Impact of utilization of solar energy in some selected rural areas of Takurgaon and Dinajpur District.

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28th June , 2005

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DECLARATION

It is hereby declared that this thesis has been prepared in the partial fulfillment of the requirements for the degree of Master of Urban and Regional Planning in the department Urban of Regional Planning, Bangladesh University of Engineering and Technology, Dhaka and this are any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Abstract

The power supply situation in Bangladesh is very precarious. Out of about 25 million households of Bangladesh, only around 4.2 million had been brought under the conventional network of electricity till to-date. Since the rural network is characterized by a comparatively lower consumer deusity, it often becomes difficult and uneconomic to reach electricity to all villages, islands, coastal areas, hilly regions and other inaccessible parts of our country within the command area of a Rural Electrification Board. The only way to overcome this difficulty is the decentralized mode of power distribution which can be conveniently provided by Photovoltaic (PV) systems.

Bangladesh is situated between 20.30 - 26.38 degrees north latitude and 88.04 - 92.44 degrees east latitude which is a good location for solar energy utilization. Daily average solar radiation varies between 4 to 6.5 kWh per square meter. Maximum amount of radiation is available on the month of March-April and minimum on December-January. The total installed capacity of solar photovoltaic applications has reached 800 KWp (estimated) and about 15,000 solar hnme systems (SHS) are operating in different parts of the country. (Mazumder, 1995).

With a view of experimenting this new solar technology under the climato-socio-economic conditions of Bangladesh, Rural Electrification Board (REB), Local Government Engineering Department (LGED) and some Non Government Organization (NGO)s have installed solar house hold system in several rural areas of the country.

The Solar Photovoltaic Pilot Project and its successful operation create the initial confidence of the operators as well as the rural consumers to the extent that this is a technology that functions and enhances the quality of life in terms

of poverty reduction, income generating activities, literacy rate, access to information and entertainment, environmental protection, etc. at remote and far-flung areas where the conventional electricity grids would never be techno-economically viable for various reasons.

To determine the actual impact of solar energy on rural livelihood in this study a comparison has been made between the solar electrified and non-electrified rural areas in both Thakurgaon and Dinajpur Districts based on some rural development indicators and finally some recommendations are suggested in order to overcome the problem of solar technology so that in future solar technnlogy can play a great role to alleviate the energy crisis in rural Bangladesh.

Title of the study

Impact of utilization of solar energy in some selected rural areas of Thakurgaon and Dinajpur district.

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Abbreviation

ADB	Asian Development Bank
BAEC	Bangladesh Atomic Energy Commission
BCSIR	Bangladesh Council for Scientific and Industrial Research
BAU	Bangladesh Agricultural University
FAO	Food and Agricultural Organization
GS	Grameen Shakti
IDCOL	Infrastructure Development Company Limited
PV	Photovolatic Technology
PDB	Power Development Board
REB	Rural Electrification Board
SHS	Solar Home System

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Chapter-1

Introduction

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Introduction

1.1 Background and present state of the Problem:

Solar energy is one of the major sources of renewable energy. The introduction of Photovoltaic (PV) technology has made it possible to generate electricity directly from the sun. Solar energy's unique attributes of no need for fuel, high durability and reliability and being able to operate for prolong periods without maintenance; make it economical for all types of remote applications.

Different Solar photovoltaic (PV) applications are gaining acceptance as a technology fur electricity generation in remote and rural areas including- Solar Home Systems (SHS), Rural Market Electrification, School Electrification, Health Clinic / Hospital Electrification, Cyclone Shelter Electrification, Micro enterprises (grocery shops, tailoring shops, clinics, restaurants, sawmills, rice mills, cellular phone services, barber shops) electrification, ICT Training Centre Electrification, signaling, Remote Telecommunication and Remote Rainfall Measuring Station, Water Pumping, pest control, aeration pumping for aquaculture, fish and poultry farming, etc. Thus the PV electricity is contributing to overall rural development.

Out of about 25 million households of Bangladesh, only around 4.2 million households had been brought under the network of conventional electricity till to-date (World Bank, 2002) Since the rural network is characterized by a comparatively lower consumer density, it often becomes difficult and uneconomic to reach electricity to all villages, islands, coastal areas, hilly regions and other inaccessible parts of our country within the command area of a Rural Electrification Board. The only way to overcome this difficulty is the decentralized mode of power distribution which can be conveniently provided by PV systems. This is a unique advantage of this new technology. Secondly, it does not need any conventional fuel and as such there is no fuel cost- a great relief in these days of energy crisis. Thirdly, there is no moving part in this system resulting into noiseless functioning leading to long durability and soundless environment.

Bangladesh is situated between 20.30 - 26.38 degrees north latitude and 88.04 - 92.44 degrees east latitude which is a good location for solar energy utilization. Daily average solar radiation varies between 4 to 6.5 kWh per square meter. Maximum amount of radiation is available on the month of March-April and minimum on December-January. The total installed capacity of solar photovoltaic applications has reached 800 KWp (estimated) and abont 15,000 solar home systems (SHS) are operating in different parts of the country (Mazumder, 1995).

