source: Halder et al. 2015

In Bangladesh, the electricity generation is highly dependent on fossil fuel especially on natural gas. Up to October 2015, total installed capacity is about 11,877MW including 6,365MW (54%) from public sector and 5,512MW (46%) from private sector, where only natural gas accounts for 62.59% raw material for the power production (BPDB 2015a). About 89% of power previously comes from natural gas and the rest is from liquid fuel, coal and hydropower (Power Division 2015a). Table 2.1 presents Current power generation mix with installed electricity capacity in Bangladesh.

Table 2.1: Installed Capacity of BPDB Power Plants as on November 2015

Fuel Type	Capacity(Unit)		Total (%)
Coal	250.00	MW	2.1 %
Gas	7434.00	MW	62.59 %
HFO (Heavy Fuel Oil)	2507.00	MW	21.11 %
HSD (Hybrid Synergy Drive)	956.00	MW	8.05 %
Hydro	230.00	MW	1.94 %
Imported	500.00	MW	4.21 %
Total	11877.00	MW	100 %

(Source: BPDB 2015a)

The demand of electricity increased proportionally with economic growth, rapid urbanization, and industrial development of the country. The population's access to electricity increased from the FY2010 baseline of 48% to 74% in FY2015. The other target indicator, per capita electricity generation, also increased from 220 kWh to 371 kWh (7FYP 2015), which is very low compared to other developing countries. GoB has taken rigorous initiatives implementing various policies and programs towards achieving target of per capita electricity consumption 600 kWh by 2020 (Halder et al. 2015).

As the reserve of natural gas is not unlimited and depleting gradually, the actual scenario of power generation has changed. To tackle the uncertainty and reduction of carbon emission, to uphold climate change and sustainable development government has prepared "Power System Master Plan 2010" to build up energy balanced sustainable power system in the country. The GoB has planned to diversify the power generation fuel mix. Renewable energy development is one of the important strategies of the fuel diversification program (Power Division 2015a). According to the plan 15% of total electricity generation will come from renewable and new energy sources by 2020. Renewable energy is a challenge, but also an opportunity for new industries, employment, and new ways to reduce dependency on fuel imports, provide electricity to poor remote areas, reduce air pollution, and provide a healthier environment.

The GoB has taken a number of actions on priority basis to promote production and use of renewable energy in different areas of the country. There has been some progress in expanding use of solar power for domestic purposes especially in off-grid areas. Irrigation pump driven by solar power, solar mini-grids in the distant islands, solar panel assembly plants and telecommunication towers driven by solar power have been installed.

2.3 Renewable Energy Expansion Initiative

Due to the high initial cost commercial use of renewable energy in sustainable manner is still a great challenge for Bangladesh like other part of the world. For a sustainable development of the renewable energy sector GoB has adopted a systematic approach. The initiative includes development of awareness, legal and regulatory framework, institutional development and financing mechanism to drive the sector.

2.3.1 Renewable Energy Policy

Renewable Energy Policy has been approved in 2008. Through this policy the government is committed to facilitate both public and private sector investment in renewable energy projects to substitute indigenous non- renewable energy supplies and scale up contributions of existing renewable energy based electricity productions. The Policy envisions 5% of total generation from renewable sources by 2015 and 10% of the same by 2020. The core objectives of the REP-2008 are

- Harness Renewable Energy Potential & Dissemination throughout the country
- Enable, Encourage & Facilitate Public & Private Sector Renewable Energy development
- Scale up Renewable Energy for Electricity & Heat Energy
- Promote Appropriate, Efficient & Environment Friendly use of Renewable Energy
- Develop Capacity at every level of Renewable Energy development.

By analyzing the REP-2008 it is found that the target for renewable energy development is specifically set in the policy which is 5% of total generation from renewable sources by 2015 and 10% of the same by 2020. The policy did not give any specific direction or discussion about the Feed-in tariff / premium payment, electric utility quota, net metering, bio-fuels obligation/ mandate, heat obligation/ mandate which needed government regulatory action. But the GoB has expressed his support for fiscal incentive in favor of the renewable energy development investors. According to the policy the incentives are given to the privet investors are given below:

- All renewable energy equipments and related raw materials in producing renewable energy equipments is exempted from charging 15% VAT.

- Renewable energy project investor both in public and private sectors is exempted from corporate income tax for a period of 5 year.
- An incentive tariff is considered for electricity generated from renewable energy sources which is higher than the highest purchase price of electricity by the utility from private generators.

REP-2008 is a guideline how and to what extent RE energy contributes in the total fuel mix. But there was no guideline how fiscal incentives will be provided for renewable energy development. In ever-changing world nothing remain constant, situation and context also change. As time passes limitation come out into daylight. By considering the limitation, the GoB is upgrading the REP-208, though it is yet to publish. It's hoped that the limitation of the current REP-2008 will be overcome by the new renewable energy policy.

2.3.2 Current Contribution and Future Plan of Renewable Energy Development in the Power Sector

Bangladesh is a densely populated country. The electricity coverage and production capacity to meet the demand is also not in a global standard. The power generation is also mono fuel dependent. The share of natural gas for power production is currently 63 percent. To reduce dependency over the mono fuel, the share of renewable energy in the power generation need to increase. The current share renewable energy is 403.6MW which is 3.6 percent of the total power generation (SREDA 2015). If the energy produced by Kaptai Hydro-electric power plant is deducted, the rest of the power is coming from the Solar PV system of which are most of are from off-grid. The share of grid connected renewable energy is very small.

To achieve the renewable energy generation target which stated in the REP-2008, the priority should be given to the solar power generation conceding the landscape and weather. For this the government already has taken "500MW Solar Power Programme" which started in 2012 and will end at 2016. From the "500MW Solar Programme" it is found that the projects are categorized in two types: Commercial Projects and Social Sector Projects according to the project financing, implementation approach and modus operandi (Power Division 2013). Privet sector will implement, operate and maintain commercial projects. While the government will be implement the social project by the

different ministries and agencies as a part of social responsibilities. Table 2.2 presents the share of commercial and social projects which is given below.

Table 2.2: Project under "500MW Solar Power Programme"

	Type of Projects		Capacity (MW)
Commercial projects	Solar Irrigation		150
	Solar Mini Grid		25
	Solar Park		135
	Solar Rooftop	Residential and Commercial Building	10
		Industrial Building	20
Social projects	Solar electrification in Health Centers		50
	Solar electrification in Remote Educational Institutions		40
	Solar electrification at Union e-Centers		07
	Solar electrification in Religious Establishment		12
	Solar electrification at Remote Railway Stations		10
	Solar PV System in Government and Semi- Government Offices		41
Total			500

(Source: Power Division 2013)

It has been found that the "500MW Solar Power Programme" of the GoB is in initial stage and yet to implement. The GoB has already approved and implementing handful number of solar power development program. Some privet investments on solar and wind power generation proposals are also approved by the GoB and some are placed for approval. GoB have set target for the organization under the control of Power Division to achieve the REP-2008 target about renewable energy development, those targets are presented in Table 2.3.

Table 2.3: Target for RE development of different government organization

Name of the Organization	Solar Power (MW)	Wind Power (MW)
BPDB	100	100
APCL	100	100
EGCB	100	100
NWPGCL	55	100
CPGL	50	100

(Source: Power Division 2015b)

The GoB has already launched a number of projects for renewable energy development. The projects are mainly grid tied solar technology based, the other form of

technology like wind and biomass are small in number and capacity. Off grid technology are mainly handled by IDCOL through IDCOL SHS program. About 1000MW power generation plan from RE is on the pipeline. The summery of the approved renewable energy development project by GoB is listed in Table 2.4. Full description of the projects is presented in *Appendix I.*

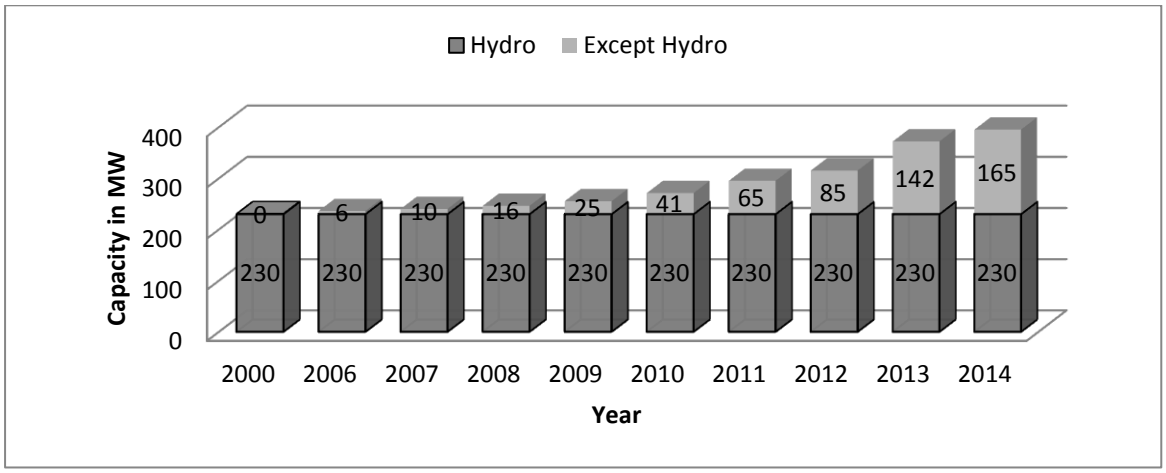
Table 2.4: Approved Renewable Energy Projects

Technology	Description	Financing Organization
Solar Park (Grid Tied)	Total Capacity of 824.6MW	ADB, IPP, GoB
Solar Park (Mini Grid)	Two project of 650kW and 36kW	BCCTF, ADB
Solar Irrigation	500 Pump on pilot basis	GoB, ADB
Solar Home System	2 million SHS	IDCOL
Solar Roof-Top	2 project (In Dhaka)	GoB
Solar Street Lighting	8400Set in 8City Corporation	ADB
Wind	One project of 60MW	IPP
Municipality Waste Power	5-7MW	GoB
Hybrid Power (Solar-wind)	Hybrid Power Project of 18MW	IPP
Wind Power (Wind Resource Mapping)	Technical Assistant Project for Wind Resource Mapping	USAID ,NREL

(Source: Power Division 2015b)

The data presented in the Table 2.2, Table 2.3 and Table 2.4 is not fully operationalized. The GoB has taken a lot of action to increase the share of RE in the power generation mix. But still the GoB is lag behind from the target. The RE development program started from 1996 by Grameen Shakti a sister concern of Grameen Bank. IDCOL started its SHS program from 2003. With the collaboration of the public and privet sector the RE development is going on. The growth of renewable energy in Bangladesh over the year is presented in the figure 2.2.

Figure 2.2: Year wise total Production of renewable energy



(Source: IRENA 2015)

From the Figure 2.2 it is evident that the development of renewable energy in Bangladesh is not that much notable if the capacity of Kaptai Hydro power plant is left out from the calculation. The share of other renewable energy except hydro is increasing but not in such pace which will lead to achieve the REP-2008 target. The share of solar, wind and biogas was 165MW which has reached to 173.4MW in 2015 by increasing only 8.4MW. The share of deferent type of renewable energy is given in the Table 2.5.

Table 2.5: Current contribution of renewable energy

Technology	Off-Grid (MW)	On-Grid (MW)	Total (MW)
Solar PV	165	0.5	165.5
Wind	1	0.9	1.9
Hydro	-	230	230
Biogas	6	-	6
Grand Total	172	231.5	403.4

(Source: SREDA 2015)

It is seen that 87 percent of solar power generation is from SHS. The share of different type of solar technology for solar power generation is presented in the Table 2.6.

Table 2.6: The share of different type of solar technology

Technology	Capacity (MW)	Percentage
Solar Home System (SHS)	143.67	86.81
Solar Irrigation	1.56	0.94
Roof-top Solar System (In Residential Building)	13.42	8.11
Roof-top Solar System (In Office Building)	6.2	3.75
Solar Mini Grid	0.641	0.39
Total	165.6	100

(Source: SREDA 2015)

2.4 Function and Role of Infrastructure Development Company Limited's (IDCOL)[2]

The major share in off-grid rural electrification has been achieved by installing SHSs (Solar Home Systems). Other types of off-grid electricity include a solar photovoltaic mini grid, a bio-digester, a small wind generator, and micro-hydro electricity. Renewable energy technologies other than SHS have not yet been widely accepted on the market and their contribution to rural electrification has not been remarkable. The IDCOL has been strongly promoting the dissemination of SHS since 2003. Infrastructure Development Company Limited (IDCOL) was established on May 14, 1997 by the Government of Bangladesh (GoB). The Company was licensed by Bangladesh Bank as a Non-Bank Financial Institution (NBFI) on January 5, 1998. Since its inception, IDCOL is playing a major role in bridging the financing gap for developing medium and large-scale infrastructure and renewable energy projects in Bangladesh. After a decade, the company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh. Commercial and developmental benefits are the main driver for IDCOL to start investing in renewable projects. IDCOL tried to achieve countrywide goals of rural electrification and meet the energy demand of the country as it is a government-owned financial institution. When IDCOL has started its SHS program 60% of the country was out of the grid area. Large off-grid market for solar energy and keenness of the donor to fund the SHS program are the commercial driver. Instead of giving high subsidy to the extension of the grid which will benefit small number of people the government decided to direct its subsidies to small-scale infrastructure so that it could reach the maximum number of people. IDCOL initially received refinancing and grant support from the World Bank and Global Environment Facility (GEF), respectively. Later on, GIZ, KfW, ADB, IDB, GPOBA, JICA, USAID and DFID came forward with additional financial and technical assistance for expansion of its SHS Program.

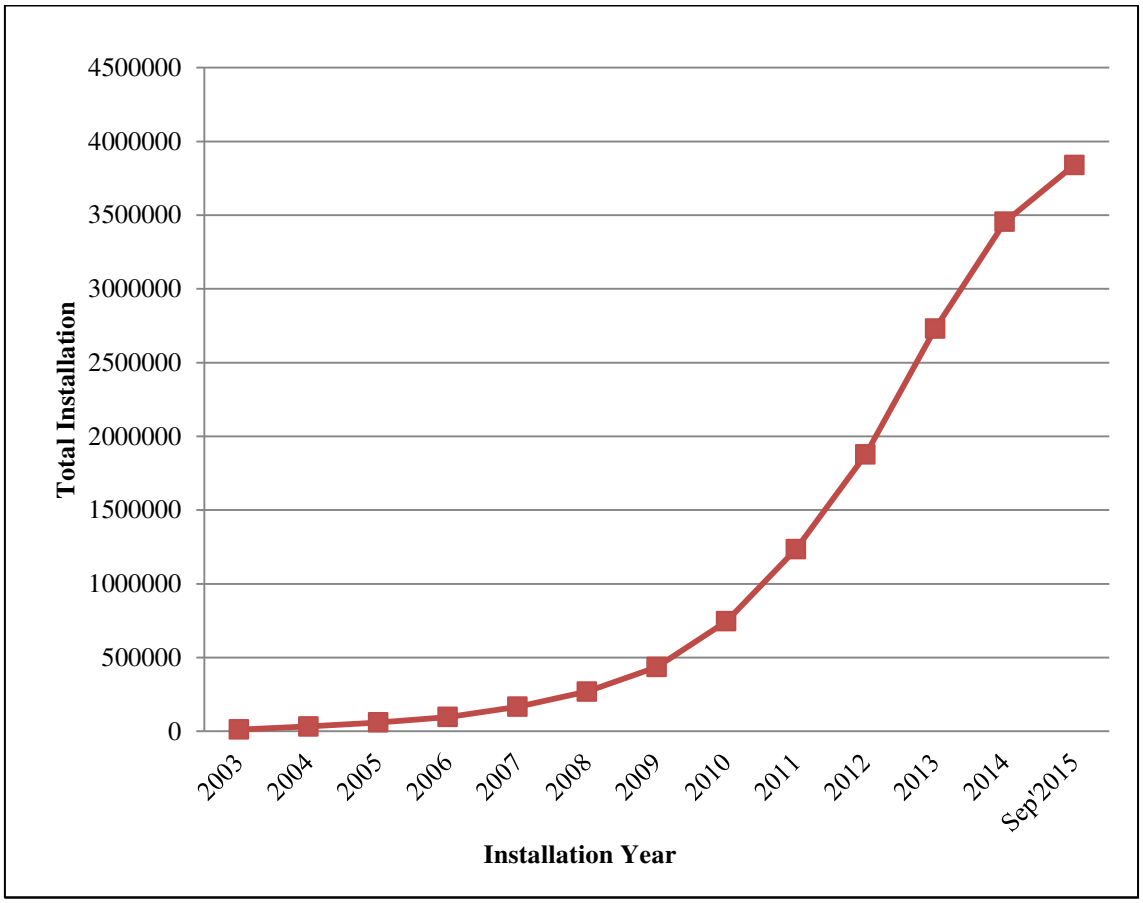
2.4.1 IDCOL SHS program

IDCOL with the support from 58 Partner Organizations (NGO/MFI and Private Entities in listed and approved by IDCOL) has been implementing the program since 2003. Till September 2015, over 3.84 million SHSs have been installed all over Bangladesh, which has ensured access to electricity for 16 million households/businesses.

[2] The information used in this section is collected from IDCOL through personal communication and by acquiring different seminar presentation of the IDCOL official at different official presentation.

Average year to year installation growth of the program up to 2013 was 56%. However, installation in 2014 has declined by 15%. IDCOL has a target to install 6 million SHS by 2018. Year-wise installation of SHS since inception of the program is presented in Figure 2.3, as well as projection is given in Table 2.7.

Figure 2.3: SHS installation growth over the years of IDCOL



(Source: IDCOL 2015a)

Table 2.7: Year-wise installation of SHS by IDCOL

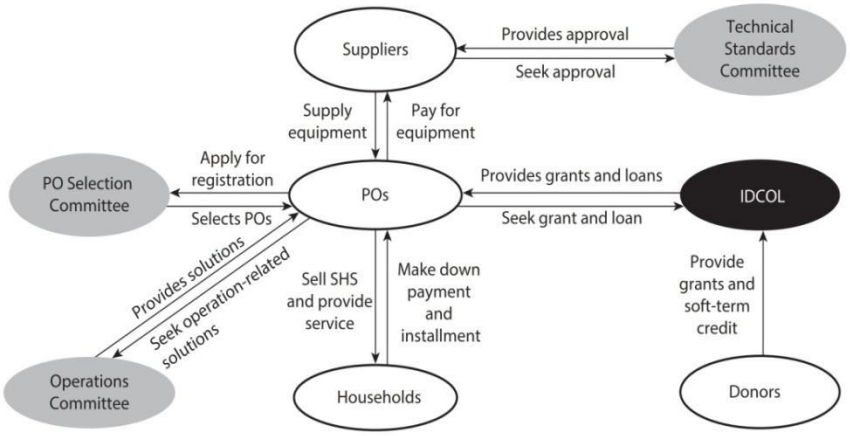
	Installation Up to Sep'15	Installation 2015	Installation 2016	Installation 2017	Installation 2018
Yearly Installation		150,000	660,000	660,000	689,407
Cumulative Installation	3,840,593	3,990,593	4,650,593	5,310,593	6,000,000

(Source: IDCOL 2015a)

IDCOL has been working as a market-oriented finance and training facilitator and has implemented and been overseeing the program through 58 Partner Organizations (POs). The POs are mostly nongovernment organizations (NGOs) and they physically

bring the materials and services to the clients' premises. IDCOL arranges the following support services: Selection of POs, preparation of technical specification for the materials, selection of suppliers, capacity building training for the POs, and monitoring the performance of the POs (Figure 2.4).

Figure 2.4: SHS program Structure of IDCOL



(Source: Kahndker et al. 2014)

IDCOL has developed an innovative, partially subsidized SHS delivery and financing scheme, which has proven quite effective in reaching its clientele base. To keep system prices affordable and ensure sustainability beyond the program intervention, IDCOL provides the POs with capital buy-down grants; through market competition, the grants are passed on to household buyers in the form of a lower unit price. Buyers also are offered microcredit financing to make SHS affordable. These incentives work together to create a robust and regulated rural market chain that ensures quality products that meet safety standards and repair and maintenance facilities with locally available spare parts (Kahndker et al. 2014).

2.4.1.1 Delivery and Financing Scheme of IDCOL SHS program

IDCOL receives equity funds from the government, and grants and loans from multiple donor agencies for off-grid program. The IDCOL provides soft loans (at a 6% to 9% interest rate with a 0.5 year or 1 year grace period and a 5 year to 7 year maturity period) to the POs and channels grants to reduce the cost of systems as well as to support the institutional development of the POs. IDCOL also provides highest 80% of the loan extended by the PO to the customer as refinancing (US$130 per system/household). In addition, IDCOL provides the POs several direct incentives that encourage them to lower

the unit price to the extent possible. Two types of grants are provided1: (a) buydown grants to reduce household-level costs and promote systems in remote areas and (b) institutional development grants to build capacity of the smaller POs. Initially, grant amounts were as high as 25% of the SHS cost. Now, it has come down to less that 10% of SHS cost. IDCOL is now providing Buy-down grant only. From 2013, this grant is only available for smaller sized SHSs (<=30Wp).

2.4.1.2 Microcredit Financing for SHS Dissemination

A vital factor contributing to the success of IDCOL's operation is its microcredit financing mechanism (Siegel and Rahman 2011). For example, a 50 Wp SHS typically costs a household about tk 27100 (340$), a bulk sum in rural Bangladesh. To make the system affordable, IDCOL requires households to make a 10 percent down payment to the POs and spread installment payments, at a flat 9 percent to 12 percent interest rate, over one to three years. Once the down payment is received, the POs enter into a sales/lease agreement for microcredit lending with the buyers, the provisions of which are approved by IDCOL. The POs also make a sales agreement with suppliers to get the SHS units and necessary parts and accessories on credit. Typical cost of different sizes of SHS as an example is listed in the Table 2.8 below which are offered to the SHS buyer. With every package some additional connection is given for mobile charging, to run a small DC fan or some other small power electrical equipment within the SHS capacity.