With a view of experimenting this new solar technology under the climato-socio-economic conditions of Bangladesh, Rural Electrification Board (REB) has undertakeu this solar PV project in some isolated islands (Karimpur and Nazarpur unions) of Narsingdi district. LGED also has installed solar house hold system in several rural areas of the districts Kushtia, Thakurgaon, Dinajpur, Sherpur, Jhenaidah etc. In this PV projects the beneficiaries are the inhabitants of remote and isolated rural areas, local manufacturer, shop-keepers of hat (rural markets) , bazaar, students, social institutions, health center etc.

The Solar PV Pilot Project and its successful operation has created the initial confidence of the operators as well as the rural cousumers to the extent that this is a technology that functions and enhances the quality of life at remote, far-flung areas and inaccessible islands, where the couventional electricity grids would never be techno-economically viable for various reasons.

The main aim of this study is, therefore, to contribute to a better understanding of the potential impact of PV systems on sustainable agriculture and rural development especially concerning income-generating activities in some selected rural areas of Dinapur and Thakurgaon districts where solar energy is already in use.

1.2 Research Objective:

The aim of this research is to find out the suitability of solar energy for rural development. To achieve the aim the following objectives have been set:

i) Compare rural development in areas with and without solar energy.
ii) Compare rural development before and after solar energy was introduced.
iii) Compare solar energy with traditional electricity system.

Possible outcome:

It is expected that the study will help to increase our knowledge on potential impact of the use of solar energy system on rural development especially concerning income-generating activities and its sustainability. It is, in fact, of paramount importance to identify the potential contribution of PV to rural development in order to gain further financial and political commitment for PV projects and programmes and to design appropriate PV projects.

1.3 Scope of the study:

This research deals with the impact of solar energy in two solar electrified rural areas of Thakurgaon and Dinajpur by comparing them with the two non-electrified rural areas of two districts respectively based on some rural development indicator such as Agricultural production, Fisheries and livestock production, Educational facilities, Commerce and Business facilities, Health service improvement ,scope of employment opportunity for woman-such as sewing, tailoring, small cottage industry, etc.

Methods used in this study include field investigation, site survey, household questionnaire survey, rural market survey, data collection and analysis.

1.4 Limitations of the study:

The study has a number of limitations. To reach the target of the study the total work was dependent on primary and secondary data, information and opinions of concerned people. The scope getting correct and required information was dependent on the following-

- The sample size and selection of variables were limited to a manageable level by considering time and resource constraints.
- As solar energy was very recently intrnduced in the study area, it was difficult to find out the depth of impact of solar electricity on the study areas within such a short time.

Chapter-2

Methodology

Chapter-2
Methodology

2.1 Outline of Methodology:
Rural development of a country is measured by some indicators- such as Agricultural production, Livestock and fisheries production, Educational facilities, Commerce and business facilities, Health service facilities, Law and order conditions, economic activities, income generating activities, etc. To measure the influence of solar technology on the above indicators, the following methodology will be adopted:

2.2 Selection of the study area: To determine the actual impact of solar energy on rural development some rural areas were selected with respect to topography, income level, literacy, communication system, cropping pattern, business pattern and other conveniences where some areas are provided with the solar energy and some are not. For this purpose, two rural areas were selected from Thakorgaon District and another two rural areas were selected from Dinajpur District.

2.3 Literature survey: An elaborate literature survey on the topic has been carried out for a better understanding and representation of the issue. Due to nature of the topic a part of the study has been based on published references, studies and official documents.

2.4 Data collection: For the purpose of the present study the required information has been collected from two sources:

2.4.1 Secondary sources: The secondary data on solar energy have been collected from the relevant govt. and non-govt. organizations such as follows:

-Various uses of solar energy in rural areas of Bangladesh from Local Government Engineering Department (LGED);

-Sustainability of solar energy technology in Bangladesh from the Centre for Energy Studies, Bangladesh University of Engineering and Technology (BUET);

-The prospect of solar energy in Bangladesh from the Bangladesh Council for Scientific and Industrial Research (BCSIR);

-The impact of solar energy on agricultural production from the Bangladesh Rice Research Institute and Bangladesh Agricnltural University (BAU);

-The cost of traditional electricity system in rural area from the Rnral Electrification Board (REB) and the Power Development Board (PDB).

-Demographic information from the BBS and other information of Livestock and fisheries production, Educational facilities, Commerce and business facilities, Health service facilities e.t.c from the Upazilla offices of the concerned area.

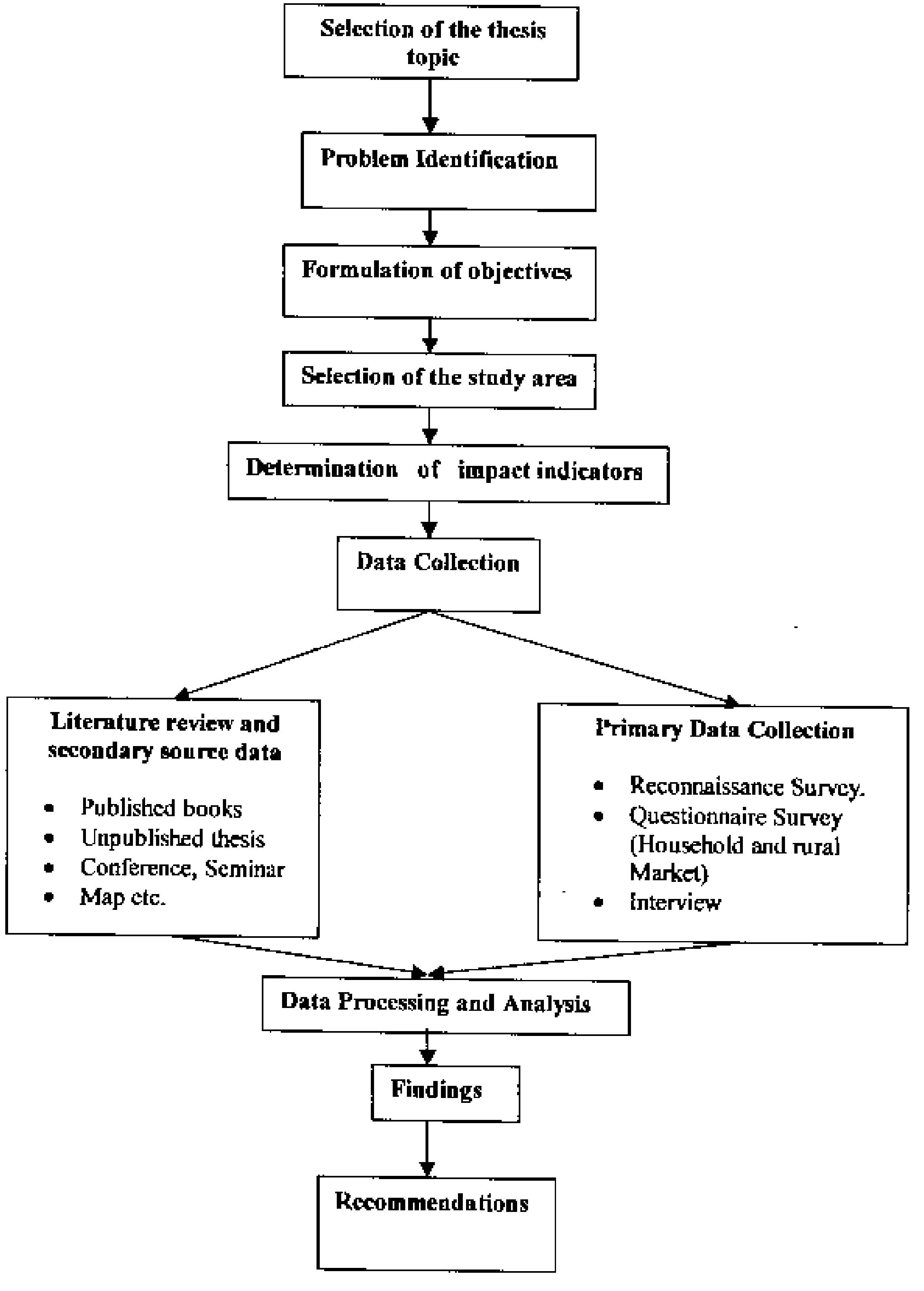
2.4.2 Primary sources: The utilization of solar energy may play a great role in agricultural production by water pumping for irrigation, pest control, aeration pumping for aquaculture. It can increase fisheries production by fisheries lighting, increase educational facilities by school electrification and increasing children's study honr nt homes, increase commerce and business facilities by lighting system for the grocery shops, tailoring shops, restaurants, barber shops etc., increase health service improvement by clinic and hospital electrification, increase law and order condition by street lighting at night, increase recreational facilities by TV and Radio in the village. Such development and improvement was also evident in the study areas. The actual impact of the solar energy was revealed by the household and rural market questionnaire survey. For this purposes all the solar houses (n=300) of Solar electrified study area of Thakurgaon District and all the solar houses (n=475) of Solar electrified study area of Dinajpur District were selected. The houses from non-electrified study area of Thakurgaon and Dinajpur Districts were selected randomly. The survey was conducted to know about the condition of the study area a year before solar electrification and a year after the introduction of solar electrification. The indicators used to asses the impacts are as follows:

- Agricultural production
- Fisheries and livestock production
- Educational facilities
- Commerce and Business facilities
- Health service improvement
- Law and Order condition
- Performance of daily activities
- Performance of household activities
- Income generating activities.
- Scope of agro-industry
- Scope of recreational facilities
- Scope of employment opportunity for woman (such as sewing, tailoring, small cottage industry, etc).

The above survey was done through household interviews in both the villages. Different people were interviewed, such as farmer, teacher, businessman, tailor, small traders, fishermen, union chairman and members. This provides information from a wide range of people.

2.5 Data Processing and Statistical Inferential Analysis: After completion of the collection of above data it was processed to establish the objective of research work.

2.6 Methodology Chart



Chapter-3

Literature Review and Impact of Solar Electricity in Rural Development

Chapter-3

Literature Review and Impact of Solar Electricity in Rural Development

3.1 Literature review

Bala (1998) gave emphasis on solar energy as an effective way to solve energy problem in rural Bangladesh. He said, "Energy is a crucial input for economic development and for improving the quality of life. Energy resources in Bangladesh comprise of commercial resources and biomass resources. Only about 37% of the needs of energy are met by commercial energy; the remaining needs, mostly in the rural areas of Bangladesh are met by biomass fuels. Energy planners must keep in mind that Bangladesh is facing energy crisis today and deforestation is taking place rapidly with consequent problems on ecology and environment. Among the alternative energy sources, renewable energy appears to be promising. Bangladesh with a population of 150 million in 2000 needs to concentrate on correcting the ecological imbalances by plantation of trees (afforestration), development of solar energy and prudent use of petroleum products."