Table 2.8: SHS price list of different system capacity

System Capacity (Watt)	Loads that can be used	Package Price (BDT)			
		In Cash	One year Installment	Two years Installment	Three years Installment
20	3 x 3 watt LED tube light	10,750/-	12,000/-	12,500/-	13,000/-
50	4 x 3 watt LED tube light and a 15" LCD/LED TV	19,500/-	22,000/-	23,500/-	27,100/-
65	5 x 3 watt LED tube light and a 15" LCD/LED TV	24,000/-	27,000/-	29,000/-	31,600/-
85	7 x 3 watt LED tube light, a 12 watt fan and a 15" LCD/LED TV	28,000/-	31,000/-	33,500/-	37,600/-
Down Payment			25%	20%	15%
Service Charge (Flat rate)			9%	10%	12%

(Source: Grameen Shakti 2015)

2.4.2 IDCOL Solar Irrigation program

In Bangladesh there are 0.27 million irrigation pump which run by electricity consuming 1500MW power and 1.34 million irrigation pump run by diesel consuming 1 million tons diesel/yr worth USD 900 million. The government has to provide USD 280 million as subsidy for diesel. Considering this calculation, IDCOL has targeted to set up 1500 solar irrigation pump by 2018. Implementation status of the current solar irrigation project is presented in Table 2.9.

Table 2.9: Solar irrigation program of IDCOL

	Approved	**Installed from approved**	**Under Installation**	**In Pipeline**	**Total**
Number of pumps	445 no.	168 no.	277 no.	92 no.	537 no.

(Source: IDCOL 2015b)

For setting up solar pump POs put in 15% of the project cost as equity and supply water to the farmers as needed, and at an agreed price, during irrigation season. POs order pumps once IDCOL approves technical specifications and install them. After installation, POs can apply for credit and grant financing from IDCOL. IDCOL provides up to 50% of the project cost as grant financing and 35% as credit support – the remaining 15% is covered by PO equity.

2.4.3 Concluding Remark of IDCOL Role

The Solar Home System program and the solar irrigation program of IDCOL is a collaborative effort where strengths of each stakeholder have been harnessed to the fullest extent. Donor agencies through their global experience, IDCOL through discharging social responsibility of the government, POs through their access to grass root levels, private suppliers through their dynamism and academicians through their professionalism have contributed in designing a model which has been very well accepted by the target group. Though the SHS program is successful, the solar irrigation program is yet to flourish. On global context it is a commendable success for Bangladesh.

2.5 Conclusion

RET is the technology of the Future. But unless this technology can reach the most deprived and vulnerable group in the world today, the millions of rural people who suffer most from the energy crisis, this technology will neither reach its full potential, nor will the economic and social problems of the world be solved (Islam 2012). The development of renewable energy of Bangladesh in a large scale is still in initial stage. The diffusion of RET in the off-grid area is a success but the grid tied RET is yet to boom. SHS has been a successful story in Bangladesh. The rural people of Bangladesh have accepted SHS on a mass scale. Once it was thought that solar energy was not affordable for the rural people. This myth has been broken. The people of the rural area are using RET for their development in a variety of way. In the next chapter literatures related to the research topic and relevant theory/theories for drawing an analytical framework which were studied to meet the research objectives and answer the research question is presented. Moreover the analytical framework is also drawn in the next chapter based on the reviewed literature and theory.

Chapter 3

Literature Review, Theoretical Concept and Analytical Framework

3.1 Introduction

To meet the objectives and answer the research questions, reviewing the existing literatures related to the research topic and relevant theory/theories; and draw an analytical framework for the study is essential. This section starts with reviewing some available and relevant literature. After that a discussion and definition around the concept *functionings* and *capabilities* is made, followed by discussion on the influence of personal, social, and environmental characteristics on these fucntionings and capabilities. Even though mainly a specific part of this capability approach theory is used as the practical analytical framework for this study, the theory is briefly explained here in order to create a comprehensible context. At the last section of this chapter analytical framework and variable matrix is drawn based on the reviewed literature and capability approach.

3.2 Literature Review

To get a better understanding the role SHS in the rural area of the developing country, literature pertaining to relevant studies in this field has reviewed. This chapter focused on the past researches that have been done relevant to this research study on socio-economic impacts of photovoltaic solar system specifically by SHS. This chapter has helped in gaining a better understanding of the research in terms of contemporary and empirical literature. The literature review has focused on the use of SHS for ME development and empirical studies from Bangladesh and beyond.

Many studies regarding impact of electrification of rural enterprises have been conducted. The electrification was based on two distinct different ways. One is centralized electrification and other is de-centralized electrification or one is grid electrification and other off-grid electrification. The popular way of off-grid electrification in the rural area of the developing world is PV based standalone electrification which is mostly known as SHS. The researches regarding how the electricity especially through SHS is working for the development of rural ME are studied and analyzed by the proposed research for better understanding of the phenomenon. Some of the selected research analyses are summarized below:

Barkat et al. (2002) carried out a very rigorous study on the Economic and Social Impact of a Rural Electrification program on Bangladesh, where they found that access to rural electrification has a significant impact on the reduction of both income poverty and all dimensions of human poverty (health, education and women empowerment). They found that electricity created significant employment opportunities. The most pronounced among those were creation of scopes for work at night, expansion of local trade and business activities, generation of employment opportunities for unemployed youth, broadening of scopes for employment in crop agriculture, establishment of small and cottage industries, increase in the opportunities for poultry raising, and increase in the scopes for earning from multiple sources. Business turnover be it daily, weekly or monthly for electrified retail shops are more than double than that of non-electrified. For wholesale electrified it is eleven-fold. Similar is true for volume of business, business hours, volume of customers, employment of electrified shops then nonelectrified. Generally, the traders of electrified areas appear more vibrant than those of nonelectrified (Barkat et al. 2002).

Prasad & Dieden (2007) explore how far existing surveys provide data on the impact of electrification on the uptake of small and medium enterprises or self-employment among households in South Africa. They indicated that growth in income generating activities primarily resulted from businesses already connected to electricity. They used household survey data between 1995 and 2004 to examine the impact of electrification on the development of micro, small and medium sized enterprises and those in self employment amongst households. They estimated that between 40% and 53% of the increase in enterprise activity was attributed to the extension of the electricity grid, indicating that enterprise growth was higher amongst those already connected. However, in the more remote rural areas the take up did appear to be stronger. It increased by more than 40% amongst non-connected and only 10% amongst the connected. Enterprises were mainly in the wholesale and retail sectors. The increase in cellular telephone technology was also a contributing factor to uptake (Prasad & Dieden 2007).

Kooijman-van Dijk & Clancy (2010) found that there is little empirical evidence to underpin strategies of poverty reduction through income generation in small scale rural enterprises by supplying energy. There paper reports on research findings from a three country study in Bolivia, Tanzania and Vietnam which aimed to provide insights into the

scope and depth of impacts of modern energy services. Qualitative and quantitative data were gathered using structure and semi-structured interviews. The nature of the data collected was shaped by the Livelihoods framework. An analytical framework of four questions was used to synthesise the findings. In answer to the questions regarding scope of impacts, at least for electricity, the impacts appear to depend on the location of the enterprise with regard to diversity of demand for enterprise services. However, the benefits of improved working conditions for many entrepreneurs and workers and of both time and access to new and better quality products and services to customers of enterprises reach a much larger group of people, and these impacts can provide a substantial impact on poverty, if not on the financial dimension of poverty. For the entrepreneurs themselves, the changes in incomes to entrepreneurs are generally small, and reduced profits per enterprise due to market saturation are a common phenomenon. At the village level, the increase in numbers of enterprises is largely compensated by closures, growth in terms of employment creation is typically limited to casual involvement of members of the (extended) family, and the increase in diversity of enterprises in rural areas is small and slow (Kooijman-van Dijk & Clancy 2010).

Asian Development Bank (2010) conducted impact evaluation study of two rural electrification projects funded by ADB in Bhutan: the Sustainable Rural Electrification Project (Loan 1712- BHU); and the Rural Electrification and Network Expansion Project (Loan 2009-BHU). The study undertaken two tasks: (i) evaluate the performance of the two loan projects using relevance, effectiveness, efficiency, likely impact, and sustainability criteria; and (ii) conduct a rigorous quantitative evaluation of the impacts of the same two projects covering three broad areas influencing quality of life (economic, social, and environmental) and their sustainability. In the process, the study has undertaken a comprehensive literature review. The study also identifies key lessons and issues, and offers recommendations for consideration by ADB management for enhancing development effectiveness of rural electrification (RE) assistance in Bhutan. The results of ADB suggest that economic benefits, in terms of percentage increase in income, in electrified households are higher than in unelectrified households, to a greater extent from nonfarm activities and, to a lesser extent, from farming. The plausible causes are establishing or upgrading microenterprises and small businesses, as well as nonfarm employment. However, data analysis reflecting the impact of RE on microenterprise activities did not provide any consistent results (ADB 2010).

Neelsen & Peters (2011) assessed the impact of electricity access in micro-enterprises in Uganda using quantitative firm-level data from 200 enterprises complemented by qualitative case studies. The study found out that there was little direct impact of electricity access on firm profits or worker remuneration. However, there was significant indirect effect mainly due to increase in demand for goods and services prompted by migration from non-electrified to electrified communities. The study concluded by stressing the need for productive energy promotion policies to be put in place to assist local entrepreneurs to make informed business decisions. By contrast, no evidence for an expansionary effect of electrification on firm profits or worker remuneration was found. In fact, many entrepreneurs consider the direct gain from connecting to the grid to be small. Qualitative information from their study, however, suggests that a positive indirect impact of electrification on firm performance is induced by the overall expansive effect electrification has on local demand. The demand increase can be partly assigned to people moving into the electrified community from surrounding non-electrified areas. They conclude that if productive energy promotion policies are put in place they should address drawing up thorough business plans to enable local entrepreneurs to take informed connection and investment decisions (Neelsen & Peters 2011).

Meadows et al. (2012) conducted a literature review regarding to identify the Linkages between Modern Energy and Micro-Enterprise. Their literature review covered the developmental impact of modern energy for micro-enterprise. In terms of linkages between modern energy and micro-enterprise, the literature reviewed by Meadows et al. (2012) indicates that:

a) Modern energy can, but does not necessarily, affect the emergence, development, productivity and efficiency of micro-enterprise.
b) While lack of access to modern energy is often characterized as a barrier to micro-enterprise development, removing this barrier (through, for example, energy developments such as electrification) does not necessarily result in microenterprise development.

According to Meadows et al. (2012) other areas that still require further investigation include:

a) The energy needs of specific types of micro-enterprises, and the role of modern energy in meeting these needs efficiently and effectively;
b) The contribution of micro-enterprise to economic and social development, particularly with regard to poverty alleviation in developing countries; and
c) The environmental impact of micro-enterprise, including energy-related impacts.

The study of Akpan, Essien & Isihak (2013) examined the impact of rural electrification through extension of existing grid on rural micro-enterprises in Niger Delta, Nigeria. The study used purposive sampling and obtained data using structured questionnaires and personal interviews with the owners of the micro-enterprises. Their result showed that although not statistically significant, on average, enterprises in communities connected to the electricity grid are 16.2% more profitable than enterprises in communities not connected to the grid, and the use of generating sets in providing back-up electricity makes micro-enterprises more profitable. The study also observed that micro-enterprise owners are fully aware of the importance of electricity access to the profitability of their businesses and those who can afford to buy generating sets willingly do so. Incidentally, the total expenditure on generating sets by some enterprises is up to three times (3×) the tariff for grid-electricity in rural areas.

An Impact analysis of Electricity Access to Rural SMEs was done by Bose et al. (2013). The main objective of their research was to identify the impact of electricity services on rural micro-enterprises. The results were based on a study from a survey carried out in two electrified villages in Paikgacha, Khulna, Bangladesh. The study detected favorable changes on the production costs, profit margin, development and modernization of business, women empowerment, quality of life, and human development due to the electrification (Bose et al. 2013).

Combining quantitative and qualitative survey instruments such as participatory rural appraisals (PRA), Kirubi (2006) discovered a positive contribution of electricity provision to micro-enterprise growth in rural areas. The study explores the relationship between modern energy and economically productive activities in rural Kenya. The Research was based on surveys done in Mpeketoni a rural Village of Kenya in Summer 2005, complimented by review of the literature. The findings reveal that access to electricity, in combination with simultaneous access to markets and other infrastructure (roads, communication, schools, etc), have contributed to robust growth of

microenterprises in clear and compelling ways. For instance, productivity per worker and gross revenues per day increased by the order of over 200% for both carpentry and tailoring microenterprises (Kirubi 2006). Other studies strongly question the developmental value of modern energy (e.g., solar PV) that provides "lighting only" in rural areas.

Karekezi & Kithyoma (2002) have observed that, while typical solar PV systems (40-100Wp) are useful for lighting in rural SMEs, they cannot meet the "heating and shaft/motive" power needs of the SMEs, which are 100-1000 times higher. PV technology, they contend, is thus unsuitable and uneconomical for agro-processing activities that often represent the most attractive options for generating incomes in rural areas (emphasis added). These energy options could significantly improve the performance of rural small and micro enterprises.

Brew-Hammond (2010) suggested that productive usage of energy for income generation must be more and more enforced ''in order to break the vicious circle of low incomes leading to poor access to modern energy services, which in turn puts severe limitations on the ability to generate higher incomes'', as increased access to energy may create new earning opportunities in two ways:

• New business options for micro, small or medium enterprises in the manufacturing, agriculture and service sectors;

• Additional employment opportunities in the energy supply chain may be created if universal access is reached.

Chowdhury (2006) conducted a study on sustainable rural energy (SRE) in Solar Electrification Cluster Village, and Solar Electrification at a Rural Health Clinic in Boradubi, Sherpur, Bangladesh. The objective of the study was to assess the direct and indirect impacts of the SRE projects on human poverty reduction and on human security. More specifically, the objectives of the present study were: (i) to look at the economic and social impacts of sustainable rural energy on poor people at the local level; (ii) to look at the governance and management of these infrastructures; and (iii) to identify lessons learned and suggest policy options in each of the infrastructure projects with a view to replication micro-macro linkages. The study also collected information by Focus Group Discussions (FGD) to assess the poverty and gender implications of the SRE. The study conclude that electrification has a positive impact on scope for work at night,

expansion of local trade and business, generation of employment opportunities for the unemployed, and establishment of cottage industries and new shops. A large majority of 60% thinks that it would increase economic activities and create more jobs, 12% think that it would improve their lifestyle, and 20% hope for more business etc. (Chowdhury 2006).

Kurschner et al. (2009) made an assessment of solar home system and improved cook stove interventions in Bangladesh. They found that SHS are used mainly by middle-class households and micro and small enterprises (MSE) in off-grid rural locations to operate light bulbs, and small electrical appliances like mobile chargers and black and white TVs. The SHS considered in their study generally do not have enough capacity to be used for electrical appliances that could be used in production, such as heating lamps in poultry farms, irrigation pumps for agriculture, or mobile phone charging on a larger scale. Around 10% of the MSE in the sample were also connected to the grid, but considered the SHS to be very important as backup, since power-cuts usually occur precisely in the evening hours when they need lighting for their business activities. In their study all MSE owners in the sample shared the perception that they could save on energy expenditure thanks to the SHS in the long run. Three quarters of interviewees stated that they were planning to invest the increased profit into their business. Furthermore, the additional money is used for private savings, family support and education, and investments in property. Business expansion resulted in the creation of a new job in only three out of 36 cases. It can be resumed from the insights gained on increased income, money-saving and investments that poverty-reducing impacts from solar systems in MSE occur mainly for the owners of MSE and their families. Although there is a low ratio of job creation, some of the jobs created could be suitable for poor people, as work in restaurants for instance is considered to be unskilled labour. An informational benefit that is particularly relevant for business people is access to information on prices and market developments through mobile phone and TV. For commercial SHS users, the most important impacts are increased profit due to longer opening hours and savings in energy expenditure (Kurschner et al. 2009).

Harsdorff & Bamanyaki (2009) studied the socio-economic and productive impacts of Solar Home Systems on households and micro enterprises as well as the impact of the support of the activities of the Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP) on the development of rural solar markets in Uganda.

After 2 years of use of the SHS, it was found that households and enterprises did not climb the energy ladder but continue to use traditional forms of energy alongside solar PV. Due to unexpectedly high expenditures on replacements for blown out bulbs total energy expenditures are not reduced. While no increased income generating activities were found in households, solar light leads to longer hours of operation and higher profits in existing micro enterprises. Nevertheless the net impact of longer opening hours on the local economy is negligible as the demand for existing products is saturated and smaller enterprises without solar light are crowded out. In contrast new businesses which are enabled through solar PV - notably phone charging and electric hair cutting - tap an unsatisfied demand diversifying the local economy. The development of rural solar markets has positive net employment effects. A 1% coverage rate of SHS leads to 0.02% newly created "green jobs" (Harsdorff & Bamanyaki 2009).

Obeng & Evers (2010) stated that in rural areas far removed from grid-electricity, public solar photovoltaic (PV) electrification projects have served useful purposes by contributing to improve the economic activities of micro-enterprises beyond daylight hours. Using systematic sampling and developing a set of enterprise-level indicators, micro-enterprises with and without solar PV were surveyed in eight rural communities in five regions of Ghana. Their results revealed that the cost avoided by using solar PV in the enterprises instead of kerosene lanterns was US$1–5/month. The results established a statistically significant association between solar PV lighting and additional income after sunset of US$ 5–12/day in grocery (merchandise) enterprises. Without the external lighting of solar-electrified enterprises, the businesses of about two night vendors were affected (Obeng & Evers 2010).

Chakrabarty & Islam (2010) conducted a study to analyze financial viability as well as eco-efficiency of the solar home systems in Bangladesh six case studies are carried out in some selected villages of Chhatak upazila in Bangladesh where NGOs like Grameen Shakti and BRAC are delivering and servicing solar home systems. Financial viability of the SHS is measured by comparing prior expenditure (before implementing SHS) for kerosene, automobile battery and other conventional sources by them. The financial viability and eco-efficiency for six different cases of SHS are calculated and compared. They found that solar electrification results a number of income generating new green employments for the rural community in Bangladesh. Although financial viability of SHS is sensitive to kerosene subsidy, their study reveals that the SHS is

financially more attractable when it is used for small income generating activities other than used only for lighting purpose. However, almost in all cases this technology is indispensable for improving environmental standard and eco-efficiency of the rural community. In summary their finding is that, positive NPVs and significantly large IRR indicate a financially viable investment opportunity for SHS when it is used for small business purpose (Chakrabarty & Islam 2010).

ESCAP (2011) published a report on "Effective Management of Technology Transfer, in Particular of Clean and Renewable Technologies, for Enhancing the Competitiveness of Small and Medium Sized Enterprises (SMEs) including its Gender Dimension". The main objective of the study was to undertake research to show how the use of clean (low-carbon) and renewable energy technologies can enhance the competitiveness of SMEs, strengthen their contribution towards mitigating climate change, and foster gender equity. The study found that solar energy presents great development opportunities in developing countries, particularly since most of them are in the Sun Belt. Solar photovoltaic energy is uniquely useful in rural areas un-served by electric grids to provide basic services such as refrigeration, irrigation, communications and lighting. For lighting, a photovoltaic compact fluorescent light system is 100 time more efficient than a kerosene used in rural areas of many developing countries to provide night lighting. The study acknowledged that access to reliable, affordable energy services is vital for SMEs to operate efficiently and profitably, yet such does not exist in many countries of the Asia-pacific region and Africa. Inability of such SMEs to access energy sources, constrains their development and thus inflicts and enormous toll on the economic development. Clean and Renewable Energy Technologies or CRETs have the potential to impart a sustainable solution for the energy needs of such SMEs (ESCAP 2011).

Mondal & Klein (2011) carried out a study to find the impacts of solar home systems (SHSs) application at selected villages in Gazipur district, Bangladesh. A questionnaire-based survey method was used by them to collect primary data from the period of October 2004 to January 2005. The research revealed that solar electrification provided direct and indirect benefits to the users of the system, with many implications of a permanent nature. Reduction of kerosene usage was the main impact of SHSs. It resulted in less pollution, higher quality light and more hours of light in the evening, as well as less work for cleaning kerosene lamps. Very few income generation activities

were created after acquiring SHSs in the studied villages. But the people who were engaged with business using traditional fuel, switched to solar light that added a little bit more income due to extended working hours in the evening. Women and children were found to benefit from the quality of light for household work and studying in the evening. Users became accustomed to the better quality of light and could not perceive returning back to kerosene lamps. Solar electrification also added to the overall comfort and satisfaction of the consumers. In the case of micro-enterprises who were using kerosene pressure lamps, the working activities were extended by 1 h. In addition, two mobile phone service centers were introduced thanks to SHSs which allowed for charging mobile phones for business (Mondal & Klein 2011).

Urmee & Harries (2011) carried out a comprehensive qualitative and quantitative survey to find those factors perceived by SHS program stakeholders as being most critical to the program's success to date and the factors considered most likely to impact on its future success. From their study it is found that the capacity to increase income generation using SHS was also seen to be a major benefit of the SHS program. Acquiring a SHS creates an opportunity to start up small businesses of various sorts. Prior to the installation of their solar home systems, many of those in rural areas had not considered it to be possible to open up a business that remained open late. Now, with a SHS, most businesses remain open after dusk in order to gain access to late evening shoppers. In this way, the SHS program has helped to reduce poverty by creating opportunities for new income earning activities, such as mobile phone charging shops, providing neon light traps for attracting and destroying insects, and operating social TV halls. The survey analysis also showed that people valued their quality of life changes and the changes in their economical situations brought about as a result of using their SHS (Urmee & Harries 2011).

Islam et al. (2011) describes the glimpses of RETs in Bangladesh in terms of its policy issues, implementation, dissemination, marketing, and research and development activities. They found that modern RETs are still in the research, development and demonstration phase in the country and rural businesses can increase their productivity and income through extended working hours and attracting more customers. SHS also can allow expanding market and reaching economies of scale which further allowed bringing down costs per unit and engaging in a profitable, sustainable business. For rural businesses, solar power meant productivity, more sales, income and jobs. A rural business

could double its turnover by using solar while minimizing energy cost. They stated that solar power especially helped improve connectivity, increase the sales of electronic goods, create new business opportunities such as mobile phones charging shops, electronics repair, maintenance shops, community television centers etc. (Islam et al. 2011).

Pode (2013) found that income for some businesses have doubled with installation of SHS, while some of the users of lights feel only repayment of installments as burden. NGOs are charging high interest for installed SHSs. It is claimed SHS program in Bangladesh as one of the most successful rural electrification program in the world. The Study ranked the motivation of rural population to improve life style as the first reason that is influencing installation of SHS. The study explored that SHS units are well received by small entrepreneurs for lighting and extending their business hours. Street eatery owner thinks that LED light is the best investment he ever made. Extended business hours in the evenings times increases the earnings by double. From the study it s seen that some customers using SHS only for lighting purpose feel that repayment amount is burden for them (Pode 2013).