Asian Development Bank also gave emphasis on the use of solar energy in Bangladesh as an alternative source of energy. In the "Environmental profile (Bangladesh)' 1997, ADB recommended following systems- (i) biogas system for heat and motive power, (ii) Solar photovoltaic power systems fpr domestic lighting, water pumping, medicine refrigeration and data communication and solar thermal systems for heating purposes. (iii) Small scale hydro power systems for mechanical and electrical energy and (iv) Windmill based power generation, water pumping and battery charging systems.

In "Renewable Energy Technologies, Their applications in developing world' (1991) L.A Kristoferson and V.Bokalders, different techniques of using solar energy is given. In this book various factors relating production, economy, and dissemination of solar devices and application of various types of solar system is discussed.

In India, many solar energy projects has been conducted P.P.S. Husain and Pandey (1991) discussed about some solar energy projects in Orissa in their book " Micro-Level Energy Planning". In that book they showed that energy planning for rural areas is very important for developing nations. The success of energy planning for any particular area depends on integration of use of various energy sources, both traditional and renewable.

Power cell, Ministry of Energy and Mineral Resources of Bangladesh has published "Status of Renewable Energy in Baugladesh" in 1997. In that report present energy situation of Bangladesh and status of renewable energy is discussed in detail. Renewable and rural energy policy is also discussed. According to the report, photovoltaic systems will be ideal for the 2500 cyclone shelters which not only provide shelter for about 1000 persons each during an emergency, but also serve as community center, school and health center one year round basis. Each could require about 1 to 2 kWp to provide power for lighting, warning beacons, refrigerators, water purification, radio communication, TV, etc.

Bangladesh Atomic Energy Commission (BAEC) launched a number of PV pilot projects to asses their technical feasibility and social acceptance and to determine the potential for local manufacture of system compouents.

In the Status Report of Grameen Shakti, (April 2000), present status of Grameen Shakti and the aim of the organizatiou is briefly discussed. Grameen Shakti has sold more than two thousand of solar home systems in different part of the country between 1997 to 2002. As the projects aimed at the poor villagers, Grameen Shakti offer two credit policies for those who want to buy the systems on credit.

3.2 Solar Energy and Rural Development:

Rural people are still an important majority in most developing countries and according to statistics will continue to be so until far into this century. Although many of these countries have had significant economic growth during the last decades, these figures are national averages; they mask the economic disparities and the lack of access to necessary basic services by the poor, especially the rural poor. Rural areas generally harbour an unequal share of poverty, especially in developing countries. Rural areas often suffer from a lack of attention on the agenda of national and international authorities since most of the political and economic attention is given to industry-driven economic growth. Apart from the unfairness to snch a big mass, it also represents an enormous amount of missed human capital. Furthermore, it should be realized that it is the rural areas where many of the resources originate (e.g. water, food, biomass energy) that are essential to the society as a whole. Particularly in many developing countries, rural areas and their natural and human resources are the cornerstones of the economy and should therefore be a major focus on the development agenda

In 1991 Food and Agriculture Organization (FAO) defined a framework for the Sustainable Agriculture and Rural Development (SARD) as part of its mandate to better the conditions of rural populations and improve agricultural productivity: "... the management and conservation of the natural resource base, and the orientation of technological and institutional change in snch a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resonrces, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable". An elaborate discussion of the role of rural energy in the Sustainable Agriculture and Rural Development (SARD) -framework is beyond the scope of this document. However, it should be pointed out that energy plays an important role in many basic human needs and in agricultural and economic development in rural areas.

Some examples of important activities requiring energy inputs in different rural sectors are:

- Agricultural sector: irrigation, land preparation and fertilization;
- Household sector: lighting, food processing and conservation, cooking;
- Rural industry and commercial services sector: lighting, processing;
- Community and social services: water pumping, refrigeration for health centres, lighting of communal buildings.

This study focuses on solar photovoltaic (PV) systems, which can fulfill only a part of rural energy needs. As has been noted before, most PV programmes have given attention to the so called "Solar Home Systems" as the most proven of PV applications. With continuing advances in PV technology, decreasing prices and growing experience in the organizational aspects of introducing this new technology, many other applications of PV have shown their potential. This promises to open the door for a greater contribution of PV systems to rural development.

3.3 Solar electricity for rural development: Experience in the Dominican Republic

The cost and difficulty of providing electricity service to rural areas in developing countries has left an estimated two billion people worldwide without the benefits of electricity. But in the Dominican Republic, as elsewhere in the developing world, the increasing use of solar photovoltaic technology offers a practical alternative for rural electrification and promises a brighter future for many rural communities. Since 1984, Enersol Associates, a US non-profit organization and ADESOL, Enersol's Dominican counterpart, have fostered rural electrification in the Dominican countryside using an approach called the Solar-Based Rural Electrification Concept. or "SOBASEC". SO-BASEC makes use of photovoltaic technology and local human and institutional resources to bring power and light to rural communities beyond the reach of existing electricity distribution networks.

3.3.1 The SO-BASEC model: First developed in the rural town of Bella Vista on the Dominican north coast, the SOBASEC approach uses micro-enterprise and credit program development to make solar technology available and affordable. To date, this approach has resulted in the installation of over 2,000 solar electric systems in the Dominican Republic. Hundreds of systems have been financed through pilot-scale revolving funds operated by non governmental organizations (NGOs).

3.3.2 Environmental Benefits: Photovoltaic systems provide many environmental advantages over other electricity supply options. The small stand-alone photovoltaic systems are highly energy-efficient and have little or no land use impact. In rural households, the systems typically replace kerosene lamps with electric lights. Kerosene lamps degrade indoor air quality by emitting carbon monoxide, sulfur dioxide, and oxides of nitrogen. They also present a serious fire hazard. By replacing kerosene lamps with solar-powered electric lights, each photovoltaic system displaces an estimated three to six tones of the greenhouse gas carbon dioxide over its twenty year life. Widespread use of photovoltaic for rural electrification could prevent the release of millions of tones of carbon dioxide.

3.3.3 Development benefits: Solar-based rural electrification improves the quality of rural life in many ways. Most notable among the quality of life benefits is the improved lighting from electric lamps over the traditional sources, kerosene and candles. A World Bank (1988) study found that one 15 watt fluorescent lamp (or one 60 watt incandescent lamp) provides the same amount of light as 18 kerosene wick lamps or 60 candles. In addition to improved household lighting, several solar electric systems now light rural Dominican schools, health clinics, and community centers. Solar-based rural electrification also complements and aids economic development efforts.

In the Dominican Republic, two dozen local technician/entrepreneurs now make a living by assembling, installing, and maintaining solar- electric systems. While the comparatively small amount of energy generated by 35 to 50 watt photovoltaic systems is not sufficient to power motors for machinery or other traditional "productive use" applications, a number of the 2,000-plus systems in the Dominican Republic do provide limited power and light for a range of small cottage industries, farm-related activities, and rural stores.

Once a workforce of trained local technicians gained employment installing small solar-electric systems, the installation of more technically sophisticated solar-powered community water pumping systems became possible, with added confidence in the availability of local maintenance services. While an estimated 40% of the rural Dominican population lacks access to potable water, photovoltaic-powered water pumping systems effectively deliver fresh water in many areas from subterranean sonrces. Enersol and ADESOL have incorporated water pumping into the curriculum of their training courses for more experienced solar energy technicians, and have assisted with the installation of four community water systems to date. Over time, the use of renewable energy powered water systems is expected to increase substantially.

3.3.4 Expansion potential: Photovoltaic systems are now the lowest-cost option for satisfying many of the electric energy needs of areas not served by distributed electricity, particularly in developing countries where the amount of sunshine is generally high and rural household electricity demand is comparatively low (Empresa Electrica de Guatemala, 1993; Inversin, et al., 1991). Their cost-effectiveness for small-scale power supply in off-grid areas, coupled with the demand for basic electric service which two billion people currently lack, suggests a large role for photovoltaics for rural household electrification. Initiatives are now under way to expand the use of photovoltaics for rural electrification in a number of countries. Enersol is working to replicate SO-BASEC in Honduras and Guatemala. Several other initiatives are in progress elsewhere in Latin America, and in Africa and Asia. Some of these initiatives, including projects in Brazil, India, Indonesia, and Zimbabwe, are receiving substantial support from bilateral and multilateral development sources. The success of these initiatives have further opened the door to international financing for solar based rural electrification and thus helped to remove a critical barrier to the widespread use of solar electric technology in rural areas.

3.4 Solar electricity in rural development: Experience in Nepal

Around 60 % of Nepalese, mostly from rural areas, are still deprived of electricity. A gamut of factors are responsible for this bleak situation, and for a number of villages in the high mountain areas, the cost of extension of grid electricity will be prohibitive and local mini-grids from micro-hydro power plants are not viable in many of these areas. This hard fact compels Nepal to look for other off-grid or mini-grid electricity sources. And solar photovoltaic (PV) technology has been proven to be a viable option. This technology, considered to be expensive compared to grid extension or mini-grid, becomes not only cost-competitive but simple to install as well in such far-flung areas with sparse population, often becoming the only viable option for electricity supply.

The history of use of solar PV technology for rural electrification in Nepal and even worldwide is not very long. Nepal saw the first case of rural electrification through PV when 3 mini-grid PV systems were installed in 1988-89 with French government support. Installations of stand-alone solar home systems (SHSs) in 1993 at Pulimarang in Tanahu district of Nepal marked a new beginning in the use of the technology in Nepal. By 1993-94, there were 3 solar PV companies in Nepal. A nnmber of organisations (GOs/NGOs/donors) started providing support for dissemination of SHSs in limited ways. The government provided subsidies for a limited number of SHS installations starting from the fiscal year (FY) 1995-96.

3.4.1 Solar energy Support Programme (SSP) of AEPC/ESAP :

The Alternative Energy Promotiou Centre (AEPC) launched the Energy Sector Assistance Programme (ESAP) -- a Danida-supported government programme -- in April 1999 for 5 years as Phase 1, with a possibility of continuing the support for 10-15 years. The solar energy component of ESAP or Solar energy Support Programme (SSP) has been supporting dissemination of SHSs in Phase 1. ESAP took aronnd 2 years to help the sector set up a subsidy policy, a delivery mechanism and other programmatic systems and structures for integrated and sustainable dissemination of SHSs.

By FY 2000-01, just before ESAP started providing subsidies on a national scale, some 8,000 SHSs were installed with subsidy from the government or with other organisations. Private sector companies have been the prime movers right from the beginning with support from Agriculture Development Bank (ADB/N), Alternative Energy Promotion Centre (AEPC), Rural Energy Development Programme (REDP), etc.