Peters et al (2014) prepare a report on behalf of the Policy and Operations Evaluation Department (IOB) of the Netherlands Ministry of Foreign Affairs based on the study of the provision of grid electricity to households through the Electricity Access Roll-out Programme. In their study on the assessment of the benefits of electricity access to micro-enterprises, a qualitative case study approach was pursued. Around 100 enterprises were interviewed using semi-structured questionnaires during the follow-up. In terms of productive take-up they found two things: First, households increased their home business activities quite considerably. Most new productive activities were low key in this area, though. Take up in (non-home business) micro-enterprises is rather humble. They generally observed a slight increase of business activities in connected communities. Some enterprises emerged and existing enterprises partly extended their operation hours, products and services. While in many cases electrification of enterprises only increases convenience and causes a redistribution of income within the community or region, some enterprises also increased net community income by serving demand from outside the community or offering products and services locally that formerly had been imported from urban areas. According to their study, the crucial factor for the development of all business activities is local demand and market access that is normally

not affected by electrification. They also identified that SHS or Pico-PV kits, though do not provide the same quality of electricity in terms of power, but that would nonetheless meet the electricity consumption patterns of micro enterprises of the rural areas (Peters et al 2014).

Liljefors & Sahlin (2014) explored the drivers and barriers for Solar Home Systems (SHSs) in Kyerwa, Tanzania from the villagers' perspective. The study was mainly qualitative and the central data was received from 30 semi-structured interviews with villagers in Kyerwa district. For the design and analysis of the study, the Sustainable Livelihoods Approach and a socio-technical perspective were used. The main drivers for SHSs were found to be improved economy, increased study opportunities for children and improved indoor environment from cutting out kerosene use. Apart from delivering the changes to households, the SHS also created business opportunities for some villagers. From their study it is found that the SHS provided tangible business opportunities, enabling diversification and improvement of income (Liljefors & Sahlin 2014).

Bond et al. (2015) has compared the development impact of three different sized solar home systems (SHS) (10, 40 and 80 Wp) installed in rural East Timor. It describes research aimed to determine whether the higher cost of the larger systems was justified by additional household benefits. To assess the development impact of these different sizes of SHS the research used a combination of participatory and quantitative tools. Participatory exercises were conducted with seventy-seven small groups of SHS users in twenty-four rural communities and supplemented with a household survey of 195 SHS users. The research findings showed that the small, 10 Wp SHS provided much of the development impact of the larger systems.

3.2.1 Inference Drawn from the Literature Review

From the above review, the study of Barkat et al (2002), Prasad & Dieden (2007), Kooijman-van Dijk & Clancy (2010), Meadows et al. (2012), Bose, Uddin & Mondal (2013) found that rural electrification enable the MEs for favorable changes on the production costs, profit margin, development and modernization of business. But the study of Asian Development Bank (2010) and, Neelsen & Peters (2011) argued that Rural Electrification on microenterprise activities did not provide any evidence for an expansionary effect of electrification on firm profits or worker remuneration.

All the study related to PV electrification concludes that SHS extended enterprises operation hours, increases productivity and improve services of the MEs. The study of Pode (2013) shows that some MEs think the repayment as a burden and no use of SHS. Kurschner et al. (2009) found that SHS is also very important as backup strategy. The study of Kirubi (2006), Karekezi & Kithyoma (2002), Chowdhury (2006), Kurschner et al. (2009), Brew-Hammond (2010), Harsdorff & Bamanyaki (2009), Obeng & Evers (2010), Chakrabarty & Islam (2010), ESCAP (2011), Mondal & Klein (2011), Urmee & Harries (2011), Islam et al. (2011), Pode (2013) and Peters et al (2014) found that SHS bring favorable changes on the production costs, profit margin, development and modernization of business of the MEs. According to Kirubi (2006), energy is essential, but not an only means for ME development.

Despite this noticeable success and donor's enthusiasm, solar PV has been criticized for being expensive especially to the rural poor people, fragile and limited to non-productive uses, facilitating both social and economic development and rural people desire electricity for light, for radio and TV and for income generating activities (GNESD 2007; Villavicencio 2004; Wamukonya 2007). It is also argued that electricity is closely linked to economic development, and thus the availability of electricity for productive use is one among several conditions that need to be met to achieve this goal (Cabraal et al. 2005). In the early 1960's and 1970's causal relationship between access to electricity and economic were predominant, but today access to electricity may be a necessary but not sufficient condition for economic growth, especially when addressing the issue of rural development (Cabraal et al. 2005). Many researchers also convincingly contested the claims from various proponents of PV that solar PV would alleviate poverty and facilitate income generation (Karekezi & Kithyoma 2002; Wamukonya 2007; Jacobson 2007).

In a nutshell the previous studies show mixed result of SHS on rural MEs. The relation between up taking SHS and MEs development is not that much strong as propagated by the International Development Agencies and local NGOs. As many research claim that SHS as an ointment for development in the rural areas but many research also argued that it need proper support like infrastructure, policy support, etc.

Although it is widely accepted that electricity access is important for enterprise performance, the empirical evidence on the subject is mixed. In addition, evidence is scarce for micro and small enterprises operating in the informal sector. It is hard to find

any specific and in-depth study about SHS and performance of MEs. From the reviewed literature it is found that, direct income generating activities are relatively rare. Modest economic gains were observed by few researchers, but not the remarkable changes that have been reported. In the above context and improved infrastructure and other support in Bangladesh, the study wants to identify to what extent the SHS playing role on ME development.

3.3 Theoretical Framework

After reviewing the existing literature it is evident that the change brought to the MEs in rural areas by up taking SHS is synonymous to the development of the enterprises. The study wanted to see what the services they are taking from SHS and also tried to find out whether these services are enhancing their ability to bring about changes in their enterprise. The objective of this study was related to the functioning and capability of the rural enterprises to bring change, in other word to develop their enterprises by up taking SHS. From the literature review it has been observed that the use of SHS is giving freedom and capability to the entrepreneurs for bringing change in their enterprises and develop their business.

Amartya Sen, the Nobel laureate economist, persuasively argues that development and freedom are inextricably connected; that the "expansion of freedom is both the primary end and the principal means of development (Sen, 1999)." Sen (1999) presents a very different approach to development. In the book titled ‘Development as Freedom’, Sen (1999) portrays development as the enhancement of human capabilities and individual freedoms geared towards achievable valued outcomes (Development). Over the last decade Amartya Sen’s Capability Approach (CA) has emerged as the leading alternative to standard economic frameworks for thinking about poverty, inequality and human development generally (Clark 2006). Robeyns (2005) stated that the capability approach is a broad normative framework for the evaluation and assessment of individual well-being and social arrangements, the design of policies, and proposals about social change in society. Robeyns (2005) also argued that not only it can be used in a wide range of fields, most prominently in development studies, welfare economics, social policy and political philosophy but also it can be used to evaluate several aspects of people’s well-being, such as inequality, poverty, the well-being of an individual or the average well-being of the members of a group.

In this light, this study has used Amartya Sen's Capability Approach to analyze the phenomenon whether the SHS is enabling the rural entrepreneur to bring any changes to the MEs. Capability Approach is briefly discussed in the following section.

3.3.1 Capability Approach

The core characteristic of the capability approach is its focus on what people are effectively able to do and to be; that is, on their capabilities. According to Sen (2001), development can be defined as increasing people's choices in life, referred to as *capabilities*. The capabilities have to be defined by the people themselves, in order to make them agents[3] of their own life. Sen (2001) also stated that development can be set equal with freedom. In order to develop, people have to be able to expand their *capabilities*, which mean their freedom to achieve *functionings* they value doing or being. The two key terms of Sen's Capability approach are:

Functionings

Functionings are the various things a person may value doing or being (Sen 1999).This means not a specific commodity, but is not limited in definition and will be different from person to person. Beside material things, also other functionings are included, so the term can as well be interpreted as good nourishment or warm friendships. It focuses not so much on goods and income, but more on what a person is able to do or to be with it.

Capabilities

Capabilities describe the real and actual possibilities open to a given person, hence its freedom to enjoy various functionings. With Sen's words, capabilities are *the various combinations of functionings (beings and doings) that the person can achieve. Capability is, thus, a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another . . . to choose from possible livings* (Sen 1992). As a comparison, a person with much money can choose between many different things to buy, just like a person with many capabilities can choose between different functionings. Thus this person is able to choose between different ways to lead its life.

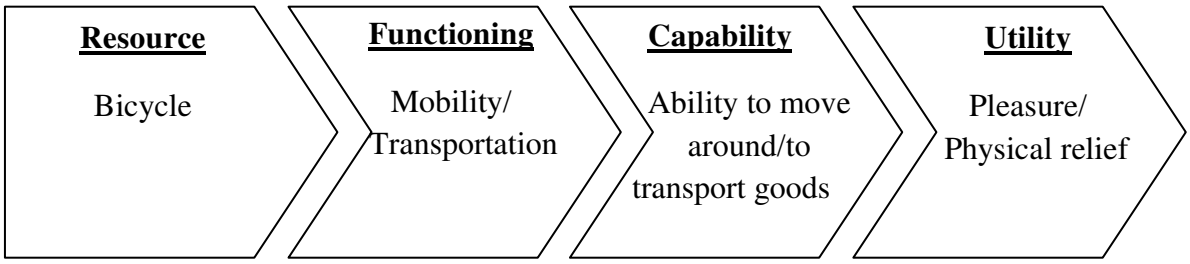
[3] Amartya Sen defines an agent as someone who acts and brings about change, whose achievement can be evaluated in terms of his or her own values and goals (Sen 2001). This differs from a common use of the term "agent" sometimes used in economics and game theory to mean a person acting on someone else's behalf.

The two concepts are interrelated but have distinct meanings:

> "A functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions, since they are different aspects of living conditions. Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have regarding the life you may lead". (Sen, 1987)

As a memorable example, Alkire et al. (2009) mention a person who has a bicycle (= *resource*). The bike theoretically enables the person to move around, which she would value (= *functioning*). In case, the person is really able to ride the bike (s/he knows how to ride a bike and is physically able to do so), the ability to move around would be given (=*capability*). This capability leads to happiness (= *utility*), since the person uses it to make a bike tour at the weekend (see Figure 3.1) (cited in Braden 2012).

Figure 3.1: Demonstration of the Capability Approach by means of the bike example



(Source: Braden 2012)

Likewise, the person could also use the resource "bike" for other capabilities, for example to carry goods to the market. In this case, the functioning would be "transportation", and the utility "physical relief", if she otherwise would have to carry the goods on her back.

According to Good & Qureshi (2009) the capability model also describes capabilities by illustrating how starting conditions (characteristics) constrain capabilities via personal, social and environmental factors. Zheng (2009) comments that: The extent to which people can generate capabilities from goods and services is influenced by three sets of conversion factors—personal, social, and environmental characteristics (Sen, 1992). Good & Qureshi (2009) argue that personal characteristics, such as mental and physical conditions, literacy, and gender, influence the types and degrees of capabilities a person can generate from resources. Social factors are a number of characteristics of

social settings, such as social norms (e.g., role of women, rules of behavior, materialism, religion), social institutions (e.g., rule of law, political rights, public policies), and power structure (e.g., hierarchy, politics). Environmental characteristics, including climate, infrastructure, institutions, and public goods, also play a role in the conversion from characteristics of the goods to individual functionings (Good & Qureshi 2009).

Zheng (2009) found one of the strengths of the capability approach is that it encompasses everyone from every section of society. Human diversity is implicated in both aspects outlined above: the distinction between functionings and capabilities, and the explicit accommodation of personal and socio-environmental factors in the conversion of commodities into functionings (Robeyns, 2000). According to Sen, "We are deeply diverse in our internal characteristics (such as age, gender, general abilities, particular talents, proneness to illness, and so on), as well as in external circumstances (such as ownership of assets, social backgrounds, environmental predicaments, and so on)" (Sen, 1992).

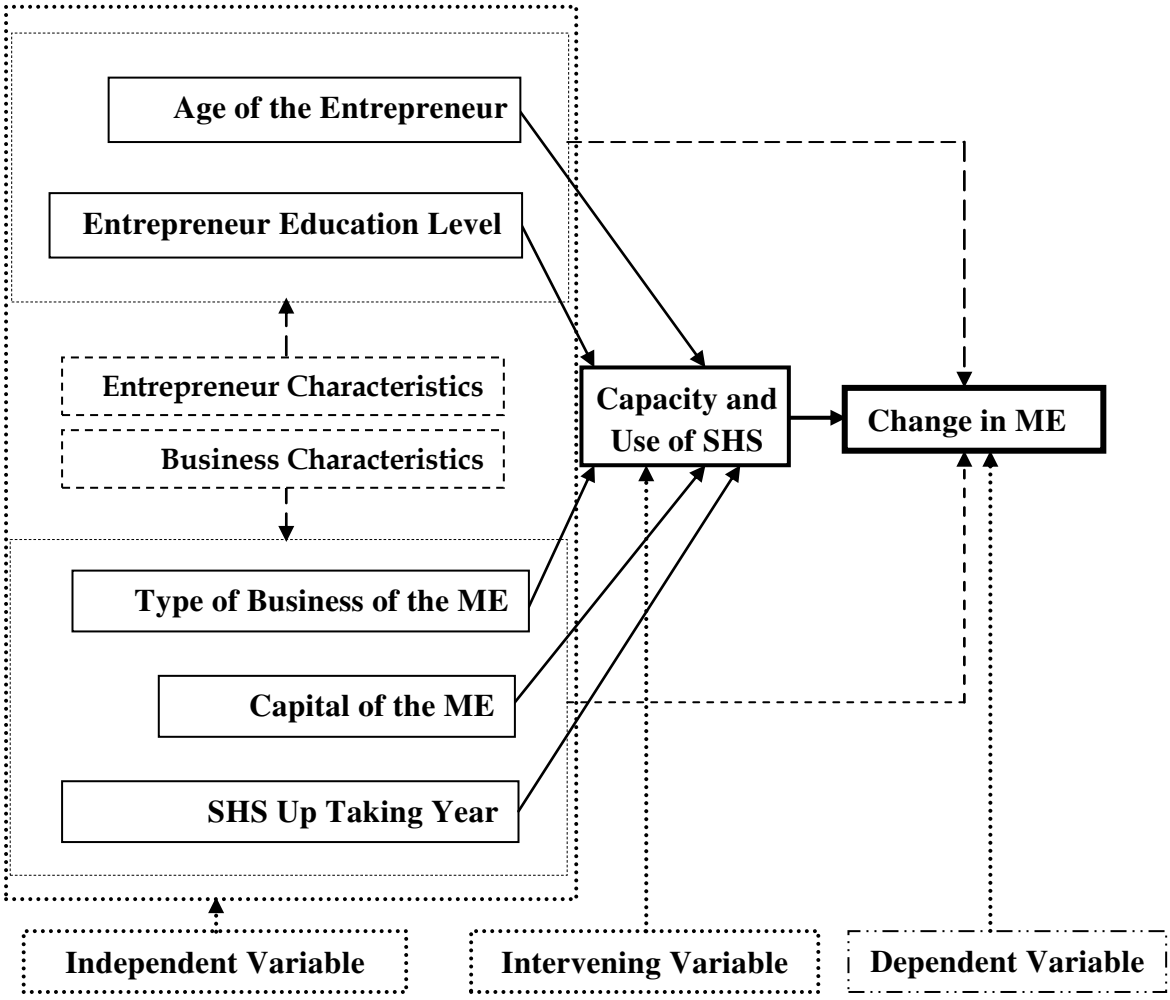
3.4 Analytical Framework

After reviewing the existent literature and relevant theory, the next important step is to draw an Analytical framework for the study. The analytical framework will be used to explain the collected data in analysis part, to draw inferences, to meet the objectives and to answer the research questions.

The analytical framework is based on the capability approach and the indicators of the dependent variable are chosen (in this study: the change of the ME) based on the reviewed literature. It has found from the theory and literature review that functioning (in this study: up taking and use of SHS) depends on the internal (age and education level) and external characteristic (types of business the ME do, capital of the ME and SHS up taking year) of an individual or group (for this study it is the entrepreneurs and their ME). Moreover From the theory, it is found that the capability depends on the vector of functionings, and functionings depends on the socio-economic and environmental characteristic. So, by the use of SHS the entrepreneurs can enhance capability, which mean their freedom to achieve *functionings* they value doing or being.

After discussing capability approach and literature review, this study has used the following analytical framework (in Figure 3.2) to analyze the role of RET (specifically SHS) on rural MEs.

Figure 3.2: Analytical framework of the study



In the analytical framework two relations was tried to establish. The two relations are as follows:

1st Empirical relation: Relation between the Independent variable and Intervening variable.

Capacity and use of SHS = *f* (entrepreneur characteristics, business characteristics)

2nd Empirical relation: Relation between the Intervening variable and Dependent variable.

Change in ME = *f* (capacity and use of SHS)

f denote function.

3.4.1 Variables Matrix

Various variables included in the analytical framework were measured and operationalized. Indicators of the dependent variables are drawn from the literature review. Measuring indicators of the dependent variables with operational definitions are given in table 3.1.

Table 3.1: Dependent Variable's measuring indicators and Operational Definition

Measuring Indicators	**Operational Definition of the Indicators**
Change in working hours	Change in number of hours that ME stay open
Change in profit	Change in monthly business income from the ME
Change in investment	Change in yearly capital of the ME
Change in Employment	Change in number of employee of the ME
Change in wages of the employees	Change in remuneration of the present employee
Change in energy expenditure	Change in monthly energy spending of the ME
Change in Working Conditions	Change of the ME's decoration, light quality and working environment.
Change in product and service quality	For Product Quality: Keeping of Products that is extensively sold in the urban area. For Product Quality: Change in the service standards and modernization
Change in customer services	Change product and service delivery to the customers and change in customer satisfaction.
Change in consumer Draw	Change in average daily number of customers
Change in Entertainment medium	Acquiring new electrical appliances for entertainment.

3.5 Conclusion

This chapter has reviewed relevant and existing literatures. The main inferences from the review are: extended working hour, increase income/profit, increase in volume of business/investment, increase in number of customers, improve business environment, better quality service and products, better service delivery, employment creation and wage increment, use of mobile and TV for business and entertainment purpose and reduction in the energy expenditure. Then the chapter has discussed the concept of

capability approach. After that, it has selected five independent variables, one intervening variable and one dependent variable from the literature review and capability approach. The picked variables are age, and educational background of the entrepreneur; types of business, capital and SHS up taking year of the ME; capacity and use of SHS; Change in Productivity, Change in Business Environment, Change in Market Information & Business Connectivity. The chapter has been ended with a diagram of analytical framework of the study. The next chapter will present methodology of this study.

Chapter 4
Methodology

4.1 Introduction

This chapter offers an overview of the methodology that have used in this study. The chapter attempts to discuss the methods that are used to collect and analyze data to find the services that the MEs are getting from SHS in detail and for assessing to what extent, these services are enhancing the capability of the MEs to bring about change in their enterprises in the rural Bangladesh.

4.2 Methods of Inquiry

The approach and strategy used to pursue a research depends upon the nature of the problem to be studied and research question to be answered. Previous studies in this field are mainly done as impact evaluation conducted by the different International Donor organization and NGOs in home and abroad. Most of the previous study was also qualitative in nature. The previous studies were mainly conducted on the rural development where the impact of SHS for ME was not discussed broadly. Small in-depth research in true sense with respect to ME is done in this regard. So both quantitative and qualitative methods have been attempted to meet the objectives of the research. Use of both methods helped to avoid biasness and gave better provision to meet the objective and answer the research question of the study. Aminuzzaman (1991:43) argued that combination of these two methods helps better to explore, unravel and understand problems, issues and relationships. It is also argued that the use of one single method in social research is not always enough to respond to the research needs rather a combination of methods is more useful to bring the desired level of methodological sophistication (Aminuzzaman, 2011: 53). For this particular study, data were collected from both primary and secondary sources. Secondary data was collected through content analysis. Primary data, on the other hand, was collected through questionnaire survey, in-depth interviews and observations. The study also included key informants' interview data to have in depth idea about the socio-economic information of the markets of the area under study.

4.3 Sources of Data

The data were gathered from primary and secondary sources. Primary data have collected through in-depth interviews, questionnaire survey and observations. Besides this, in-depth interviews (14 key personnel of the public, privet and international organization) were conducted with a view to achieve five important reasons. First, these in-depth interviews have given the insight thinking of the service providers' regarding to what extent and how SHS is playing its role for ME development, as there are some government organizations and several NGOs which are installing SHS throughout Bangladesh, especially in the rural areas. Second, it has given the direction to formulate and conduct the survey in the study area. Third, it was also very helpful to verify and supplement the information received from the survey. Fifth, it has provided the current scenario and information about SHS. Finally, it helps out to analyze and interpret the findings by the questionnaire survey, observation and content analysis.

Major part of the primary data which is needed to address the research questions were come from the questionnaire survey. All the questions of the questionnaire were close ended. The study also included seven key informants' interview data to have in depth idea about the socio-economic information of the markets of the area under study.

Observation presents a lively picture of the general scenario of the role of SHS for ME development which is reflected in the analysis and discussion part of this writing. This study used the non-participant observation method to see the benefits that the MEs are getting from the SHS and how, and to what extent SHS is developing the user's inner attitudes to make changes in their enterprise. Observation method helped the study to understand facts, concepts and reality and answer the research question.

Secondary data was collected through Content analysis. The sources of secondary data have came from published books, research reports, journal articles, unpublished dissertations, government policies and publications, official website of the government organizations as well other relevant websites too, newspaper and published and unpublished document in printing and online of related interest. These content analyses have helped the study to identify and understand the relevant concepts and theories. Also it helped to find out the adequate data line with study's objectives.

4.4 Data Collection Technique

A brief description of the data collection techniques which were used in the study is detailed under.

Questionnaire Survey: The researcher has conducted the questionnaire survey by himself. The survey was conducted among the MEs those are using the SHS. The questionnaire was divided into two parts: part one is for the socio-economic and demographic information of the respondent and ME; and the other part is for the relevant questions which will help the study to meet the research objectives and research questions. The questionnaire was pre-tested in the study area before conducting the questionnaire survey. All the data were collected in Bengali language and the English translations was done later. As it was expected that the respondents will be not interested to read and fill the questionnaires by themselves, therefore the researcher has asked the questions to the respondents and has filled up the questionnaires by himself according to respondent's answer. The options for the answers in the closed ended questions were predetermined by reviewing the existing available study on the research problem. The questionnaire which was used for survey is given is *Appendix II* which is written in Bengali and English translation of the questionnaire is presented in *Appendix III*.

In-depth interview: Interview was held with 14 key personnel of the public, privet and international organization. List of the 14 key personnel is given in *Appendix IV*. It was kind of informal discussion (without any questionnaire or format) to know the facts and figures of concerned issues. The detailed interview with the respective officials was particularly very crucial to contemporary development issue of SHS and rural development. The study also toke interview of seven key informants to get the socio-economic information of the markets under the study area. The key informants were local people (senior villager or senior entrepreneur).

Observation: In the time of questionnaire survey, researcher observed the overall condition of the study area and the business proposition of the respondents. The researcher observed some shops closely of the study area to understand the day to day operation and influence of SHS on their enterprises and to construct case study.

Content analysis: The books and published documents relevant to the study were collected from various sources such as documents and website of Power Division,

Ministry of Power, Energy and Mineral Resources; Infrastructure and Development Company Limited (IDCOL), Bangladesh; Bangladesh Power Development Board (BPDB), Bangladesh Rural Electrification Board (BREB); Sustainable and Renewable Energy Development Authority (SREDA), Bangladesh etc; and from Library such as Central Library of Dhaka University; Library and Seminar of Institute of Renewable Energy Studies, Dhaka University; Bangladesh Public Administration Training Center (BPATC); Resource Center of Master in Public Policy and Governance (MPPG) Program, Department of Political Science and Sociology, North South University; Central Library of North south University etc. Online journals, articles, unpublished dissertation, newspaper and books were accessed by using myAthens, google scholar and internet browsing through World Wide Web (WWW).

4.5 Selection of Study Area

The main focus of the study is to find to what extent the SHS is bringing change to the rural MEs. Therefore the unit of analysis of the study is rural market. Seven village markets namely Bipingonj Bazar, Kalikapur Bazar, Baromari-Lashimur Bazar, Fandar Bazar, Tinali Bazar, KamarKhali Bazar, Shimultali Bazar of Durgapur Upozilla, Netrokona were selected to collect primary data in this regard. The markets have a diverse kind of trade and service related micro enterprises; and have most of the feature of typical rural market. Description of the study area is given in Appendix *V*.

4.6 Sampling Method and Population Size

Purposive Sampling method was used to select the sample, so that maximum variety of respondents can be incorporated in the research. The major reason behind this kind of sampling was to cover all potential MEs related to the research work and those who could be easily available. Seven village markets have surveyed for this study as mentioned above. In case of in-depth interview, the selected interviewees were divided into three categories; e.g. from government sector, privet sector and international donor agency

For the in-depth interview 14 key personnel of the public, privet and international organization were interviewed. The study has aimed to collect data by questionnaire survey from 50 MEs but after scrutinized only 47 questionnaires were further processed.

4.7 Data Analysis Tools and Plans

There are two types of statistical analyses, namely; descriptive and inferential statistics (Adeola-Omole 2013). All the data collected for this study were analyzed and interpreted with descriptive statistics. Descriptive statistics enables this study to summarize and organize data in an effective and meaningful way.

The collected data was processed by using statistical techniques *Statistical Package for the Social Sciences (SPSS)* for tables, graphs, charts and inferential analysis. At first the data from the primary source are presented. Then those findings from the data are compared and explained with results from secondary source as well as findings from the interview with different department officials according to the analytical framework. Finally, explanation and infer is presented on the basis of the findings and analysis. Some rearrangement has also done with the questions of the questionnaire for a comprehensive analysis. The rearrangements are as follows.

By merging question no 1 and 2 of the section D of the questionnaire, seven point Likert Scale is made for quantitative analysis of the change in working hour with the other variables. Rearrangement is also done for some other changes also. The changes and other related information is presented in Table 4.1.

Table 4.1: Rearrangement of some question for quantitative analysis

Merged Question No.	Section of the Questionnaire	Indicator	Scale with Description
1 & 2	E	Profit	1 Highly Decreased 2 Moderately Decrease 3 A little Decrease 4 No change 5 A little Increase 6 Moderately Increase 7 Highly Increase
1 & 2	F	Investment	
1 & 2	I	Energy expenditure	
1 & 2	M	Customer drawn	
1 & 2	L	Customer services	1 Highly Dissatisfied 2 Moderately Dissatisfied 3 A little Dissatisfied 4 Neutral 5 A little Satisfied 6 Moderately Satisfied 7 Highly Satisfied

4.8 Limitation of the Data

Number of sample size is only 47. Sample size may be a concern. This might have led to questions on generalized this study's findings. Another limitation is the busyness of the respondents to give more attentive time for answering the questionnaire. Yet in order to make the study a success, many attempts were taken within the existing environment, which also suffered from some limitations. The respondents in the study were asked to recall those past data from their back up mind. As a result, there might me some deviation from the actual incident. Though efforts were there to ensure a modest representation of target groups but the sample size might be more than that.

Realizing this limitation, the study has tried to compensate and address the issue of generalization by explaining findings not only with other primary data like case study and from observation and including interviews of higher rank officials of the international donor organization, government organization and private organization, but also with the use of secondary sources.

4.9 Reliability and Validity of the Data

To assess the degree of measurement error present in any measure, two important characteristics of a measure must address by the research those are reliability and validity (Hafiz and Shaari 2013). To achieve reliability, the study has included a wide range of socio-economically different entrepreneurs and different types of MEs.

Sometimes discussions have been made on the research topic with the respondents of the questionnaire survey by the researcher to know their views on the research issue, and it has been checked whether their views are reflected on the questionnaires filled by the researcher or not. If not, the researcher has discussed with the respondent about the difference that the respondent made between his/her oral statements and filling up the questionnaire, and if necessary the researcher has made correction in the filled up questionnaire with the permission of the concern respondent. The researcher has asked the questions of the questionnaire to respondents and explained it (when they felt any difficulty to understand). And finally, the researcher was watchful about data validation and used cautious observation and checked the data whether these were reflecting the true facts and respondents' views or not. Finally findings of the survey have validated by the findings of the in-depth interviews, observations and content analysis.

4.10 Ethical Consideration

This study was conducted according to sound ethical standards to uphold the public's trust in the research profession. According to Ligthelm et al. (2005), "ethics are of particular importance in research because research is based on the principle of public cooperation". Accordingly, this study was conducted in a way as to encourage the respondents to provide honest answers. The information provided by the respondents was strictly confidential and their privacy was guaranteed. The issue of confidentiality was explained to the respondents before questionnaire survey and during interview. In addition, the issue of anonymity was considered by the researcher, in which the participants were assured that they would not be identified with regards to the data given. The photographs during the survey were taken with the permission of the respondents and their use was explained to them. There was a good measure of effort to ensure the findings are not manipulated and misrepresented.

4.11 Conclusion

This chapter has summarized the methods that have used in this study. It is hoped that the methodology discussed above is enough to meet the objectives of the study and answer the research questions. In next chapter, the data which are obtained from the primary sources are presented, analyzed and discussed. For the analysis and discussion the secondary data were also used.

Chapter 5
Data presentation, Analysis and Discussion

5.1 Introduction

This chapter gives a systematic discussion of collected data and an analysis of those data keeping in view with the research question and objective of the research. The results are presented according to the objectives and analytical framework of this study. Demographic features of the respondents, short descriptions of the surveyed MEs, system capacity of SHS are presented in the first sections. The data are presented and analyzed with the help of the SPSS. It is very much essential to present the data in the above mentioned manner because it will help to understand what the changes the MEs have experienced and what factors affected the up-taking of SHS, to analyze the relationship between the variables related to the analytical framework. The presented data is also important, because of the relation between the data is analyzed and discussed according to the research objectives and research question, as well as with the analytical framework in the later section of this chapter. The main objective of this study is to look at the change of the ME by up taking SHS and study the role of SHS on this change. After the analysis of usage and up taking of SHS, the rest sections tell the changes brought to the ME after up taking SHS and role of SHS on these changes.

5.2 Demographic Features of the Respondents

An entrepreneur is an individual who makes choices both for uptake and for use of SHS. Insights into characteristics of the entrepreneur is necessary to understand firstly who, and under which circumstances, invests in energy uptake for his income generation and for ease of operation of the enterprise, and secondly, for whom and under which circumstances investments in modern energy uptake and appliances leads to change the present condition (Kooijman-van Dijk & Clancy 2010). The research of Bates (1990) found that level of education has positive effect on making good business judgments, exposure to new technology, exploiting opportunities well and thereby contributing to business longevity and success. Age of an entrepreneur has close relation with the entrepreneurial success through its effect on growth ambition, determination and willingness to test abilities (Welter, 2001). So the demographic variable has significant

influence in up taking SHS. The demographic variable of the respondents is described in this section.

The role of age, education, ethnic diversity, gender, religion and marital status are included in the set of demographic characteristics. Total number of the respondents of this study is 47. Bangladesh is a highly masculine society. Most of the employment sector is dominated in number by the male. It is also observed by this study. Out of the 47 entrepreneur only one entrepreneur is female. As it was expected that the number of female entrepreneur in the village is small and don't have any significance influence, the sex feature of the entrepreneur is kept out of this study. According to the capability approach in the context of Bangladesh, age and the level of education has influence on the functioning and capability. The age and level of education of the respondents are presented in the Table 5.1.

Table 5.1: Age and Education Level of the Respondents

Age of the Respondents (n=47)		
Range of Age	**Frequency (No. of ME*)**	**Percent (%)**
18-30	12	25.5
31-50	26	55.3
51 and Above	9	19.1
Education Level of the Respondents (n=47)		
Education Level	**Frequency (No. of ME)**	**Percent (%)**
Illiterate	12	25.5
literate	7	14.9
Class 1 to Class 5	4	8.5
Class 6 to 10	15	31.9
SSC	8	17.0
HSC	1	2.1

* *ME = Micro-Enterprise*

In this study it was found that two of the respondents were Hindu and one was Christian, rest of the entrepreneur was Muslim. It was also found from the literature review that the religion of the entrepreneur has no influence on the technology adoption and ME performance, so it was not taken as a component of analysis. The study area of this study has a high density of Ethnic population compare to the other part of the

country. So the preliminary thought was that there will be a significant number of ethnic entrepreneurs. But it was found from the survey that the number of ethnic entrepreneur was only one, rest of the respondents was Bengali. From the survey it is found that 45 entrepreneur main occupations is business and two respondents main source of income is agriculture. Most of the surveyed entrepreneur's age fall between 31 year and 50 year, which is composed 55.3 percent out of total entrepreneur surveyed. The rate of literacy of Bangladesh is 69 percent. From the survey it was found that the rate of literacy among the respondents is 74.5 percent, which is similar to the country's literacy rate. Only 12 entrepreneurs (25.5 percent) are illiterate according to the survey. The rate of having formal education of the respondents is 60 percent.

So from the demographic data of respondents it can be said that the people who are doing business in the rural village market are mainly in middle aged and to greater extent got formal education. The data reveals that most are in the productive age according to the United Nations human development criteria (Garoma 2012).

5.3 Description of the ME

In context of Bangladesh, rural MEs encompass the enterprises most are related to Poultry & livestock, Cosmetics & General store, Electrical and Hardware store, Transportation, Grocery & Stationary, Barber Shop, Furniture shop, Cloth Business, Jewelry, Workshop, Food grain, Hotel & Restaurant, Medicine store, Book stall, other retail trades. Micro entrepreneurs come in all types and their businesses in many sizes and capital etc. Enterprises in this study divided into three broad sectors. The sectors are: i. Only Retail , ii. Only Service and iii. Both (retail and service). The types of Business are doing and business sector of the MEs are presented in Table 5.2. It is evident from the Table 5.2 that the retail sector dominant in the rural village market. Most of the shop do not confined themselves in only one type of business. In one confined shop they engaged themselves in various types of business that means the rural entrepreneurs have diversified their business most.

Capital is an important characteristic out of the basic characteristics of microenterprises. The capital of the MEs varies with the nature of business. The change in the MEs also to some extent depends on the capital of the enterprise. Through time however, some enterprise turn into a more profitable and better opportunity sector. Major

Portion of ME's capital found below 100,000 tk which is 60 percent out of total MEs. The capital of the surveyed ME is presented in the table 5.2

Table 5.2: Business Activity, Business Sector and Capital of the MEs

Business activity	**Frequency (No. of ME)**	**Percent (%)**
Pharmacy with Cloth Shop	1	2.1
General Store (Grocery Shop & Other)	10	21.3
Pharmacy with Song Load service	1	2.1
Cloth Shop with Tailoring service	2	4.3
Grocery Shop with Tea Stall	5	10.6
Rice Mill	1	2.1
Tea Stall	3	6.4
General Store (Grocery Shop only)	5	10.6
Pharmacy	8	17.0
Furniture Shop	2	4.3
Barber Shop	1	2.1
Rice Shop	1	2.1
Restaurant	2	4.3
Cloth Shop	1	2.1
Jewelry Shop	1	2.1
Electrical Shop with phone charging Business	1	2.1
Tea with cloth shop	1	2.1
Vehicle Repair shop	1	2.1
Business sector of the ME		
Retail	32	68.1
Service	2	4.3
Retail + Service	13	27.7
Capital of the ME		
Less than 50000 tk	17	36.2
50001 tk to 100000 tk	12	25.5
100001 tk to 200000 tk	8	17.0
200001 tk to 300000 tk	4	8.5
300001 tk to 50000 tk	6	12.8

Along with types, sector and capital of the ME, structure and ownership, formal registration, presence of bank A/C, keeping record of income and expenditure, staff, age of the ME, working duration and entertainment medium also play significant role for ME

development and work environment. The summary of different characteristics data of the surveyed MEs is presented in Table 5.3

Table 5.3: Summary of the characteristics of ME

Characteristics	**Responses (n=47)**		
Structure of the Shop	**Iron Sheet (%)**	**Semi Brick (%)**	**Brick Building (%)**
	63.8	31.9	4.3
Ownership of the shop building	**Own (%)**	**Rented (%)**	
	59.6	40.4	
Registration of the ME	**Yes (%)**	**No (%)**	
	61.7	38.3	
Type of Bank A/C maintaining	**Personal A/C (%)**	**Business A/C (%)**	**No A/C (%)**
	40.4	2.1	57.4
Keep record of your business income and expenditure	**Yes (%)**	**No (%)**	
	12.8	87.2	
Total Staff	**No One (in Number)**	**Salaried (in Number)**	**Family Member (in Number)**
	30	9	8
ME's approximate operating age	**Less 5 Years (%)**	**5 to 10 years (%)**	**Above 10 years (%)**
	14.9	19.1	66.0
Working days per week	**7 Days (%)**	**6 Days (%)**	**5 Days (%)**
	91.5	6.4	2.1
Working hours per day	**Below 8 hours (%)**	**8 to 12 Hours (%)**	**Above 12 Hours (%)**
	6.4	55.3	38.3
Entertainment medium	**Do not use any Medium (%)**	**Use some Medium (%)**	
	61.7	38.3	

From the Table 5.3 it can be said that the MEs remain 7 days a week (91.5 Percent) and operate 8 to 12 hours (55.3 percent) daily. Ownership of the shop building is an important determinant which enables the changes in the ME. 59.6 percent of the surveyed ME is doing their business in their own building. It is encouraging to observe that 61.7 percent ME have government registration.

5.4 Types and Number of Services Taken from SHS and Capacity of the SHS

For the analysis of energy uptake, it is useful to distinguish between the functions of energy service has within the enterprise (Kooijman-van Dijk & Clancy 2010). This is an important distinction to make, as not all SHS have the potential or are intended to contribute to income generation in the enterprise, or their contributions to enterprise functioning and impacts work in different manners. It also depends on the Wp capacity of the SHS. The energy services that the MES are taking have been categorized into some categories based on the purpose of use. These are for business (e.g. Weight Machine, Soldering Iron, Mobile Charging Business, Lending Lighting connection), for lighting, for comfort (e.g. Fan), entertainment (e.g. Sound Box, VCD, Satellite Dish, and TV), and energy for communication (e.g. Mobile Phone Charging for self), which are presented in Table 5.4. While the first category includes mainly specific services, the last three categories of energy uses occur in a range of sectors. Different categorical use of SHS is presented the Table 5.4

Table 5.4: Use of SHS

Purpose of Use	Frequency (No. of ME)	Percent (%)
For Business service	10	21.27
For Lighting	47	100
For Comfort	20	42.55
For Communication	36	76.6
For Entertainment	09	19.15

Table 5.4 provides an overview of how many MEs of the total sample of 47 MEs are making use of SHS for the different categories of services. Different types of services which are using SHS mainly depend on the Wp capacity of the SHS. The greater the capacity of the SHS the greater the electricity backup and higher rating electrical appliances can be used. Different types of services are taken by the MEs. The services the MEs are taking from the SHS are namely illumination, charging mobile phone, running small DC fan, powering TV, powering VCD, powering Satellite Dish and Soldering Iron. The number of lighting connection per system and other services that are used in the MEs are presented in Table 5.5.

Table 5.5: Purpose of SHS use (n=47)

No. Lighting Point	Frequency (No. of ME)	Percent (%)
1 Lighting Point	9	19.1
2 Lighting Point	18	38.3
3 Lighting Point	9	19.1
4 Lighting Point	5	10.6
5 Lighting Point	3	6.4
6 Lighting Point	3	6.4
Lending of Lighting Connection		
Lending with fair (1 Lighting Point)	4	8.5
Lending without fair (1 Lighting Point)	1	2.1
Phone Charging		
1 Charging Point for own mobile phone	32	68.1
More than 1 Charging Point for mobile phone charging business	4	8.5
No Mobile charging facility	11	23.4
Electrical Appliance Usage		
Fan	20	42.6
TV	8	17.0
Satellite Dish	2	4.3
Weight Machine	3	6.4
VCD	1	2.1
Sound Box	1	2.1
Soldering Iron	1	2.1

The SHSs are differentiated among others by their capacity to produce electricity and is calibrated in terms of Wp. Number of services taken by the entrepreneurs are also different according to their need, capacity and tactics. The numbers of services taken by the entrepreneurs are given in Table 5.6.

Table 5.6: No. of service taken from SHS by the entrepreneurs (n=47)

No. of Services	Frequency (No. of ME)	Percent (%)
1 Type	9	19.1
2 Types	9	19.1
3 Types	21	44.7
4 Types	8	17.0

As the MEs are using SHS for different purpose, so the capacity of the SHS is also crucial. SHS are also different by different system capacity. System capacity of SHS in the surveyed MEs is presented in Table 5.7. From the table it can be found that which

capacity of SHS dominant in the typical rural MEs. Not all the MEs using their own SHS, one of the surveyed ME rented his SHS connection from the neighbor enterprise.

Table 5.7: System Capacity of SHS of the MEs (n=47)

System Capacity	Frequency (No. of ME)	Percent (%)
10W	2	4.3
20W	13	27.7
40W	3	6.4
50W	10	21.3
65W	9	19.1
85W	8	17.0
Greater than 85W	1	2.1
Rented	1	2.1

It is also important to note that with the course of time and rapid change in the technology the size and price of the solar PV technology also changed. The price of the different size of SHS also reduced remarkably from the past. So the up taking rate has also changed over the years. The rate of adoption of SHS in the MEs according to some specific range in year is presented in Table 5.8.

Table 5.8: SHS up taking year of the MEs (n=47)

Year	Frequency (No. of ME)	Percent (%)
Before 2004	7	14.9
2004-2006	5	10.6
2007-2009	6	12.8
2010-2012	18	38.3
2013-2015	11	23.4

The choice of the capacity of the system depends on when the choice was made. Those who up take SHS early were of wealthier entrepreneurs. Early up taker have purchased higher capacity SHS because they were able to afford it and also because the energy services demanded could not met by lower capacity systems. Over time, however, lower capacity and cheaper systems came on the scene and could meet energy service demand obtained previously only from higher capacity and costlier systems. For this reason, purchasing of small size SHS increased in the recent time in the surveyed ME.

5.5 Role of Different Characteristics of the Entrepreneur and ME on the Capacity and Usage of SHS

From the previous sections of this chapter, it is found that the use of SHS for other than lighting purpose is not remarkable. Capacity and use of SHS for different purpose is also different. That means that the capacity and use of SHS also differ according to the characteristics of the entrepreneur and ME. Types of service taken from SHS depend not only on the characteristics of the entrepreneur and ME but also with the capacity of the SHS. The Pearson correlation tells the strength and direction of a relationship between two quantitative/numerical variables (Johnson & Kuby 2007). A Pearson correlation analysis was conducted to examine whether there is a relationship between usages of SHS with the capacity of SHS. The results revealed a significant and positive relationship ($r = .558$, $N = 46$, $p = .000$). The correlation was positive and strong in strength. Higher types of use of SHS are associated with higher capacity of SHS (For details see *Appendix VI*). That means the higher the capacity of the SHS, the entrepreneur are taking more number of services from the SHS.

Individual relationship between age and education level of the entrepreneur, business sector, capital and SHS up taking year of the ME with the capacity of the SHS and number of services taken from the SHS is presented in Table 5.9. Now if it is looked at the individual relationship between the characteristics of the entrepreneur and the ME, the result reveals that age and education level do not have any significant relation with the system capacity of SHS and number of services taken from SHS by the entrepreneur. But significant relationship exists between capital of the ME and number of services taken from SHS. The ρ value .304 and .376 indicate that there is a moderate correlation between the capital of the ME and number of services taken from SHS by entrepreneur. As the ρ values are positive, which are 0.304 and 0.376; it can be understand that as the capital of the ME increases, system capacity of SHS also increases, and for number of services taken from SHS increases with the increase of capital of the ME. On the other hand the ρ value between the SHS up taking year and system capacity is -0.558 which tells that the correlation between them is strong and their relationship is also strong. The Pearson correlation value (ρ value) between SHS up taking year and system capacity is -0.558 which indicate that in the recent years SHS up taking of lower system capacity increases.