The all-round development objective of ESAP is "to improve living conditions of the rural population by easing its access to energy technologies with better performances in terms of productivity, nse versatility and environmental impacts".

Electricity through a SHS typically sized between 30 and 50 Wp well suits the requirement of rural households. And it makes a tremendous difference to the life of the rural people. Electricity not only provides them with to operate other appliances for information, education and entertainment. A recent SHS users' survey conducted in 20 Village Development Committees (VDCs) of 13 districts of Nepal shows 77.73 % of SHS users use solar electricity to operate radios, 37.44 % to operate cassette players, 50.24 % to operate TV and 8.06 % to operate VCDs. Rural people are thus benefiting from solar electricity in a number of ways.

Solar electricity has been able to make a substantial social impact in backward rural areas where electricity was a distant dream until a few years back. Improved child education because of increased study hours and coaching under electric lamps has been cited to be a benefit by most of the users. Other benefits cited are increased conversation among family members, improved household activities and improved socialization /interaction among villagers. Similarly, SHS users have reported that there has been significant decrease in eye- and respiratory- related health problems and improvement in cleanliness of the household environment. It is obvious that as rural people have better access to education, information and entertainment, social problems such as gender and caste discrimination will be gradually alleviated. Having access to electricity, information and education also helps to enhance rural people's self-esteem.

On the economic front, SHS installation has not just helped in saving on kerosene, batteries, etc., but also opened up new economic opportunities in rural areas. The above mentioned study pointed out that users are using solar electricity in small ways to initiate more productive or income generation activities. There are good examples of establishment of rural enterprises directly related to the business (SHS dealers, service centres and spare parts shops). And there are many examples of household-level income generation or enterprises in rural areas such as knitting/weaving, photography, electronic repair centres, running telephone and fax machines, tuition classes, restaurant business, video shows etc. In whatever small numbers, the dissemination of SHSs has directly helped in skill development, employment and entrepreneurship among rural people. Of course, the extent of creation of economic opportunities depends a lot more on improvement of the all-round socio-economic and political conditions in the country.

3.5 PV electricity in rural development through adult literacy programme: Experience in Honduras :

In several rural development projects of FAO in Honduras, educatinn has been identified as an important priority by the target population. The regular basic education programme has not succeeded in providing a literacy basis for large parts of the population (especially adults, hut also children). Cooperation was sought with a nationally developed adult education programme (EDUCATODOS, financed by USAID) that is hased on radio or cassette lessons and textbooks, which are studied in self-help groups, supported by a facilitator (mainly for logistical help, external motivation and examinations.). The programme is hugely popular in many communities that FAO assists. In the area of Southern Lempira alone about 160 groups are functioning, consisting of approximately 1,600 students in six different level classes. People have classes five to six nights a week and the vast majority pass their exams.

Because most adults are occupied in the day-time, preferred class hours are after dark. Groups are supplied with a cassette player (cassettes being highly preferred to radio lessons because of the possibility to listen to parts of the message repeatedly), pressurized kerosene lantern and a regular supply of dry-cell batteries, kerosene and alcohol. The pressurized kerosene lamps showed regular problems of broken glass, mantels and clogged tubes because of dirt. In 1998 solar lanterns were introduced as an experiment in four villages. In 1999 during the first evaluation participants judged the solar lanterns superior to the pressurized kerosene lanterns: easier to handle (no filling, pumping, pre-lighting with alcohol; no weekly trips for alcohol and kerosene), better quality light (softer to the eye), no noise, no smoke, and no danger of fire. No problems were encountered.

In 1999 22 small PV systems (24 - 40 Wp) were acquired, with the help of donations from PV manufacturers, and installed in schools and community centres. Community groups were organized and trained to maintain the systems, to organize the use of the building and to raise money for maintenance and spare parts. The communities also paid 10-15 percent of the investment costs, having a choice between a 24 or 40 Wp system. The buildings/systems are being used for adult education programmes (replacing kerosene lamps, use of kerosene, alcohol and dry cell batteries), community meetings, festivities, etc. Several communities have also established a community shop for basic groceries in the same building with a PV-powered light facilitating longer opening hours at night. The education programme itself has been evaluated thoroughly (Steenwyk 1997, 1998 and 1999).

The programme was found to have a significant impact on income (on average US$41 more income for every study year per participant) against costs per participants (state-financed) of US$28. Traditional basic education costs US$100 on average per participant. Other important impacts of the programme include benefits such as higher self-esteem, improved health, improved civil participation, increased knowledge of reproductive health, and increased school performance of their children (the last two especially related to women). Although these benefits cannot all be accounted to the solar systems, they do make it possible to impart these classes at night. The solar systems also provide the same service at a lower cost (LCC) and higher commodity, while the bigger systems provide far more service. Discussions are presently ongoiug with the

Ministries of Energy, Education and the Social Investment Fund (FHIS) to include such small community-based systems on a nation-wide basis.

3.6 PV electricity in rural development through pumping for irrigation: Experience in India

The Indian PV programme - as part of a renewable energy programme - is one of largest and oldest in the world. Started in 1975, it shifted its focus to rural applications from 1982 onwards. The programme (and number of PV installation) received a major boost in 1992 when a revolving credit fund was introduced, coinciding with the privatization of deliveries. By 1999 more than 39 MWp had been installed, including applications for telecommunications (still around 50-60 percent of installations), lighting (home and street), solar lanterns, vaccine refrigerators and pumps.