Table 5.9: Pearson Correlations analysis of characteristics of the entrepreneur and the ME with the system capacity of SHS and Number of services taken from SHS

	System Capacity of SHS	Number of Services taken from SHS
Age	.233	.026
Education Level	.020	-.053
Types of Business sector	-.031	-.138
Capital	.304*	.376**
SHS Up Taking Year	-.558**	.121

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Age and education level of the entrepreneur, business sector, capital and SHS up taking year of the ME are taken as independent variable, capacity of the SHS and number of services taken from the SHS is identified as intervening variable for this study. But for the 1st empirical relation, which has discussed in the third chapter in analytical framework, capacity of the SHS and number of services taken from the SHS is considered as dependent variable. To what extent the empirical relation is matched with this study survey data, it can be found from the regression analysis. Linear regression analysis was conducted to examine whether set independent variable (For 1st empirical relation: age and education level of the entrepreneur, business sector, capital and SHS up taking year of the ME) impact on the two dependent variable (For 1st empirical relation: capacity of the SHS and number of services taken from the SHS). Summary of the linear regression analysis is presented in Table 5.10 for both the dependent variable capacity and number of services taken from SHS by the entrepreneur (for details see *Appendix VII*).

Table 5.10: Summary of the linear regression analysis for 1st empirical relation

System Capacity of SHS			**Number of services taken from SHS**		
R^2= .360	Adjusted R^2= .280		R^2 = .171	Adjusted R^2= .070	
ANOVA Sig. (ρ) = .002			ANOVA Sig. (ρ) = .159		
Coefficients			Coefficients		
	Beta	Sig.		Beta	Sig.
Age	.255	.234	Age	.012	.934
Education Level	-.023	.863	Education Level	-.045	.768
Types of Business sector	-.029	.829	Types of Business sector	-.162	.283
Total Capital	.143	.300	Total Capital	.340	.032
SHS Up Taking Year	-.499	.001	SHS Up Taking Year	-.023	.881

From Table 5.10 it can found that The R-square is the proportion of variation in the dependent variable (System capacity of the SHS and number of services taken from SHS) that is explained by the five independent variables. It is expressed as a percentage. So 36 percent of the variation in system capacity of the SHS can be explained and 17.1 percent of the variation in number of services taken from SHS by the entrepreneur can be explained by five independent variables (age and education level of the entrepreneur, business sector, capital and SHS up taking year of the ME) in the 1st empirical relation.

The Table 5.10 also tells whether the overall effect of the five independent variables on capacity of the SHS and number of services taken from the SHS is significant or insignificant. The sig. (or ρ-value) for capacity of the SHS is .002 which is below the .05 level and number of services taken from SHS is .159 which is above the .05 level; hence, it can be concluded that the 1st empirical relation is statistically significant for system capacity of SHS and statistically insignificant for number of services taken from SHS with the five independent variables, or that the independent variables have a significant combined effect on the system capacity of SHS and no significant combined effect on number of services taken from SHS. By looking at the individual significant value (ρ-values) from the Table 5.10, it can be seen that SHS up taking year (Coefficients sig. = .001) is significant predictors (or significantly related to) of system capacity of SHS and total capital of the ME (Coefficients sig. = .032) is significant predictors (or significantly related to) of number of services taken from SHS by the entrepreneurs. The standardized beta tells us the strength and direction of the relationships. System capacity of SHS is negatively related to SHS up taking year. Recent SHS up taking year correspond to use of SHS of lower system capacity by the entrepreneurs and the higher capital of ME corresponds to higher number of service taken from SHS. Age, education level and total capital of the ME are not a significant predictor of system capacity of SHS. And age, education level and SHS up taking year are not a significant predictor of number of services taken from SHS by the ME.

From the study it has been found that the main purpose of using SHS is for illumination or lighting purpose. Among the MEs, 2 lighting connection/point is used most. A crosstabulation was done between the independent variable and different types of use by SHS. No significant findings or SHS usage pattern were come out from the crosstabulation. But it was found from the study that the rural MEs are using SHS for various income generating activity. The way the rural entrepreneur are using SHS as an

income generating tool are as lending lighting connection to the neighbor shop with fair, by doing mobile charging business, running weight machine and Soldering Iron with the help of inverter[4]. One entrepreneur is doing his poultry business with the help of the heat produced by the SHS light. So the rural entrepreneurs are using the SHS for various types of services. The study of Sadeque et al. (2014) found that the 20Wp capacity of SHS is gaining popularity in the rural Bangladesh. It was also found from the study that the rural MEs those who buy SHS in the recent years, they are buying the smaller capacity (mainly 20Wp) SHS. The typical services the 20Wp capacity SHS can give serve two LED light, a mobile phone charging point and a additional point for small DC fan. Without running the DC fan for longer time the 20Wp capacity can give 4 hours backup at the night time or at bad light.

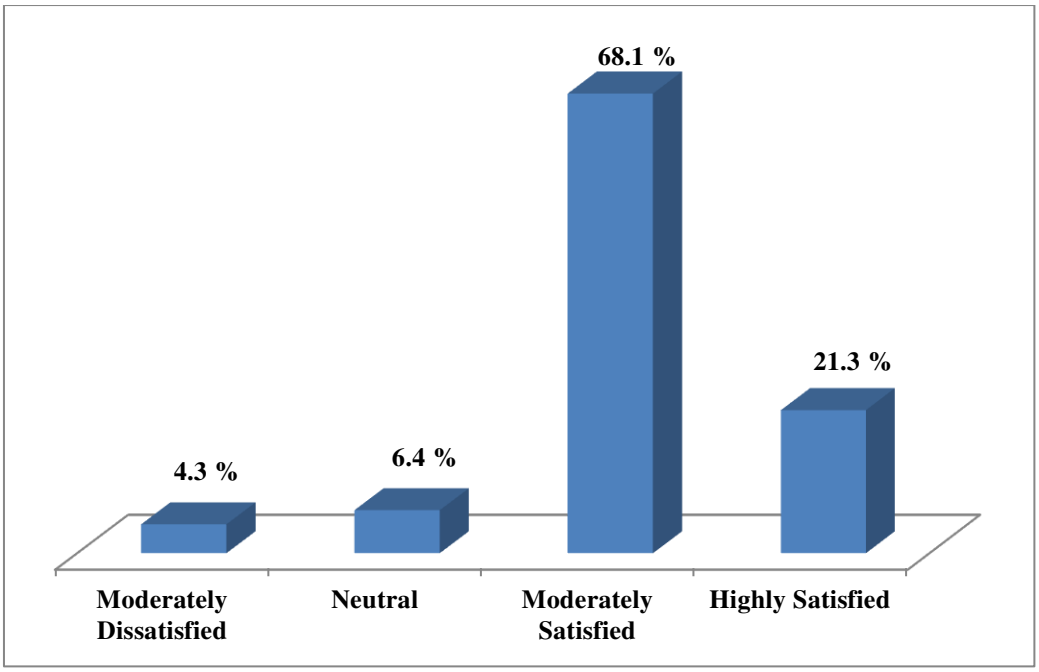
The most prominent use of SHS in the rural off grid MEs are better illumination. As better light is needed for everyone and the cost associated to full fill this demand is not that much in the rural off grid area, the rural MEs where the grid connection is not available are taking the opportunity to buy SHS. And also the rural market which are about to get grid connection within short period time, the entrepreneur of that market are also purchasing SHS of small capacity (20Wp) considering the poor quality of grid electricity supply. The study also found that those entrepreneurs are wealthy, they adopt SHS early and the capacity is also large. Over the time the price of different size's SHS decreases and the adoption rate also increases among the entrepreneur whom business capital is less than 100000 tk.

Being the device most frequently used by all households, their average usage time was about 215 minutes per day for lighting purpose. Mobile phone chargers (in 76.1 percent of total surveyed entrepreneur) and running small fan (in 43.5 percent of total surveyed entrepreneur) were other prevalent devices. Their average daily usage time was stated as 150 minutes for phone chargers and 120 minutes for running small DC fan. Table 5.5 displayed some typical appliances used by the rural entrepreneurs. SHS users were generally satisfied with their system (see Figure 5.1). Figure 5.1 shows the SHS usage satisfaction levels among the survey entrepreneurs. As the figure shows, 68.1 percent of the survey entrepreneurs were moderately satisfied with their SHS usage. All

[4] Inverter is an electronic device which converts DC current to AC current.

the survey entrepreneurs gave their opinion comparing with the grid electricity use rather than comparing with the previous energy sources.

Figure 5.1: Satisfaction Level of the Entrepreneur about SHS use (n=47)

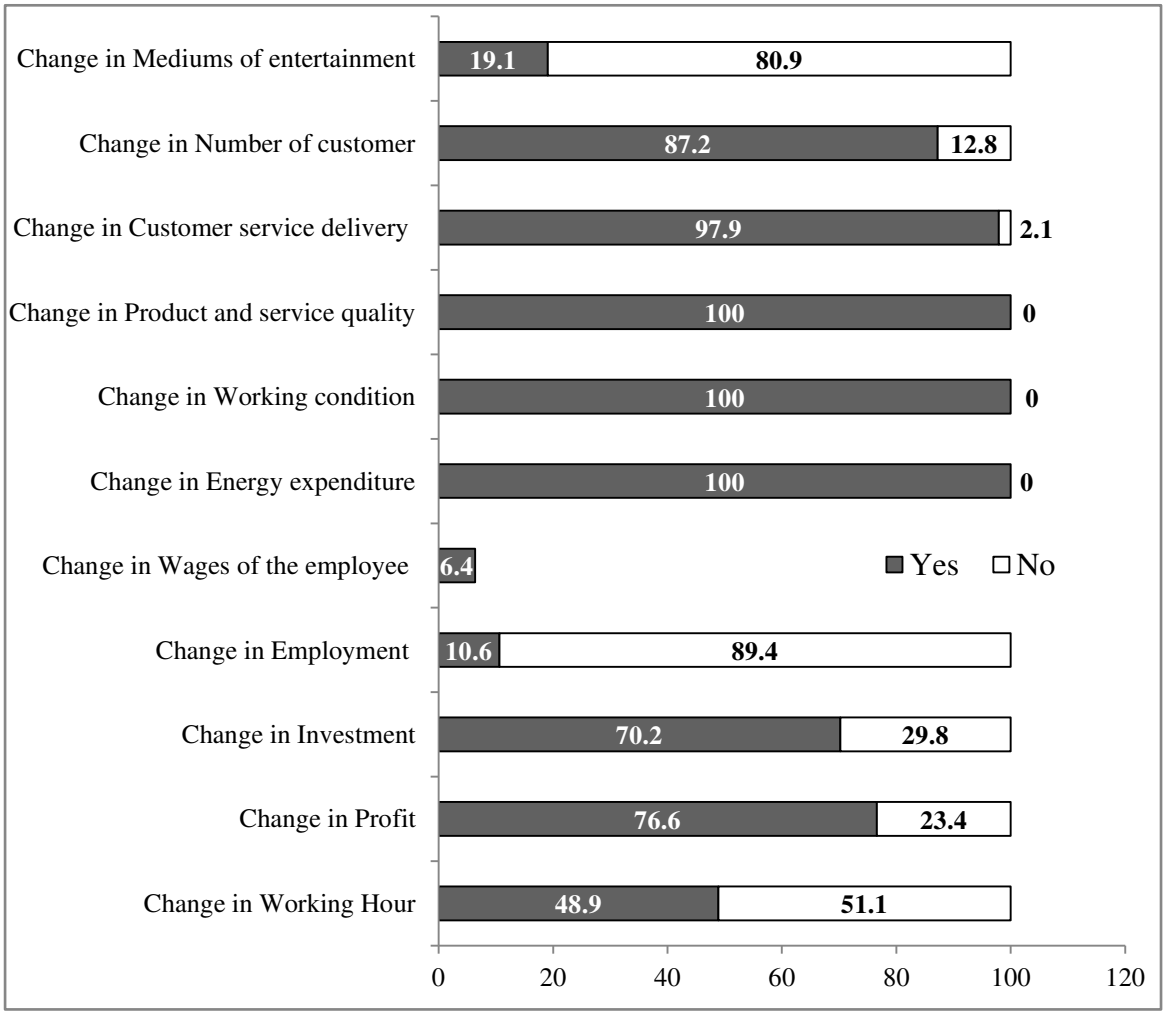


What capacity of SHS entrepreneur buy thus apparently depends on many factors. These need to be considered together. While the presented data indicate that the pattern may not be much systematic and the explanatory power of the independent variables together is not much. But still it can be said from the presented data and analysis that the capital of ME is a significant factor for the types of use and capacity of SHS.

5.6 Changes in the ME after Up Taking SHS

The objectives and answers of the research questions of this study lies in the presented data regarding the changes that the MEs are encountering after up taking SHS. The data which will explain the dependent variable of this study's analytical framework (which has discussed and presented in the third chapter) is presented in this section. Based on the data of this section discussion and analysis have carried in the next sections. The indicators of the dependent variable are drawn from the literature review and the indicators of the dependent variable are presented in Table 3.1 in the third chapter of this study. The changes that the MEs have experienced are given in Figure 5.2.

Figure 5.2: Change observed by the ME (n=47)



Change in different aspect related to the dependent variable is presented in the Figure 5.2. But to what extent the entrepreneur thought that the experienced changes are due to the adoption of SHS, is analyzed and discussed in the next sections. It is presented in the previous section that only 9 MEs have salaried employee. Out of the 9 MEs who have salaried employee, only 5 MEs appointed new worker for their enterprise. For this reason the respondents answer regarding change in employee is only 6.4 percent. Same explanation is also applicable for change in medium of entertainment. The level of changes observed by the ME is presented in the Table 5.11. The level of change is mainly based on the perception of changed observed by the entrepreneurs over the time after up taking SHS in their ME. Data were not collected in quantify value rather these data are the perception of the surveyed entrepreneurs.

Table 5.11: Descriptive statistics of the level of changes observed by the ME

Change Indicators	N	Min	Max	Mean	Std. Deviation	Comment	Measuring Level
Working Hour	47	3	7	4.83	1.090	A little Increase	1 =Highly Decreased 2= Moderately Decrease 3= A little Decrease 4= No change 5= A little Increase 6= Moderately Increase 7= Highly Increase
Profit	47	1	7	5.19	1.154	A little Increase	
Investment	47	2	7	5.09	1.231	A little Increase	
No of Customer	47	2	7	5.17	1.340	A little Increase	
Energy Expenditure	47	1	7	5.30	2.136	A little Decrease	1 =Highly Increased 2= Moderately Increase 3= A little Increase 4= No change 5= A little Decrease 6= Moderately Decrease 7= Highly Decrease.
Working Condition	47	1	2	1.77	.428	Partial Change	1 = Complete Change 2= Partial Change 3= A little Change 4= No change
Customer Satisfaction	47	1	4	1.68	.695	Moderately Satisfied	1=highly Satisfied 2=Moderately Satisfied 3= a little satisfied 4= No change 5= Dissatisfied

From Table 5.11 it can be said that the change level are not that much significant but the situation has improved from the past. The working hour of the MEs has increased a little after up taking SHS. Not only the working hour but also the other change indicators have little or moderately changed to positive direction. Some of the entrepreneurs experienced a little decrease in working hour; been highly decreased in profit; reduction in number of customer and reduction in investment. The reason behind these negative experienced is that they failed to remain competitive in the market in current time. The change in the energy expenditure revealed that the experienced is mixed. In recent time the rate of SHS up taking has increased. Those who have taken SHS recently their installment is not fully paid. So they observed increase in energy expenditure. The data presented in Table 5.11 encompasses all the surveyed MEs responses. From Table 5.11 it can be said that the level of change is little those are directly monetary related. The room for change in the number of customer is little through the use of SHS. Diversification of business can increase the number of customers. After up taking SHS, the entrepreneurs thought that their customers are more satisfied than before. More explanation, relation between the different variable and discussions are presented in the following sections.

5.7 Relationship between the Personal and Business Characteristics with the Change in the ME after up Taking SHS

The changes that have occurred for the introduction of SHS are dynamic in nature. The change varies according to the personal characteristics and business characteristics. To find the relationship, a bivariate correlation analysis has conducted between the personal and business characteristics with some selective aspect of changes of ME. The selection of the aspect of changes is based on the number of responses. Where the total response for the change was more than 30, the aspect of changes was considered for this analysis. The summery of the bivariate correlation analysis is presented in Table 5.12.

Table 5.12: Summary of the Pearson Correlation matrix between independent variables and some selected dependent variables of this study

Change Indicators	Age	Education Level	Types of Business sector	Capital	SHS Up Taking Year
Working Hour	-.223	.148	.172	.156	-.196
Profit	-.040	.127	.157	.390**	-.028
Investment	.007	.020	-.263	.528**	-.166
Energy Expenditure	.089	-.124	-.091	.322*	-.345*
Working Condition	-.053	-.075	-.181	-.001	-.040
Customer Satisfaction	.048	.120	.134	-.103	.131
No of Customer	-.012	.047	-.054	.433**	-.114

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The aspect of changes left out from the Table 5.12 are *change in employment, wage of the employee and medium of entertainment, product and service quality due to inadequate number of data and inappropriate level of data for the correlation analysis.* That means the changes brought to employment, wage of the employee and medium of entertainment is too small that further quantitative analysis is redundant. The question regarding change in the product and service quality was set in dichotomy and answer for

the question was constant in nature. For this reason correlation analysis about change in the product and service quality is kept out of the table 5.12.

From the Table 5.12, it can be accredited that capital of the ME has significant positive relation with the change in the profit, investment, energy expenditure and number of customer. The negative correlation between the SHS up taking year and change in energy expenditure reveals that the recent SHS adopters are spending more money than before adopting SHS. The reason is that most of the SHS was purchased by installment (taking loan from the IDCOL PO). Those who adopted SHS earlier they have already repay all the installments but those who take SHS recently they are yet to pay off their loan amount/installment. From this study it has found that 87 percent (40 entrepreneurs) entrepreneurs have bought their SHS by installment. Out of them, 60 percent (24 out of 40) have already paid off their loan.

By taking the independent variables (age, education level, types of business sector, Capital of the ME and SHS up taking year) as predictors and change in different aspect of the ME as dependent variable, linear regression analysis was executed (for details see *Appendix VIII*). The regression analysis reveal that percentage of the variation of change in the ME explained by independent variables (age and education level of the entrepreneur, business sector, capital and SHS up taking year of the ME) is low for every changes in the ME. Change of investment is the only change which can be significantly explained (30 percent) by independent variables, and only capital of the ME is a significant prediction of the relations. It can be concluded from this section is that capital of the ME is the most significant factors which influence the changes in the ME

5.8 Relationship between the Capacity and Use of SHS with the Change in the ME

Most of the previous study regarding role of SHS for socio-economic development reveals that the un-electrified rural areas are observing many changes, for rural MEs the changes are discussed in the third chapter of this study. It is found by Bond et al. (2015) that different system capacity and use of SHS give different development impact. So to what extent the size and use of SHS is influencing the changes in the MEs and relation between them is discussed in this section. Different usage and size of SHS is presented in the Table 5.4, Table 5.5 and Table 5.6. The relationship between the size and use of SHS is also analyzed in the section 5.5.

From the 2nd empirical relation which has got from the analytical framework of this study, it can be found that the changes in the ME are related with the use and size of the SHS. The bigger the size of SHS the more the backup it can give and the more appliances can be used which will in term facilited the change of the ME in different aspect. To have a comprehensive idea about the individual role of size and usage of SHS on the changes of ME, a correlation matrix is developed between the SHS capacity and number of services taken from SHS with some selective aspect of changes in the ME. The summary of the matrix is presented in the Table 5.13.

Table 5.13: Summary of the Pearson Correlation matrix between intervening variables and some selected dependent variables of this study.

Change Indicators	SHS's peak capacity	No. of Services taken from SHS
Working Hour	.098	.076
Profit	.264	.373**
Investment	.337*	.349*
Energy Expenditure	.163	.171
Working Condition	-.017	.079
Customer Satisfaction	-.158	-.034
No of Customer	.265	.363*

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Why some aspects of changes are kept out of the analysis presented in Table 5.13 is already explained in the previous section. From the Table 5.13 it can be found that there is no impact of different size SHS on the changes in the enterprise. Whatever be the size of SHS, the change in the MEs do not differ significantly except change in the investment. It can be said from the survey data that those who are using higher capacity of SHS and higher number of services the rural MEs are taking, they have observed more change in the investment in their ME. That mean their business has been expanded. The discussion on the role of SHS for the aspect of changes which is stated in the variable matrix Table 3.1 is presented in the next section. The answer of the research questions will also get from the next section. By answering the questions, objectives of this study will also achieved.

5.9 Discussion on the Role of SHS for Bringing Change in the ME

Data from the previous section tells that the change of the MEs for different aspect was different. And the change in any individual aspect for the different entrepreneur is also different for different reasons. It is also matter of question whether the changes which are observed by the MEs are due to the use of SHS. Those who experienced change in different aspect in their ME, their opinion regarding the influence of SHS are presented in the Table 5.10. The measuring scale of influence was: 1 = high influence, 2 = moderate influence, 3 = a little influence and 4 = no influence.

Table 5.14: Descriptive statistics of influence of SHS for observed changes

Change Indicators	N	Minimum	Maximum	Mean	Std. Deviation	Influence of SHS
Working Hour	23	1	4	1.70	1.063	Moderate
Profit	36	1	4	2.47	1.082	Between Moderate and a little
Investment	33	1	4	2.97	1.237	a little
Employment	5	2	4	3.40	.894	Between a little and No
Employee Wage	3	4	4	4.00	0.000	No
Energy Expenditure	47	1	2	1.02	.146	High/Strong
Working Condition	47	1	2	1.77	.428	Moderate
Products and Service Quality	47	1	4	2.17	.916	Moderate
Customer Service Delivery	46	1	2	1.61	.493	Moderate
Numbers of Customers Drawn	41	1	4	2.29	1.101	Moderate
Entertainment Medium	9	1	4	1.33	1.000	High

In Table 5.14, N denotes the number of entrepreneur (who observed changed in their ME) opinion about the influence of SHS for the respective changes. This section has tried to analyze the role of SHS for brining change in the rural MEs by a systematic approach. At first nature of change and role of SHS is analyzed. After analyzing all aspect of the change and role of SHS for the change, the relationship between the capacity and use of SHS with the changes of MEs in different aspect are analyzed and discussed.

5.9.1 Change in Working Hour

The prime benefit of SHS for the ME in the rural areas is that the use of solar light after sun set. The use of SHS enables the rural ME to extend their working hours. From the survey it was found that the changed in working hour observed by the SHS is about fifty-fifty (Table 5.8). The question arises whether due to the introduction of SHS has any influence on the change in working. After getting the data regarding the question "To what extent do you think SHS has influences the changed in working hours of your enterprise?" it can be said that those who have observed changed in their working hours have strong influence of SHS (Table 5.14).

Box 1

Case 1: Mr. A is doing business in Tinali Bazar since 2008. He started his business with tea stall. After taking SHS in the year 2011, he started to sell grocery item from his shop. When he started his tea stall, he closed his shop at around 10 pm. After taking SHS, his volume of business and number of customer have changed but the working hour did not change, because after 10pm the number of customer is not sufficient for doing business. So he closes his shop at 10pm. For the lack of customer despite having SHS, his working hour did not change.

Case 2: Mr. B is doing business in Fandar Bazar since 1995. He tooke SHS in the year of 2013. He runs a pharmacy. He also did a LMAF course and give consultancy to his patients besides selling medicine. He also attends outdoor call. He had closed his shop at 8pm before up taking SHS. After stating using SHS, still he does not stay at his shop beyond 8pm, due to lack of customer.

Case 3: Mr. C is doing business in Bipinganj Bazar since 1996. SHS was introduced in the market in the year of 2004. He runs a grocery shop. He had been closing his shop at 7pm before 2011. Until the year of 2011 the number shops which were using SHS was small in number. But after that rate of adoption of SHS increased and the working hour of those shops also increased. To remain competitive in the market he started to close his shop at 9 pm. Due to indirect influence of SHS his working hour changed. Realizing the need of SHS, he bought SHS of 40W from GS in installment. But after up taking SHS his working hour sremain same. He did not observed any change in his working hour.

It is observed during the survey data that some MEs in the study area remain open till 11pm those closed earlier when they were using kerosene burned light. The change in the working hour in the MEs is ranging from 1 hour to 5 hours. From this study it is found that the average changes in the working hour is about 2 hours among the MEs those who have experienced change in the working hour. Those who have diversified their businesses and investment have changes they experienced more change in working hour compare to the other enterprises. They also expressed that the influence of SHS on the change in their working hour is high. The change in the working hour among the different sector is not that much significant. For the MEs, those do both retail and service business experienced less change compare to others, the type of business they are mostly doing is the Pharmacy and Cloth and Tailoring shop. The customer of those MEs is nearly fixed. The change in the working did not occur for 51 percent of the shop which is big in number. The reason behind this lays in the nature of business and volume of customer and also the introduction time of SHS in the market. If the case of the box is analyzed it is found that the customer density and first up taking of SHS by the market has influenced the phenomenon of no change in the working hour. The reasons with case study for not changing in working hour are explained in Box 1.

The previous studies which have discussed in the change in working hour are mostly qualitative in nature. The study of Chowdhury (2006), Kurschner et al. (2009), Harsdorff & Bamanyaki (20090, Mondal & Klein (2011), Pode (2013), Asaduzzam et al. (2013) found positive change in the working hour of the ME but their study did not compare the working hour among all the MEs in the market. The previous studies only told the stories those have experienced the change. This study has tried to explain the change in working hour comparing all the MEs of the market.

5.9.2 Change in Profit

The economic impacts of the SHSs are limited to an increase in income of shops and small businesses (Blunck 2007). Most of the study involved in dissemination of SHS in Bangladesh clearly emphasized the potential of SHSs for income-generating activities (Chowdhury 2006; Kurschner et al. 2009; Chakrabarty & Islam 2010; Mondal & Klein 2011; Urmee & Harries 2011; Islam et al. 2011; Pode 2013). Furthermore, the use of SHSs in rural market of the off grid area for increasing income were frequently mentioned. Irrespective of SHS utilization, the number of overall change on the profit

(Income) was quite low. Those entrepreneur who observed changed in the profit in their MEs, they expressed that the influence of SHS on this change is moderate. 20 percent of the surveyed entrepreneur answered that the influence of SHS over the change in profit is strong. Out of the surveyed entrepreneurs only 10 entrepreneurs (21.27 %) are making money directly by the use of SHS, rest are using SHS consumptively rather than productively.

From the study, it is found that some entrepreneurs are using SHS for productive purpose such as phone charging business, lending lighting point with fair, powering weight machine and Soldering Iron. Due to the presence of SHS the entrepreneurs also think that they have gained partial control over the change in the profit. The number of MEs those diversified their business after acquiring SHS is also significant in number. During the study it was observed that the most notable diversification of the business was the grocery shop. Now they have introduced mobile recharge and mobile money transfer business in their enterprise. One entrepreneur also started song load business in his shop beside his regular business. Those who have diversified their business in different aspect the profit of their business also increase.

Most activities were conducted during daytime and the provided solar electricity capacity was too small for the use of productive appliances or machinery. Only three entrepreneurs of grocery shop were using SHS for powering weight machine, illuminating of one poultry farm by the use of heat and light of the SHS. Even though predicted by most study, change in profit due to use of SHS were not yet very prevalent. The observation was in many cases that, most of the MEs have observed positive moderate change in their MEs. One thing is that those capitals are comparatively high they observed more change in their profit in monetary value. Most previous studies also shared this notion. The reasons behind this change in the profit are attraction of a new clientele, higher income from regular customers, diversification of offered services, longer working hours etc.

Entrepreneurs stated that SHS ownership is an important factor for local competition. However, this at the same time revealed a potential critical issue. It's observed during the study that some customers are fixed for specific shop. Those entrepreneur diversified their business have observed increase in income. It was an important factor for change in the profit of the ME. It is also found that those ME's

capital is below 50000 tk, they also bought medium and higher size of SHS. But they utilize their SHS as an income source. Some cases are explained in the Box 2 for better understanding the changes in the profit. Fifteen entrepreneurs were able to quantify their change in profit. Among them average in the profit is 3466 tk (with standard deviation of 3419 tk) among the entrepreneurs who observed change in their MEs. From these data it can said that profit has varied in wide range among the MEs. From the previous section it has found that those wealthier entrepreneurs observed high level of change in profit compare to the poor entrepreneurs. The average change in profit among the MEs also identical to the analysis of section 5.7.

Box 2

Case 4: Mr. D runes grocery shop in Bipinganj Banzar since 2008. In the year 2011, he bought 65Wp SHS from RSF. After taking SHS, he added mobile money load and mobile money transfer business. Additional to this, he started mobile charging business. He takes 5tk for each mobile charging. He charged 10 mobiles per day. So addition income is about 1500tk per month. He also gets additional benefit from the mobile money load and mobile money transfer business. The customers who come to his shop for mobile money load and mobile money transfer business and mobile charging also bought grocery item from his shop. This way the profit of his business has doubled after up taking SHS.

Case 5: Mr. E is doing business in Baromari Lakshipur Bazar since 2001. He runs grocery shop. He brought SHS in the year 2012. The capacity of the SHS is 65Wp. After taking SHS, he lends one lighting point to the neighboring shop with fair of 300tk.He also start a side business of "Caram playing" in the night with fair. He takes 5 tk for every game. With these additional businesses he earns additional 2000 tk per month.

5.9.3 Change in Investment

The diversification of the business was a prominent change in the MEs that has observed during the survey. Diversification of business means additional investment. As the MEs in the surveyed area have stared additional income earning activity, the investment has also increased. The greater diversification was the introduction of mobile money load and transfer business which required small capital to operate. The volume of business also increased due to the extended working hour and increase in the number of customers. Due to the improvement in the lighting the entrepreneurs also increases their

number consumer items in their enterprises. It is found from this study that the influence of SHS on the change in the investment is little (Table no 5.14). The entrepreneurs those have diversified their business in other than mobile related business, they expressed that the diversification of their business has occurred due to meet up the growing demand of the customers and from aspiration to expand their business. There is no relation between the diversification and introduction of SHS in their enterprises.

The study of Peters et al (2014) and Liljefors & Sahlin (2014) found that SHS increases business activities slightly and also created business opportunity. From this study it is also evident that those who experienced change in investment in their MEs did not change the investment radically. The capacity of SHS is not adequate to expand business enormously because SHS cannot run high power devices like drill machine or lathe machine or refrigerator. So the scope is also limited for SHS. Within this limited scope the MEs change in investment can be considered significant. Sixteen entrepreneurs were able to quantify their change in investment. Among them average change in the investment is 25937 tk (with standard deviation of 18727 tk) among the entrepreneurs who observed change in their MEs.

5.9.4 Change in Employment

Most of the rural MEs run by single person. As the capital is also small the creation of employment by the rural MEs is also limited. But due to the use of better working condition, many enterprises have started doing business with SHS. It creates self employment. During the survey it was found that only 9 MEs have employee and in 8 entrepreneur's family member is working. After up taking SHS only 5 MEs have recruited new employee. But the influence of SHS was zero. The direct influence in the creation of employment opportunity in the MEs is not seen from this study. However the new employment was influenced by the increase in investment and diversification of business. The study of Chowdhury (2006) showed that SHS generate employment opportunities for the unemployed. Kurschner et al. (2009) found in their study that there is a low ratio of job creation. Business expansion resulted in the creation of a new job in only three out of 36 cases in their study. By the analysis of the data of the key informants, it has found that the number of MEs have increased in the surveyed market remarkably since the introduction of SHS in the market. The data about the net increment of MEs in the surveyed market is presented in Box 7. The key informants have stated that they think

that there is no relation between the new establishment of MEs and introduction of SHS in the market. But the role of SHS for creating self employment can't be denied. During the study it has observed that some new ME have been started because of SHS only. These businesses are computer center and SHS equipment supply and repair shop. It is also seen during the survey that some entrepreneurs have closed their business after up taking SHS. The reason behind the closer is that they were unable to remain competitive in the market and generate sufficient income to run his family. The direct causal relation between the employment generation and up taking SHS is not noteworthy.

5.9.5 Change in Wages of the Employee

The role of SHS for changing the wages of the employee is not seen by this study. The entrepreneurs whose employee's wage has changed, they told that there is no relation between the up taking SHS and change in the wage. Neelsen and Peters (2011) found little direct impact on worker remuneration. In this study, it is also found that the changes in the wage occurred only for 3 MEs. There is no direct relation between the change in the wage and use of SHS. From the observation it has found that one of the furniture shop employee's wages has changed. The reason behind this was that the work load has increased of the carpenter due to the increase in demand of furniture and extension of the working hour. The shop owner increases his employee wages considering the inflation and work load. So the direct relation was not present there but a remote relation was there between the extended working hours due to the use of SHS in the ME. So the role of SHS for change in wage of the employee is not observed by this study.

5.9.6 Change in Energy Expenditure

After extending working hour of the ME, the prominent benefit of the SHS is reduction in the use of kerosene. Reduction in the energy expenditure has been observed by many studies (Kurschner et al. 2009; Obeng & Evers 2010; Mondal & Klein 2011; Islam et al. 2011). This study found mixed experience regarding reduction in the energy expenditure. All the surveyed MEs have experienced change in their energy expenditure. But the analysis on the change in the energy expenditure shows that 61 percent of the surveyed ME's energy expenditure has decreased. The rest's energy expenditure has increased. It is observed from this study that those who repay the all installment, they think that their energy expenditure has come to nearly zero. But the installments of those MEs are not completed observed increase in the energy expenditure.

Two cases are explained in Box 3 for better understanding of change in energy expenditure due to up take of SHS.

The typical cost of lighting kerosene lanterns was 200 tk to 500tk. It is observed that the ME's whose energy expenditure was low before up taking SHS, they bought small size SHS namely 20W and 30W. The installment of the small size SHS vary from 300 tk to 415 tk. For the bigger size SHS, the installment is 700 tk to 1050 tk. The choice of different size SHS is also different for the MEs. The relation between the capital of the ME, nature of business with the choice of different size SHS has no specific pattern.

Box 3

Case 6: Mr. F is doing business in Kamarkhali Bazar since 2009. He runs a pharmacy. The capital of his enterprise is 150000tk. In the year 2011, he bought 85Wp SHS from BGEF by installment of 1050tk per month. Before that the energy expenditure was 250 tk per month. The energy expenditure has increased by 800 tk per month. He faced some difficulty in paying installment in the first few installments. After few months he bought a small notebook and started song load business beside his regular business. He charged 10 tk for 15 songs to load in the mobile phone. The average daily customer of the song load is 3. Additional income increases to about 1500tk per month. After starting the song load business he faced no difficulty to give the installment. He also bought a TV card and enjoying TV since then. His medium of entertainment also changed.

Case 7: Mr. G is running a vehicle repair shop in Tinali Bazar since 2002. He bought his SHS (20W) in the year 2013. He closed his shop before evening when he did not use SHS. He did not have any energy expenditure before up taking SHS. After up taking SHS, his energy expenditure has increased. Some installment is yet to pay. His monthly installment is 350 tk. Now he has to spend additional 350 tk monthly for energy. It can be said that his energy expenditure has increased. But his working hour has increased by 1 hour. Now he is earring additional 300 tk monthly. Still he lags 50 tk per month. But He is expecting that when full installment will be paid, no cost of energy will be there.

Due to the use of SHS, it has found from the survey that MEs have gained full control over their energy expenditure. But one pattern has identified from the survey that those MEs uptake SHS before the year 2012 they bought medium size (40W and 50W) SHS and big size (65W and above) SHS. After that all MEs bought small size (20W and 30W) SHS. The study of Blunck (2007) explored that the high initial costs during the repayment period of the loan is not affordable to low and medium-income households.

The study also found the same findings. MEs whose capital or use of SHS is limited it did not create any opportunity or change in their MEs.

5.9.7 Change in Working Condition

The main benefit of SHS is the lighting facility. From the survey it has found that all entrepreneurs have experienced change in their working condition. About 25 percent of the surveyed entrepreneurs stated that working condition has completely changed and the rest observed partial chance in their working condition. SHS has a strong influence over the change. It was observed during the survey that all entrepreneurs are feeling comfortable when they are conducting their business. Due to the better illumination the entrepreneur could carry out their activities more comfortably than before. Mondal & Klein (2011) also found that SHS bring overall comfort. This make sense that the entrepreneur are valued their quality of working condition. The use of SHS also makes it easier to carry out customer services. Some entrepreneurs have stated that now they have arranged their item in a customized order. Before up taking SHS, they had arranged their business item around the kerosene lamp or surrounding them. Now they are using wooden rack in the wall. These increase the convenience in doing business. Due to the presence of SHS now they are working in a smoke free condition. To what extent the working condition has changed can be understand from the case explained in Box 4.

Box 4

Case 8: Mr. H is doing business in Bipinganj Bazar. He runs a jewelry shop. The business has started by his father in the year of 1980. After the death of his father he is running the business. He bought SHS in the year of 2008. The system capacity of the SHS is 85W. He runs a digital weight machine and 4 light and 1 small DC fan. He is alone in the market who run jewelry shop. He has no competitor in the market. But he purchase SHS for convenience and comfort. Before that he did not work at night. Now he is working at night. But he expressed that he bought his SHS not for the extended working hour but he likes to work at night in the SHS light. He bought large size SHS because he uses his lights in the day time also. Because the illumination by the daylight also not adequate for his work. He needs more light closer to his working furnace. The light of SHS gives him the adequate illumination. His working condition has improved remarkably due to the use of SHS.

5.9.8 Change in Product and Service Quality

SHS not only influenced to diversify the business but also influence to bring change in the product and service quality. All the entrepreneurs have stated that their product and service quality has change after up taking SHS. The living standard of the rural area is increasing day by day. So their demand of better quality product also increased. To meet the increasing demand, the rural MEs are keeping better quality product and giving better quality services.

To what extent the SHS is influencing the change is also studied by this study. It is found that the influence of SHS is partial over the change in the product and service quality. SHS has strongly influence the change in the service quality of the pharmacy and the grocery shop which have diversified their business. The restaurant and tea stall also observed change in their service and product quality and the influence of SHS for this change is also strong. Due to better working condition the entrepreneurs are now keeping and selling better quality products and those run service business observed development in their service. Some case study is presented in Box 5.

Box 5

Case 9: Mr. I is a village doctor. He also owns a pharmacy which was established in 1990. He obtained LMAF degree from government authority. He gives initial treatment and consultancy to the villagers. Before up taking SHS he found difficulty in giving treatment to his patents in night. After up taking SHS, now he can check the blood pressure and heart beat comfortably and with ease. He is taking care of the patents more watchfully than before. His service quality has improved due to the use of SHS.

Case 10: Mr. J is runs a grocery shop. He also sell cosmetic items. He started his business in 2008. He bought his SHS in 2011. Before 2011 he did not keep high quality cosmetic item in his shop. After up taking SHS he redecorated his shop and started to keep good quality cosmetics. The demand of good quality product was before but he did not keep it in his shop. But after up taking SHS things have changed.

5.9.9 Change in Customer Service Delivery

Change in any aspect of change in the ME is done with a view to give better customer service delivery. The study of Mondal & Klein (2011) found that use of SHS is

also increased overall comfort and satisfaction of the consumers. The MEs observed better working condition due to SHS. Now they can serve the customer in better way than before. This study found that the customers are moderately satisfied by taking service from the enterprises those are using SHS. The customers are also feeling comfortable now to get services from the MEs. The customers are moderately satisfied with the product and services they are getting from the surveyed MEs. But due to the lack of capacity, the workshop or rice mile or saw mill etc cannot run by SHS. For these kinds of work they still need to travel the nearby grid connected market. The change in the comfortness is due to the better service delivery by the surveyed MEs. The customer can now see the product in the night time in the MEs. They can chose and buy their desired product with ease. Some entrepreneurs observed radical betterment in the customer service delivery.

On the other hand it was also observed during the study that the customers also think that they are now getting better service from the surveyed MEs. From the case study which is explained in the Box 6 it is evident that the customers are getting better customer delivery but there are still some area where the MEs could improve their customer service delivery. The expectation expressed by the customers partially can meet by the surveyed MEs but to full fill the complete demand it need grid electricity or higher SHS capacity (in kW range).

Box 6

Case 11: Mr. K is a farmer from village Bipinganj. He worked in the field from morning to evening. He comes to the market in the night time. Before introduction of SHS he felt difficulty to choose his desired product from the MEs in the poor light. He also hasd difficulty when he wanted to pay the money for the product. Now he finds it easy to choose his desired product and pay money for the bought product due to better light. He also drinks tea in the market and gossip with his friends and elders. When he goes to the tea stall, he also gets the opportunity to see the TV program. The tea stall also have satellite dish. He gets better environment and entertainment there. Before introduction of SHS in the tea stall he had to drink tea in a smoky environment and no way to get entertainment. Now the situation has changed. He is now satisfied with the customer service that he get from the MEs. Mr. D runs a grocery shop in Bipinganj Banzar Bazar. He thinks that Mr. K is now highly satisfied by his customer service after up taking SHS.

5.9.10 Change in Number of Customers

During the survey it was also found that the number customers after the evening also increased. Most of the villagers who work in agriculture sector return home late in the evening. They came to the market few in number in the late evening. Before the introduction of SHS in the MEs they usually went to the big market (namely to the grid electrified market). The reason was that the shops remain open late in the night and also have higher quality product. Due to the use of SHS most of the MEs now remain open late in night also. Now they can buy their daily needed product from the SHS electrified market because of that they get the local market open when they are free from their daily work.

The change in the extension of working hour, investment, working condition, customer service delivery leads to increase in the volume of customers. It is also true that the number of customer is also limited in the rural area. Total numbers of customers remain same. So by only lighting facility number of customers can be increased a little. From the study it was found that those who diversified their business their volume of customer changed moderately. The reason for which the number of customer are changing can be understand better from the cases presented in the Box 1, Box 2, Box 3, Box 4 & Box 5.

5.9.11 Change in Mediums of Entertainment

Jacobson (2007) find that solar PV is more closely tied to the increased use of TV, and other 'connective' applications such as radio and cellular phones. From the study it has found that the change in the entertainment medium was low in scale. Only 18 entrepreneurs use medium of entertainment. The medium of entertainments other than mobile phone are TV, TV with VCD and Satellite Dish, Radio and Sound Box. Only 11.1 percent of the surveyed entrepreneur bought medium of entertainment after up taking SHS. From the survey it has found that only one entrepreneur do not have mobile phone. But out of the rest entrepreneurs, only 9 entrepreneurs use mobile phone to listen music and watching video. The influence of SHS for using mobile phone for entertainment is also high. The reason is that they can charge their mobile in their shop. They do not need to worry for charge level of the mobile. Those who use TV, TV with VCD and Satellite Dish and Sound Box, they bought this devices because of the use of SHS in their MEs.

5.10 Discussion on the socio-economic change in the study area

The data of the survey present only the role of SHS for ME development. Data regarding socio-economic change based on the change in the MEs of the market for macro level role of SHS. Data which has gathered from key-informant is presented for better understanding in Box 7.

After the uptake of SHS by the MEs of the market, the rate of new ME establishment remain low. So the growth or closer of the ME is also low. In the study areas no social institutions have established after first up taking of SHS by the market except one. Only a community clinic has established in Baromari-Lakshmipur Bazar in 2011. There was no direct or indirect influence of SHS behind the establishment of the community clinic. No houses have built around the market till their inception. The price of the land per decimal has ten folded from the first up taking year of SHS by the market. But the raise of the price of the land was due to the inflation and higher purchase capcity of the people not for growth in number of MEs.

Box 7

Establishment year of the market where the survey was conducted.

Market	Bipingonj	Kalikapur	Fandar	Baromari-Lashimur	Tinali	KamarKhali	Shimultali
Year	1981	1982	1985	1988	2000	2003	2007

First up taking SHS year of the market where the survey was conducted and number of ME.

Market	Bipingonj	Kalikapur	Fandar	Baromari-Lashimur	Tinali	KamarKhali	Shimultali
Year	2003	2003	2003	2003	2004	2003	2008
No. of ME	60	30	6	5	10	45	5

No. of ME in 2015 of the market where the survey was conducted.

Market	Bipingonj	Kalikapur	Fandar	Baromari-Lashimur	Tinali	KamarKhali	Shimultali
No of ME	60	40	25	35	40	35	30

New establishment of social institution after up taking SHS market where the survey was conducted.

Market	Bipingonj	Kalikapur	Fandar	Baromari-Lashimur	Tinali	KamarKhali	Shimultali
Yes/No	No	No	No	Yes	No	No	No

Change in recreational activity (apart from TV) after up taking SHS market where the survey was conducted.