The Ministry of Non-conventional Energy Sources (MNES) has deliberately targeted the agricultural sector in its RE-policy. A major part of Indian agriculture (approximately 30 percent) is under irrigation and another 30 percent is estimated to have irrigation potential. The Indian Government has always stimulated the use of electricity for pumping with subsidized connection costs and electricity tariffs (up to 80 percent subsidy). This led to high electricity consumption for irrigation (25 percent in some states; Baktavatsalam, 1998) and contributed to a growing gap between generation capacity and demand of up to 40 percent in some states. Scheduled power cuts of up to 75 percent of the day in peak summer months had become a regular feature in some states, besides unscheduled power lay-offs, e.g. by overloading of transformers. Finally, due to scarcity in material, connections for irrigation pumps had waiting periods of up to three years.

In 1992 a demonstration programme for Solar PV pumps for agriculture and other uses was introduced. With the aid of subsidies and soft loans PV pumps were introduced in several phases. At the end of the first phase, in 1995, 463 pumps had been installed. 81 percent of the users expressed satisfaction with the overall performance of the system. At the end of March 1997 a total of 1 816 pumping systems had been installed: 58 percent for irrigation and agriculture; 30 percent for horticulture; and 12 percent for other uses (including pisci-, aqua- and silviculture). By the end of 1999 a total of 3 100 pumping systems had been installed.

The most common irrigation system is a 900 Wp surface mounted pump, costing around US$6 250 (including electronics, pump and installation excluding irrigation equipment) 34. At preseut, financial incentives include a soft loan (5 percent) and a subsidy of US$3 per Wp up to US$5 000. For the described 900 Wp-system, this would mean a subsidy of approximately 40 percent. MNES also supports training programmes on operation and maintenance and water management aspects of the PV pumping systems. These cover the actual users, local technicians and rural youth.

The installation of more than 3100 PV pumping systems has led to a wealth of experience both in the technical, financial and organizational field. Most of the installed systems are working satisfactorily and niche markets for the use of PV irrigation systems seem to be increasing, mainly for horticulture and other high value crops and in combination with water saving irrigation techniques. The adequate use of, for example, drip irrigation systems can save both water and fertilizer, increase production and augment the viability of PV pumps (due to lower water, i.e. energy demand).

Research conducted by the Central Plantation Crops Research Institute (India) led to the conclusion that through such irrigation techniques the use of Nitrogen fertilizer could be reduced to 1/3, phosphatic fertilizer to 1/10 and potassic fertilizer to 2/5. In addition to an 80 percent reduction in fertilizer expenses, crop performance improved (Hart, 1998). With the aid of appropriate financing mechanisms, private sector companies have been included in the project, laying the basis for sustainable markets. On the other hand, markets are developing much slower than anticipated and high investment costs continue to be a major obstacle for the widespread use of such systems. Appropriate subsidy and financing mechanisms will continue to be necessary for the time being to lower this barrier. The experience has also shown that the introduction of PV technology must be combined with adequate technical support infrastructure and training programmes in improved agricultural and irrigation practices, including adequate field preparation, correct water management and selection of adequate (high value) crops. A final conclusion from this experience is that the above-mentioned technical and agronomic assistance should be made available to the farmers from one source (one institution) to facilitate the adoption of PV powered irrigation equipment and improved irrigation techniques.

3.7 A summary of experiences:

From the above discussion it is clear that for the developing countries solar energy is playing an important role in various aspects of rural development such as Agricultural production, Fisheries and livestock production, Educational facilities, Commerce and Business facilities, Health service improvement ,scope of employment opportunity for woman-such as sewing, tailoring, small cottage industry, etc. As Bangladesh is a rural based country and only 16% areas of total country is under national grid electricity, the experiences of solar electricity uses of above developing countries may be a replica for the improvement of rural life in our country.

Chapter-4

Solar Electricity in Bangladesh

Chapter –4

Solar Electricity in Bangladesh

4.1 Electricity network in Bangladesh

Power consumption per capita is a measure of standard of living of country. The growth in electricity consumption is proportional to population and economic growth and rural electrification. Total installed power plants of the country in 1994-95 were 2908 MW and the peak demand was 2038 MW. Technology mix of the installed power plants were as follows: steam turbine 63.2%, gas turbine 21%, hydro 7.9%, combined cycle 6.2%, diesel engine 1.7% (Bala, 1998). Rural Electrification Board (REB) administers the overall program of rural lectrification and Palli Biddyut Samiti (PBS) owns and manages specific distribution system within a particular area. Every PBS covers an area of 1500 sq km on an average. Total uumber of PBSs established upto June 1995 was 53 and the total number PBSs energized was 45. In 1994-95, peak demand of REB system reported as 261 MW. Total energy consumption's by different end users in 1994-95 was 1050 GWh and the shares of different categories of consumers were as follws: Domestic 30.7%, Irrigation 26%, Industry 37.5%, commercial and other 5.8% (Bala, 1998).

Up to June 1995, REB network covered 339 thanas, of which 234 thana were energized. Total nnmber of villages electrified by REB was 16,484. Additional 2000 villages have heen electrified by Bangladesh Power Development Board. Thus, now roughly 28.4% of villages have electricity network. The rest of the villages are still now under the darkness. In this circumstances solar technology stands as a new alternative euergy source in Bangladesh.