Market	Bipingonj	Kalikapur	Fandar	Baromari-Lashimur	Tinali	KamarKhali	Shimultali
Yes/No	No	No	No	No	No	No	No

Some part of the Bipingonj Bazar, Kalikapur Bazar, Baromari-Lashimur Bazar, Fandar Bazar and KamarKhali Bazar is situated on government owned land where temporary businesses take place. Government auction take place for the specific place. The auction price also increased but that happened not for the growth of the market. This is due to inflation largely and partial influence of SHS. No new social or economical activities have started based on the development of the MEs competition or market expansion in the market area where the survey was conducted. Socio-economic change in the surrounding market area where the data were collected has not taken place. The study found a computer center in the Bipingonj Bazar, Baromari-Lashimur Bazar, Fandar Bazar which run by SHS. In the Bipingonj Bazar a digital studio is also found whose power comes from SHS. This ME's setup was due to the intervention of SHS.

5.11 Conclusion

SHS has the ability to enhance ME development. From the study it has found that SHS is being utilized by some entrepreneurs to broaden the economic opportunity. It was observed during the study that most of the entrepreneurs failed to do so due to lack of two crucial determinants which are competence and exposure through skill formation and infrastructure development (namely road and transportation). Another reason for insignificant changes in the MEs is for small number of customers and their low purchasing power in the surrounding villages. Barnes (1988) has categorized enterprise into three categories with respect to their "energy demand for their work". Most of the surveyed MEs falls in the second category those do not need electricity to run the enterprise but presence of electricity can generate more income. So the productive use of SHS is crucial for generation of income directly. But from the data of the study it can be said that the entrepreneurs are using SHS for productive purpose limitedly. SHS is mainly used for lighting and other frequent uses of SHS are mobile charging and running small DC fan. The use of SHS as an income earning tool is very rare though some digital centers have been established in most of the studied market. Some entrepreneurs also have weight machines but the percentage is also low. The changes observed by the enterprises are very high in the working condition and customer comfort evolution. The economic change was also observed but the value is very low and in significant. The data do not give any indication to establish any relationship between the different size of SHS and change in the MEs. In the next chapter discussion for future policy consideration, conclusion and recommendation is presented.

Chapter 6
Conclusion

6.1 Introduction

The research objectives of this study were to examine the role SHS for MEs development in the rural off-grid area in Bangladesh and study the changes experienced by the ME after up taking SHS. To meet the research objectives, some research questions were set-up. By answering the research questions, efforts were made to meet the objectives. From the study it was found that rural entrepreneurs are using SHS mostly for lighting, charging mobile phone and powering small DC fan. Productive use of SHS has been observed by this study but the numbers are low. Some of the entrepreneurs are using SHS as a development tool. Functionings are the various things a person may value doing, as it found the theory of this study; the entrepreneurs are using SHS according to their values. But due to the capacity limitation of the SHS, [freedom for] achieving functions (no. of services taken from SHS) is also restricted. The services are taking from SHS by the entrepreneurs are lighting, phone charging; running small DC fan, weight machine and Soldering Iron; powering TV, VCD, Satellite Dish. This study identified that SHS is being used for five types of purposes. These are (i) Productive/Business purpose, (ii) Lighting purpose, (iii) Comfort purpose, (iv) Communication purpose and (v) Entertainment purpose. From the data and analysis of the study it can be said that the number of service taken from SHS has a close relationship with the changes observed by the MEs. This study found more *welfare change*[5] than economical changes by SHS. The role of SHS for bringing change in the enterprise is different for different change indicators. The influence of SHS on the changes is discussed in the previous chapter in section 5.9. SHS is not equally helping to all the entrepreneurs for bringing changes in their MEs. Those entrepreneurs who have higher capital, they observed more change in their MEs. As a whole, the role of SHS to bring about change in the investment and profit of the MEs were little; to bring about change in the working hours, working conditions, product and service quality, customer service delivery, and number of customers of the MEs were moderate. No role of SHS was found for brining change in the employment and employee wages by this study. Change in the energy expenditure and medium of

[5] For this study welfare change is considered as a positive change of the change indicators of the ME which are not directly related to monetary change. These are namely working condition, product and service quality and customer service delivery.

entertainment has been found to be highly influenced by the use of SHS. The number of entrepreneurs observed change in the medium of entertainment is small but the role of SHS is for bringing the change is high. Not only the role of SHS for changing investment and profit is little but also the average change is quite low in monetary value. Those who have used SHS for business purpose (productive use of SHS), they observed high level of change in all change indicators. This study conclude that SHS can enhance the capability to bring change in the MEs by the entrepreneurs (as it is explained by case and discussion in the previous chapter) but due to the limitations of the SHS and lack of business aptitude of the entrepreneurs, the desired level of change is not happening for the MEs.

It is hoped that the finding of this study will dispell several current myths. Overall findings of this study suggest that the role of SHS for brining change in the MEs is heterogeneous. Based on the findings of the study, interviews with the 14 key personal and observation there are some issues which need to be considered for future policy making in this area is presented in the next section.

6.2 Issues for Future Policy Consideration

The data from the survey on the role of SHS for ME development provides a preliminary set of insights into the role of SHS adoption in relation to different dimensions of changes in the MEs. From this study it can be said that the relationship between the use of SHS and ME development is mediated by other aspects of entrepreneur and business characteristics, which have exaggerate the actual relationship. For instance, the extended working hour or change in investment or changes on the product and service quality in the MEs are shaped by the special socio-economic characteristics (namely capital of the ME) of the entrepreneurs and not by the intervention.

Even though direct and indirect role of SHS have been observed to a certain extent but in an overall calculation, the number of entrepreneurs those who have observed change did not over ride the counterpart. Owning SHS does not mean development. Innovative and productive use of SHS can ensure sustainable development of the MEs. From this study, it has been found that the MEs have purchased their SHS without considering their needs and usages. The benefits of the SHS are mostly utilized by the wealthier entrepreneurs. They also observed more aspect of change in their entrepreneurs. The entrepreneur are more solvent that other rural professionals. Mostly, they did not find

any difficulty to pay the installments in time. There are still some entrepreneurs who found it difficult to pay the installments. The reason is behind that they bought SHS without considering their need. Findings from the survey revealed that ME's of low capital have observed least change in their enterprise. Still there are some entrepreneurs who have developed their enterprise in a fruitful way with low capital.

All the surveyed entrepreneurs demand for grid electricity connection. SHS is full filling the lighting demand but for some other demand they need grid connection. Most of the entrepreneur told that they would like to have a ceiling or pedestal fan in their shop. Small DC fan is not enough. Some entrepreneurs also stated that they would like to buy TV, computer, printer, scanner, photo copier, fridge etc. For incapacity of the SHS they are not using these appliances. Limiting the economic activity is observed during the study. Due to the use of SHS the entrepreneurs are in the first stage in the energy ladder[6]. The use of SHS is not enough to put the entrepreneurs in the upper stage of the energy ladder. The findings of the survey revealed that income-generating activities which have stimulated by the availability of solar electricity is not in a mentionable scale. To promote the increased use of electricity for productive purposes, the development of low-voltage appliances depending on entrepreneur demand, such as sewing machines, electrical hot gun etc are desirable. In combination with integrated training on innovation and enterprise development can increase in income-generating activities, hence the development also. In sharp contrast, the role of SHSs on the MEs change in different aspect was observed to be quite limited, as SHS was hardly used productively.

Economic growth was facilitated a little through higher incomes of MEs using SHS for improving their business activities. The survey data revealed that SHSs had significant positive role on MEs business environment development. Even though economic benefits were limited, strong changes in the business environment were found.

The reduction of economic disparity between the wealthy and poor entrepreneur was not influenced after introduction of SHS in the market. Compared to influences on economic development, the SHSs' direct impacts on socio-economic change of the surveyed areas was not seen that much. It is also found from the study that the SHS did not play role for the social development in the study area. The expansion of the market

[6] An energy ladder shows the improvement of energy use corresponding to an increase in the household income.

area or creation of new social institution was not found in the study area after the introduction of SHS in the market. Those who bought TV, they are watching TV mostly for entertainment purpose. The use of TV for information (national news and business information) was not found during the study. It is also found from the survey that the entrepreneurs are using TV for entertainment purpose only.

Role of SHS for MEs development cannot be generalized that easily. Increase in MEs income due to productive use of solar electricity is seen not seen in majority of the MEs. This development of the MEs seems to be dependent on entrepreneur skills and ability for additional income generation, awareness about electricity's respective potentials, as well as the availability of productive appliances and machinery suitable for utilization with SHSs. The study found that the outcomes by up taking SHS in the MEs basically are welfare measures, not for better economic opportunities and well-being. The analysis of the surveyed data also shows that SHS do not increase the economic capabilities of entrepreneurs in a large scale. Many of the determined changes are essentially based on improved illumination conditions. By both quantitative and qualitative analysis, it is concluded that the change in the enterprise mainly depends on the context and capital of the ME. It was also observed from the study that some entrepreneurs are up taking SHS to survive in the business competition.

The current state of renewable energy development in Bangladesh is also discussed by this study. From the secondary data it has been found that the rate of rural electrification is outstanding. Due to the tremendous effort by the GoB, the electricity coverage area has expanded to 72 percent population of the country. If the electrification rate continues in this pace the GoB is hopeful to expand the grid network to every corner of the country. The demand and supply also increased respectively. In the current days Bangladesh is not having any regular load shading problem. Some research already commented that SHS is a viable financing if it is used for 15 years. If the grid connection is extended to every potential commercial and residential customer, the current SHS user will also come under the grid network. Those who are using SHS now, they already invest a great deal of money in SHS. How they could be compensated or how already installed SHS may be utilized that should be considered for future planning by the policy makers.

Development should be defined as a self-set goal. This study finds larger welfare change than economic change, which means SHS has a high opportunity cost. More over it has been found from this study that the economic disparity between the wealthier and poor entrepreneur has increased. From this study it can be realized that SHS has failed to increase productive use of energy such as increase in income and creation of new employment in the rural off grid MEs.

The gender empowerment or participation of women in the MEs did not increase after up taking SHS. Or no example has been observed that SHS has influenced in any way for female engagement in the MEs.

6.3 Recommendation for Future Practice

The utilization of resource is important rather than only having it. SHS is a resource in the off grid area. Though GoB has taken a lot of initiatives to bring electricity to the whole country within 2020 but due to geographical and economical constrains in the remote rural area, the island and hill area will not be covered by grid electricity. The demand of SHS will be always there. For these reasons some recommendation is given to get optimum result out of SHS program. Some of the recommendations are not only applicable for SHS program but also applicable for grid expansion program in the marginal area. The recommendations are

1. Integrated training on SHS use and maintenance and productive use of SHS by PO of IDCOL when they give customer training.
2. Awareness program on radio/television campaigns and community meetings to encourage productive use of SHS.
3. Technical advice and training regarding selection of appropriate size of SHS by the customer in the off-grid area.
4. Net metering or compensation package for SHS owner if they get grid connection before 15 years.
5. International donor agency, NGO and GoB should conduct a large scale survey on the productive use of SHS in the off grid area to know what extent SHS is aiding socio-economic development in the off grid area, prepare action plan for promotion of productive use of SHS.

6.4 Conclusion

The analysis of the data of this study has revealed the limitations of SHS interventions focused solely on supplying technology, limited energy access in particular, without taking into account the creation any equal development opportunity for the MEs. In the MEs analyzed in this study, the most relevant factor explaining these inequalities is capital and lack of knowledge about proper use and choice of SHS, which needs to be urgently addressed by the GoB, IDCOL and international development organization. This study also confirms the potential of SHS by providing information about the implications of the use of and access to electricity in relation to the real freedoms people can achieve.

6.5 Scope for future Research

This study has certain limitations. Some relevant and crucial issues have not been covered by this research and therefore there is ample scope to conduct study on this issue. It has not analyzed, for instance, the socio-economic development of entrepreneur due to limitations of time and resource. Likewise, questionnaire survey and the case studies could be extended to other non-SHS MEs and grid connected MEs and compare the development between them.

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Appendix I

Approved list of RE development project by Power Division, GoB

	Types of Project	Name of the Project	Capacity	Location of project the	Financed by	Tentetive Completet-ion Year
BPDB						
1	Solar park (Grid Tied)	Dhorla 30MW Solar Park	30MW	Kurigram	IPP	June 2016
2		Ranguni Solar Park	60MW	Chittagong	GoB	June 2017
3		Sharisha Bari Solar Park	3MW	Jamalpur	IPP	December 2015
4		Kaptai Solar Park	7.4MW	Chittagonh	ADB	June 2016
5		Hatiya Hybrid Solar Park	4.2MW	Noakhali	ADB	June 2016
6		Thakurgaon Solar Power Project	5MW	Thakurgaon	GoB	June 2017
7		Ishwardi Solar Park a. Ishwardi Solar Park b. Shirajganj Solar Pakr	a. 2MW b. 1MW	a. Ishwardi b. Shirajganj	GoB	December 2016
8		Gangachara Solar Park	55MW	Rangpur	GoB	December 2016
9		Sonagazi Solar power Plant	100MW	Feni	GCF	June2017
10	Solar Mini Grid	Habibpur Union, Shalla	650kW	Shunamganj	BCCTF	*
11	Solar Street Lighting	Solar Street lighting in8 City Corporation	8400Set		ADB	June2017
12	Municip ality Waste Power	Keranigonj Municipality Waste to Electricity project	5-7MW	Dhaka	GoB	*
BREB						
13	Solar Irrigation	Solar Irrigation Project	*	*	ADB	*
NWPGCL						
14	Solar Park)Grid Tied(	Shimulia solar park Sirajganj	5MW	Sirajganj	GoB	December 2015

EGCB						
15	Solar Park (Grid Tied)	Munshiganj Solar Power Plant	75MW	Munshiganj	ADB	June2017
16	Solar Mini Grid	Siddhirganj Solar Project	36kW	Dhaka	ADB	December 2015
RPCL						
17	Solar Park (Grid Tied)	5MW Solar Park	5MW	Mymensingh	*	*
18	Solar Park (Grid Tied)	Padma Rivar Island Solar Park	200MW	Rajshahi	*	
DPDC						
19	Solar Rooftop	Solar Rooftop in Government Office building of Dhaka like Secreteriet Building	*	*	*	*
20		Rooftop Project on Solar in Gonovhobon	*	Gonovhobon	DPDC	*
IPP Project						
21	Solar Park (Grid Tied)	"200 MW (AC) Solar Power Project by Sun Edision Energy Holding (Singapore) Pte Ltd.	200MW	Cox's Bazar	IPP	*
22		"20MW +10% Grid-Tied Solar Power Project. yb " Joules Power Limited (JPL)	20MW	Cox's Bazar	IPP	*
23		50 MW (AC) Solar Park by HETAT-DITROLIC-IFDC Solar	20MW	Mymensingh	IPP	*

24		32MW (AC) Solar Park by EDISUN-Power Point & Haor Bangla-Korea Green Energy Ltd	32MW	Sunamganj	*	*
25	Wind Power	Cox's Bazar Wind Power by US-DK Green Energy (BD) Ltd.	60MW	Cox's Bazar	*	*
26	Hybrid Power	Solar-wind Hybrid Power Project by M/s. ReGen Powertech Private Limited	18MW	Feni	*	*
Power Division						
27	Wind Power (Wind Resource Mapping)	TA Project for Wind Resource Mapping		Inani, Anwara, Shitakondo, Mongla, Lalpur, Jafrabad, Rajshahi, Bodorganj, Mymensongh and Modhopur	USAID and NREL	December 2016
BADC						
28	Solar Irrigation	Solar Irrigation Project by BADC	*	*	*	Installation of 500 Pump is on process for Pilot basis.

* = Yet to finalize

Appendix II

প্রশ্নপত্র নং - **তথ্য সংগ্রহের তারিখঃ**

বাজারের নামঃ

অংশ – কঃ ব্যক্তিগত তথ্য

১. নামঃ.....

২. বয়সঃ ..... ৩. লিঙ্গঃ ..... ৪. শিক্ষাগত যোগ্যতাঃ.....

৫. বাড়িতে বিদ্যুৎ আছে কি না?

□ হাঁ (পরবর্তি প্রশ্নে যান)	□ না (পরবর্তি অংশে যান)

৬. বাড়ির বিদ্যুতের উৎস

	□ পল্লীবিদ্যুৎ	□ সৌরবিদ্যুৎ	□ অন্যান্য.....
সংযোগ নেয়ার সময়কাল			

অংশ - খঃ ব্যবসার তথ্য

৭. ব্যবসা প্রতিষ্ঠানের নাম (যদি থাকে): .....

৮. ব্যবসা প্রতিষ্ঠানের ব্যবসার ধরনঃ..... ৯. ব্যবসা প্রতিষ্ঠানের শ্রেনীঃ .....

১০. ব্যবসার মোট মুলধনঃ (সকল অস্থায়ি সম্পদ সহ) .....

১১. মোট কর্মচারীঃ (যদি থাকে) বেতনভূক্ত..... পারিবারিক সদস্য.....

১২. ব্যবসা প্রতিষ্ঠানের শুরুর সময়কালঃ.....

১৩. সৌরবিদ্যুৎ এর মাধ্যমে বিদ্যুৎ নেয়ার পূর্বে আলো ও অন্যান্য বৈদ্যুতিক যন্ত্রপাতি (যদি থেকে থাকে) ব্যবহারের জন্য কোন উৎস ব্যবহার করতেনঃ (ড্রাইসেল ব্যাটারী=১ গাড়ির ব্যাটারী/রিচার্যেবল ব্যাটারী=২ জেনারেটর=৩ মোমবাতি=৪ কেরোসিন কুপি=৫ হেরিকেন=৬ হ্যাচাক লাইট=৭ চার্যার লাইট=৮ অন্যান্য=৯)

	উৎস		উৎস		উৎস
□ বাতি (আলো)		□ ফ্যান		□ ফোন চার্যিং	
□ টিভি		□ রেডিও		□ অন্যান্য.....	

১৪. বর্তমানের আলোর উৎস হিসেবে নিম্নোক্ত কোন উপাদানগুলো ব্যবহার করেনঃ (সৌরবিদ্যুৎ ছাড়া) (ড্রাইসেল ব্যাটারী=১ গাড়ির ব্যাটারী/রিচার্যেবল ব্যাটারী=২ জেনারেটর=৩ মোমবাতি=৪ কেরোসিন কুপি=৫ হেরিকেন=৬ হ্যাচাক লাইট=৭ চার্যার লাইট=৮ অন্যান্য=৯)

উৎস	ব্যবহারের কারন	দৈনিক গড় ব্যবহারের সময়কাল	মাসিক গড় খরচ

অংশ – গঃ সৌরবিদ্যুৎ ব্যবস্থা স্থাপনের মূল্য ও তার প্রযুক্তিগত তথ্যাদি

১৫. আপনি কত সময় ধরে সৌরবিদ্যুৎ ব্যবহার করছেন? .....

১৬. আপনি সৌরবিদ্যুৎ সংযোগের ধরন কোনটি

□ নিজের সৌরবিদ্যুৎ ব্যবস্থা	□ পাশের দোকানের সৌরবিদ্যুৎ ব্যবস্থা

১৭. সৌরবিদ্যুৎ ব্যবস্থা সরবরাহকারী প্রতিষ্ঠানের নামঃ.....

১৮. সৌরবিদ্যুৎ এর সর্বোচ্চ ক্ষমতা (ওয়াট পাওয়ার):..... ১৯. স্থাপনের তারিখঃ.....

২০. সৌরবিদ্যুৎ ব্যবস্থা ক্রয়ের অর্থের উৎসঃ

□ সম্পূর্ণ নগদ টাকা	২১ নং প্রশ্নের উত্তর দিন
□ সরবরাহকারী প্রতিষ্ঠানের কছ থেকে কিস্তিতে(ঋনের মাধ্যমে)	২২ নং প্রশ্নের উত্তর দিন

২১. খরচ সম্পূর্ন নগদ টাকায় পরিশোধ করলে, মোট কত খরচ হয়েছে .....

২২. যদি সরবরাহকারী প্রতিষ্ঠানের কছ থেকে কিস্তিতে (ঋনের মাধ্যমে) সৌরবিদ্যুৎ ব্যবস্থা ক্রয় করেন

- সৌরবিদ্যুৎ ব্যবস্থা স্থাপনের সম্পূর্ন খরচ কত্?.....
- সৌরবিদ্যুৎ ব্যবস্থা ক্রয়ের টাকা কি সম্পূর্ন পরিশোধ করা হয়েছে কি না? □ হ্যাঁ □ না
- ঋনের টাকা পরিশোধ করতে কোন সমস্যা হয়/হয়েছিল কিনা? □ হ্যাঁ □ না

অংশ – ঘ: কর্মসময়

১. আপনি কি মনে করেন সৌরবিদ্যুৎ ব্যবহারের কারনে আপনার ব্যবসার মোট কর্মসময়ের কোন পরিবর্তন ঘটেছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি ব্যবসার কর্মসময়ের কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে ঘন্টা/দিন উল্লেখ করুনঃ .....ঘন্টা/দিন □বেড়েছে/□কমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

৩. সৌরবিদ্যুৎ ব্যবহারের সাথে ব্যবসার মোট কর্মঘন্টার সম্পর্ক কিরুপ

□ ঘনিষ্ট সম্পর্ক	□ আংশিক সম্পর্ক	□ অল্প সম্পর্ক	□ কোন সম্পর্ক নেই	□ বলতে পারছিনা

৪. সৌরবিদ্যুৎ ব্যবহারের পর থেকে আপনি এখন আপনার ব্যবসার কর্মঘন্টা কতখানি নিয়ন্ত্রন করতে পারছেন

□ শক্তিশালী নিয়ন্ত্রন	□ আংশিক নিয়ন্ত্রন	□ অল্প নিয়ন্ত্রন	□ কোন নিয়ন্ত্রন নেই	□ বলতে পারছিনা

অংশ - ঙঃ ব্যবসায়িক মুনাফা

১. সৌরবিদ্যুৎ ব্যবহার করার পর থেকে আপনার ব্যবসার মুনাফার কি কোন পরিবর্তন হয়েছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি মুনাফার কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে টাকা/মাস উল্লেখ করুনঃ .....টাকা/মাস বেড়েছে .....টাকা/মাস কমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

৩. আপনার এই পরিবর্তিত মুনাফার উপর সৌরবিদ্যুৎ ব্যবহারের কেমন প্রভাব রয়েছে

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

৪. সৌরবিদ্যুৎ ব্যবহারের পর থেকে আপনি এখন আপনার ব্যবসার লাভ কতখানি নিয়ন্ত্রন করতে পারছেন

□ শক্তিশালী নিয়ন্ত্রন	□ আংশিক নিয়ন্ত্রন	□ অল্প নিয়ন্ত্রন	□ কোন নিয়ন্ত্রন নেই	□ বলতে পারছিনা

অংশ -চঃ বিনিয়োগ

১. আপনি কি মনে করেন সৌরবিদ্যুৎ ব্যবহার শুরুর পরে আপনার ব্যবসার বিনিয়োগের কোন পরিবর্তন ঘটেছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি বিনিয়োগের কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে টাকা/বছর উল্লেখ করুনঃ .....টাকা/বছর বেড়েছে .....টাকা/বছরকমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

৩. আপনার এই বিনিয়োগের পরিবর্তনের উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ – ছঃ চাকুরী (যদি কর্মচারী থেকে থাকে)

১. আপনি কি সৌরবিদ্যুৎ ব্যবহার শুরুর পরে কোন কর্মচারী নিয়োগ দিয়েছেন

□ হ্যাঁ (..... জন)	□ না

২.আপনার দোকানের কর্মচারীর নিয়োগের উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ -জঃ বেতন (যদি কর্মচারী থেকে থাকে)

১. সৌরবিদ্যুৎ ব্যবহার শুরুর পরে আপনার দোকানের কর্মচারীদের বেতনের কোন পরিবর্তন কি ঘটেছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি আপনার দোকানের কর্মচারীদের বেতনের কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে টাকা/মাস উল্লেখ করুনঃ .....টাকা/মাস বেড়েছে .....টাকা/মাস কমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

৩.আপনার দোকানের কর্মচারীদের বেতনের এই পরিবর্তনের উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ –ঝঃ জ্বালানী (বিদ্যুৎ) ব্যবহারের খরচ

১. সৌরবিদ্যুৎ ব্যবহার শুরুর পরে আপনার দোকানের জ্বালানী (বিদ্যুৎ) ব্যবহারের খরচের কোন পরিবর্তন কি ঘটেছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি আপনার দোকানের জ্বালানী (বিদ্যুৎ) ব্যবহারের খরচের কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে টাকা/মাস উল্লেখ করুনঃ .....টাকা/মাস বেড়েছে .....টাকা/মাস কমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

৩. সৌরবিদ্যুৎ ব্যবহারের পর থেকে আপনি এখন আপনার ব্যবসার জ্বালানী (বিদ্যুৎ) ব্যবহারের খরচ কতখানি নিয়ন্ত্রন করতে পারছেন

□ পুরোপুরি নিয়ন্ত্রন	□ আংশিক নিয়ন্ত্রন	□ অল্প নিয়ন্ত্রন	□ কোন নিয়ন্ত্রন নেই	□ বলতে পারছিনা

অংশ – ঞঃ কর্ম পরিবেশ

০১. সৌরবিদ্যুৎ ব্যবহারের কারনে আপনার কর্মপরিবেশের কতখানি পরিবর্তন হয়েছে

□ সম্পূর্ণ পরিবর্তন	□ আংশিক পরিবর্তন	□ অল্প পরিবর্তন	□ কোন পরিবর্তন হয়নি	□ বলতে পারছিনা

অংশ – টঃ দ্রব্য ও সেবার মানের

০১. সৌরবিদ্যুৎ ব্যবহারের পর থেকে আপনার দ্রব্য ও সেবার মানের কি কোন পরিবর্তন হয়েছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

০২. দ্রব্য ও সেবার মানের এই পরিবর্তনের উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে বলে মনে করেন

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ – ঠঃ গ্রাহক সেবা

০১. সৌরবিদ্যুৎ ব্যবহারের পর থেকে আপনার গ্রাহক সেবার মানের কি কোন পরিবর্তন হয়েছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

০২. গ্রাহক সেবার মানের যে পরিবর্তন ঘটেছে, তাতে সৌরবিদ্যুৎ ব্যবহারের কেমন প্রভাব রয়েছে?

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ – ডঃ গ্রাহক সংখ্যা

১. সৌরবিদ্যুৎ ব্যবহার শুরুর পরে আপনার গ্রাহক সংখ্যার কি কোন পরিবর্তন কি ঘটেছে

□ হ্যাঁ	□ না (পরবর্তি অংশে যান)

২. যদি আপনার দোকানের গ্রাহক সংখ্যার কোন পরিবর্তন ঘটে থাকে তবে তা কোন ধরনের পরিবর্তন (যদি সম্ভব হয় তাহলে লোকসংখ্যা/দিন উল্লেখ করুনঃ .....জন □বেড়েছে/□কমেছে)

□ খুব বেড়েছে	□ মোটামুটি বেড়েছে	□ অল্প বেড়েছে	□ অল্প কমেছে	□ মোটামুটি কমেছে	□ খুব কমেছে

০৩. গ্রাহক সংখ্যার এই পরিবর্তনের উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে বলে মনে করেন

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অংশ – ঢঃ বিনোদনের মাধ্যম

১. সৌরবিদ্যুৎ ব্যবহার শুরুর পর আপনি আপনার দোকানে বিনোদনের জন্য কোন যন্ত্রটি ক্রয় করেছেন

□ টিভি	□ ভিসিডি	□ সিডি	□ রেডিও	□ অন্যান্য	□ কোন কিছুই না (পরর্তি অংশে যান)

০২. আপনার উপরোক্ত যন্ত্রাদি ক্রয় ও ব্যবহারে উপর সৌরবিদ্যুৎ ব্যবহারের কতখানি প্রভাব রয়েছে বলে মনে করেন

□ শক্তিশালী প্রভাব	□ আংশিক প্রভাব	□ অল্প প্রভাব	□ কোন প্রভাব নেই	□ বলতে পারছিনা

অন্যান্য

১. সৌরবিদ্যুৎ কি আপনার সম্পূর্ন বৈদ্যুতিক চাহিদা পূরণ করতে সক্ষম

□ হ্যাঁ	□ না

২. ভবিষ্যতে যদি পল্লী বিদ্যুতের সংযোগ চলে আসে তবে কি আপনি পল্লী বিদ্যুতের সংযোগ গ্রহন করবেন

□ হ্যাঁ	□ না

৩. পল্লীবিদ্যুতের সংযোগ গ্রহন করলে আপনার সৌরবিদ্যুৎ ব্যবস্হা কি করবেন

□ রাখবো (নিম্নে তার কারন উল্লেখ করুন)	□ রাখবোনা (নিম্নে তার কারন উল্লেখ করুন)

৪. আপনার যদি পল্লীবিদ্যুতের সংযোগ থাকত তবে আপনার সামর্থ অনুযায়ী আপনি আর কি কোন যন্ত্র ক্রয় করতেন

□ হ্যাঁ (নিম্নে তার নামগুলো উল্লেখ করুন)	□ না
১) .....২)..... ৩) .....৪).....	

অংশ ধঃ সৌরবিদ্যুতের ব্যবহার ও সন্তুষ্টির তথ্যাদি

(সন্তুষ্টির স্কেল খুব সন্তুষ্ট=১ মোটামুটি সন্তুষ্ট=২ সন্তুষ্ট না=৩ মোটামুটি অসন্তুষ্ট=৪ খুব অসন্তুষ্ট=৫ জানিনা=৯)

	বৈদ্যুতিক যন্ত্রাদি		দৈনিক গড় কত সময় (ঘন্টা) ব্যবহার করে থাকেন	ব্যবহারের কারন	সন্তুষ্টির ধরন
	বাতি				
	নং	ক্ষমতা			
	টেলিভিশন (□ রঙ্গীন/ □ সাদা-কালো)				
	নং	ক্ষমতা			
	ফোন চার্যিং				
	নং	ক্ষমতা			
	ফ্যান				
	নং	ক্ষমতা			
	রেডিও				
	নং	ক্ষমতা			
	অন্যান্য ……..				
	নং	ক্ষমতা			
সব কিছু মিলিয়ে আপনি কতখানি সন্তুষ্ট					

Appendix III

Questionnaire No.: **Date of Data Collection:**

Name of the Market:

Section-A: Personal Information

1. Name of the Entrepreneur: ……

2. Age:……..3. Sex:…… 4. Education Level of the Entrepreneur:……

5. Is your household has access to electricity

☐ Yes	☐ No (Go to Next Section

6. What is/are the mean/s of your household electrical energy supply?

	SHS	Grid	Other…….
Year of getting connection			

Section-B: Business Information

7. Name of the Enterprise (If any): ……

8. Types of Business activity: ……9. Types of Business sector: …….

10. Total Capital: ……. 11. Total Staff: Salaried …… Family Members ……

12. Enterprise's approximate establishment year:……

13. Sources of Energy prior to SHS (If applicable):

Application	Energy Source		
Light		Fan	
TV		Radio	
Phone Charging		Other appliance……	

14. Which of the following energy sources does your enterprise use now? (Dry cell batteries=1, Car or other rechargeable battery=2, Generator (Diesel/Petrol)=3, Candles=4, kerosene lamp/hurricane=5, kerosene Kupi=6, Hyacaka Light (Pressure Lamp)=7, Charger Light=8, Other=9…….)

	Energy sources	Purpose of use	Average time of Operation (hours per Day)	Monthly Average Expenditure
○				
○				

Section-C: Cost and technical Information of SHS

15. From how many months or years has yours enterprise been using SHS?.....

16. Source of SHS connection

☐ Own connection	☐ Via neighbor shop

17. Solar Home System (SHS) Provider:……..

18. What is the SHS's peak capacity in Wp?..... 19. Date of Installation:……

20. How did you finance the SHS? Multiple entries are possible.

☐ Money from own enterprise / savings	Go to Q21 of this section
☐ Loan from IDCOL POs/NGOs/Bank	Go to Q22 of this section

21. If paid in cash, what is the total cost of your system?.....

22. If acquired through loan from IDCOL's PO/NGO:

a. What is the total cost of your system?.....

b. Have you paid off your loan? ☐ Yes ☐ No

c. Do you face any difficulty to pay your installment: ☐ Yes ☐ No

Section-D: Working Hour

1. Do you think that your business working hours have been changed due to use of SHS?

☐ Yes (Go to Next questions)	☐ No (Go to Next Section)

2. In which direction your working hours have been changed (if possible give it in approximate hours/day ……..)?

☐ Highly Increased	☐ Moderately Increased	☐ A little increase	☐ A little decrease	☐ Moderately decrease	☐ Highly decrease

3. To what extent do you think SHS is influencing the Working Hours of your enterprise?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

4. To what extent do you think that by acquiring SHS, now you have gain control (empowered) over business working hours?

☐ Strong Control	☐ Partial Control	☐ A little Control	☐ No control at all	☐ Do not know

Section-E: Profit

1. Do you think that profit of your business has been changed after using SHS?

☐ Yes (Go next questions)	☐ No (Go to next section)

2. In which direction your working hours have been changed (if possible give it in approximate tk/Month ……..)?

☐Highly Increased	☐Moderately Increased	☐A little increase	☐ A little decrease	☐Moderately decrease	☐Highly decrease

3. To what extent do you think that use of SHS is influencing the profit of your business?

☐ Strong Influence	☐Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

4. To what extent do you think that by acquiring SHS, now you have gain control (empowered) over profit of your business?

☐Strong Control	☐ Moderate Control	☐A little Control	☐ No Control	☐Do not know

Section-F: Investment

1. Do you think that your investment in business has been changed after using SHS?

☐ Yes (Go to Next questions)	☐ No (Go to Next Section)

2. In which direction your investment has been changed (if possible give it in approximate tk/Year ……..)?

☐Highly Increased	☐ Moderately Increased	☐A little increase	☐A little decrease	☐Moderately decrease	☐Highly decrease

3. To what extent do you think that use of SHS is influencing your business investment?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-G: *Employment*

1. Do you employ any person/s in your enterprise after using SHS?

☐ Yes (No. of employee ……)	☐ No (Go to Next Section)

2. To what extent do you think that use of SHS has influenced the new employment?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-H: Wage

1. Do the wages of your employee have been changed in your enterprise after purchasing/using SHS?

☐ Yes	☐ No (Go to Next Section)

2. How much wage has been changed (if possible give it in approximate tk/month ……..)?

☐ Highly Increased	☐ Moderately Increased	☐ A little increase	☐ A little decrease	☐ Moderately decrease	☐ Highly decrease

3. To what extent do you think that use of SHS has influenced the change of your employee wage?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-I: Energy expenditure

1. Do you find any change in your monthly electrical energy expenditure after using SHS

☐ Yes	☐ No (Go to Next Section)

2. In which direction your electrical energy expenditure is changed (if possible give it in approximate tk/month ……..)?

Highly Increased	Moderately Increased	A little increase	A little decrease	Moderately decrease	Highly decrease

3. To what extent do you think that SHS is influencing energy expenditure of your enterprise?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-J: Working Condition

1. To what extent Do you think use of SHS bring change in your enterprise working condition.

☐ Complete Change	☐ Moderate change	☐ Small Change	☐ No change	☐ Do not know

Section-K: Product quality

1. Do you find any change in your product and service quality after acquiring SHS in your business?

☐ Yes	☐ No (Go to Next Section)

2. To what extent do you think that use of SHS has influenced this change in your products and service quality?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-L: Customer services

1. Do you find any change in your customer service delivery (satisfaction of the customer) after acquiring SHS in your business?

☐ Yes	☐ No (Go to Next Section)

2. To what extent do you think that use of SHS in your business is influencing the customer satisfaction?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-M: Customer drawn

1. Do you find any change in number of your customer after acquiring SHS in your business?

☐ Yes	☐ No (Go to Next Section)

2. In which way your numbers of customers have changed due to the use of SHS (if possible give it in approximate person/day ……..)?

Highly Increased	Moderately Increased	A little increase	A little decrease	Moderately decrease	Highly decrease

3. To what extent do you think that use of SHS in your business is influencing your numbers of customers drawn?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Section-N: Entertainment Medium

1. Which mediums of entertainment do you brought after acquiring SHS?

☐ TV	☐ VCD	☐ CD	☐ Radio	☐ Other	☐ Nothing (Go to next section)

2. To what extent do you think that SHS has influenced you to buy and use the entertainment medium in your enterprise?

☐ Strong Influence	☐ Moderate Influence	☐ A little Influence	☐ No Influence	☐ Do not know

Other Information

1. Can the SHS fulfill your electricity demand? ☐ Yes ☐ No

2. Will you take the grid connection, if it's available? ☐ Yes ☐ No

3. If you take the grid connection what you will do with your SHS?

Will keep (give the reason below)	Will not keep (give the reason below)

4. What are the appliances do you want to buy if you get grid connection (in context with the present financial ability)

1……. 2…… 3……..

Usage and satisfaction level by SHS:

(1= Highly Satisfied, 2= Moderately Satisfied, 3= Not Satisfied, 4= Moderately Dissatisfied, 5= Highly Dissatisfied, 6=Don't Know)

	Application Used		Time of use (hours per day)	Purpose of Use	Satisfaction Level
	Light				
	No.	Rating			
	TV (☐ BW / ☐ Color)				
	No.	Rating			
	Phone Charging				
	No.	Rating			
	Fan				
	No.	Rating			
	Dish (Satellite)				
	No.	Rating			
	Other Application……				
	No.	Rating			
				Overall Satisfaction	

Appendix IV

14 Key Personnel List

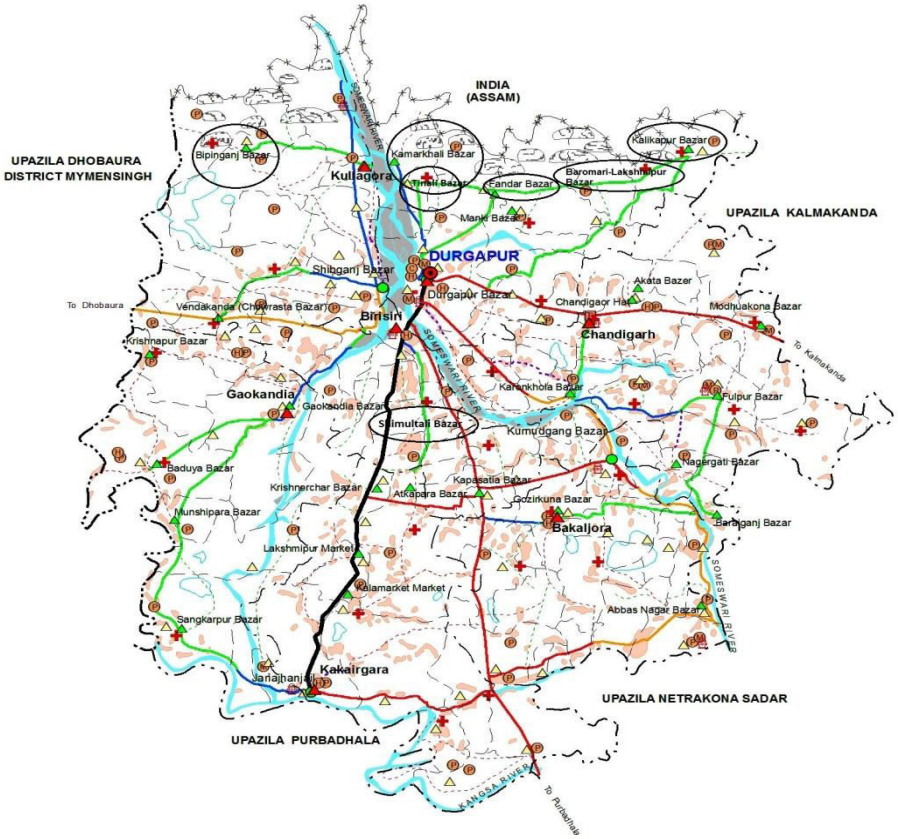
Sl No.	Name of the organization	Name of the Interviewee	Designation
01	SREDA	Siddique Zobair	Member (EE&C)
02	SREDA	S. M. Sanzad Lumen	Assistant Director (Solar)
03	BREB	S.M. Zafar Sadek	Director, RE Directorate
04	IDCOL	Ms. Farzana Rahman	Vice President and Unit Head (Investment), RE
05	IDCOL	Md. Abdullah Al Matin	Technical Officer, RE Project
06	IDCOL	Ms. Sadia Haque	Asst. Relationship Manager, SHS Program
07	World Bank	Zubair K. M. Sadeque	Task Team Leader (RERED II) PROJECT
08	GIZ	Dilder Ahmed Taufiq	Senior Advisor, Sustainable Energy for Development (SED)
09	Dhaka University (DU)	Dr.Saiful Huque	Professor & Director, Institute of Energy, DU
10	United International University (UIU)	Prof. Dr. M. Rezwan Khan	VC,UIU
11	GS	S.M. Musa	General Manager
12	GS	Engr. Bikash Das	Manager (technical)
13	RSF	Nitai Pada Saha	General Manager
14	BGEF	Dipal C. Barua	Founder & Chairman

Appendix V

Description of the study area

The field research was conducted in Bipingonj Bazar, Kalikapur Bazar, Baromari-Lashimur Bazar, Fandar Bazar, Tinali Bazar, KamarKhali Bazar, Shimultali Bazar of Durgapur Upozilla, Netrokona (Dhaka Division). Durgapur Upazilla is situated in the north-east part of Banglades. It is bounded by Meghalaya (State of India) on the north, Netrokona Sadar and Purbodhala Upazilla on the south, Kalmakanda Upazilla on the east, Dhobaura Upazilla on the west. The Durgapur Upazila has an area of 279.28 km^2, of which the vast majority (260.55 km^2) is plain land with a reserve forest of 9.17km^2. It has 1 municipality and & 7 Union[7], 210 Village. Density of population is 805. Total population of Durgapur Upozilla is 224873. Total number of Hat/bazaar is 31. Literacy rate is 39.5 % (BBS 2011)

Map of the study area:



(Source : LGED Digital map retrieve from www.lged.gov.bd)

[7] Smallest administrative rural geographic unit comprising of mauzas and villages and having union parishad institution (BBS 2011)

Appendix VI

Correlation matrix between SHS's peak capacity and number of Services taken from SHS

Correlations			
		SHS's peak capacity	Number of Services taken from SHS
SHS's peak capacity	Pearson Correlation	1	.530**
	Sig. (2-tailed)		.000
	N	46	46
Number of Services taken from SHS	Pearson Correlation	.530**	1
	Sig. (2-tailed)	.000	
	N	46	47
**. Correlation is significant at the 0.01 level (2-tailed).			

Appendix VII

Linear regression analysis for SHS's peak capacity with independent variables

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.600[a]	.360	.280	1.397
a. Predictors: (Constant), New SHS Year, Types of Business sector, Age, Total Capital, Education Level				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	43.861	5	8.772	4.494	.002[b]
	Residual	78.074	40	1.952		
	Total	121.935	45			
a. Dependent Variable: SHS's peak capacity in Wp						
b. Predictors: (Constant), SHS Up Taking Year, Types of Business sector, Age, Total Capital, Education Level						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.682	1.267		3.697	.001
	Age	.397	.328	.160	1.210	.234
	Education Level	-.042	.142	-.040	-.297	.768
	Types of Business sector	.113	.242	.061	.466	.644
	Total Capital	.180	.156	.153	1.154	.255
	SHS Up Taking Year	-.602	.163	-.504	-3.693	.001
a. Dependent Variable: SHS's peak capacity in Wp						

Linear regression analysis for Number of Services taken from SHS with independent variables

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.413[a]	.171	.070	.957
a. Predictors: (Constant), SHS Up Taking Year, Age, Types of Business sector, Total Capital, Education Level				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.745	5	1.549	1.690	.159[b]
	Residual	37.574	41	.916		
	Total	45.319	46			
a. Dependent Variable: Number of Services taken from SHS						
b. Predictors: (Constant), SHS Up Taking Year, Age, Types of Business sector, Total Capital, Education Level						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.250	.850		2.647	.011
	Age	.001	.219	.001	.005	.996
	Education Level	-.035	.098	-.055	-.357	.723
	Types of Business sector	-.096	.164	-.087	-.584	.562
	Total Capital	.263	.108	.368	2.430	.020
	SHS Up Taking Year	-.005	.113	-.006	-.041	.967
a. Dependent Variable: Number of Services taken from SHS						

Appendix VIII

Summary of the regression analysis between the independent and dependent variables

Dependent Variable (Changes)	R Square	ANOVA sig. (ρ)	Significant coefficients
Working Hour	.140	.270	
Profit	.226	.054	Capital (ρ= .003)
Investment	.306	.008	Capital (ρ = .001)
Energy Expenditure	.203	.087	
Working Condition	.047	.843	
Customer Satisfaction	.061	.750	
No of Customer	.190	.112	Capital (ρ = .005)