4.2 Introduction of solar energy in Bangladesh :

In Bangladesh, the uses of solar energy started in the beginning of 1980. That year Dhaka University established a research center which has been named the RERC (Renewable Energy Research Center). Within 1981 a Commercial Enterprise the Rahim-Afrooz initiated solar electricity for use by the Army. From the 1990s many NGO's like Grameen Shakti, CMES, BRAC, Energy System, Siemens Bangladesh took many steps to make solar energy popular in the domestic life of rural and urban people. BRAC sold hundred (100) Home System's to make convenient electricity for rural people. Moreover PDB, BIWTA, BDR, T&T, EPI, Forest, Bangladesh Railway are trying now to upgrade our power deficiency by using alternating energy source like "solar electricity". The role of GO and NGO in producing solar electricity is given below:

4.2.1 Solar Electricity under Rural Electrification Board (REB):

The remote rural areas of Bangladesh, where the grid system extension is expensive due to their remote locations and very low consumer density. This expensive distribution network, offer ideal alternative opportunities for setting up renewable energy system based on solar PV, biomass, biogas, micro- hydro etc. With the cost of solar PV systems still high, applications only in isolated areas are presently considered to be viable option, where virtually no other cost effective electricity generation & supply options are available.

1st Solar Project:

Title of Project/ Installation: Diffusion of Renewable Energy Technologies.
Location of Project : Karimpur and Nazarpur Unions of Narshingdi District.
System capacity: A total of 62 KW

Description: Electrification of Karimpur and Nazarpur unions of Narshingdi district by stand-alone and central charging station based solar systems. Types of load connected are domestic, commercial, Social institutions & Health Center etc.

Cost of Installation :TK. 766 lacs

Project objective :

- Diffusion of Renewable Energy .
- Reduction of environmental pollution.
- Electrification of remote and isolated areas through domestic, commercial, irrigation, and health Center loads.

Appliances used: Fluorescent lamp. Fan (Table and Ceiling), TV/VCR/ Radio/ Cassette player.

Beneficiaries/communities: Inhabitants of remote and isolated areas, local manufacturer, shop-keepers of hat & bazaar, students, social institutions, health center etc.

Beneficiary contribution : Through the socio-economic changes of the beneficiaries, they will contribute positively towards the national development. Local manufacturer/suppliers are contributing to the national economy through their boosted business activity/new income- generating activity.

Observation :Socio-economic changes and reduction of environmental pollution have been observed in the project area. The people of the project think that their PV system is better than the grid system as it is within their control and there is no fear of unwanted load shedding.

Present condition: Under this project against the target of connecting 440 consumers by the generation of 35 KW solar energy a total of 806 consumers were connected through generation of 62 KW. The project started running smoothly and commercially back in June/97. In Janury/2000 DESA had extended its grid line in to the project area. Consequently some consumers had returned their systems which are now being relocated in different Palli Bidyut Samitics(PBSs).

2nd Solar Project: (Proposed)

Title : "Diffusion of renewable energy technologies- 2nd phase".

It is the second solar project approved by the Government.. Total project cost is Tk 27.96 crores, which includes a foreign currency component of Tk 1550 crores. Project implementation period was from 1999 to 2004. Austogram Upazila, Shingra Upazila, Kotalipara Upazila, Moheshkhali, Kutubdia & St. Martin islands will be solar electrified under the project. Total consnmer connection target is 6000. Procurement of some project materials is under pipe line using GOB fund. Negotiation is under way getting foreign funds.

3rd Solar Project:(Proposed)

Title: "Bangladesh Rural Electrification & Renewable Energy development (PV component)"

It is a proposed project. Project Implementation Plan (PIP) has been submitted to the ministry for approval. On approval it can be implemented with the financial assistance from World Bank, IDA and GOB. Total project cost has been estimated at Tk. 4822.67 lacs which includes a foreign currency component of Tk. 372225 lacs. It covers 6 Palli Bidyut Samitics namely Serajgonj, Natore-2, Pabna-2, Barisal-1, Sunamganj, and Cox's Bazar. Consumer connection target is 16000. Some preparatory (pilot phase) work of the project have been started under GEF PDF-B funding

GTZ (German Technical Co-operation) funded project:

Title : "Promotion of renewable energy in rural area of Bangladesh "

The main objective of the project is to test, promote & disseminate, renewable energy in selected remote areas of Bangladesh. Project period is 3 years and estimated cost is DM 4.00 million. Ministry of Power, Energy & Mineral Resources (MPEMR) is the lead ministry for this project and REB has been selected as the implementing agency of the project by GTZ

Table-4.1: Recent ret installation based data by REB (updated 03.03.2003)

SL	Location/Project Site	Capacity of Each System Installed or distributed	Numbers of System	Implementing Agencies/Beneficiaries	Funding Sources	Numbers of Peoples Served
1.	Karimpur & Nazarpur Unions of Narshingdi Sadar PS under Narshingdi District Project Status : Completed project	Total installed capacity of the project = 62 KW PV Module wattage of different stand alone system are 2x6Wp, 46Wp, 2x46wP, 16X46 wP (For health center)	Total No of consumers connected under the project = 806	REB/Household, commercial establishment, religious, educational & social institutes, health center etc.	GOB, French Government	A Total of 806 consumers of different type & load category were served.
2	Remote & off-grid areas of Austogram of Kishoreganj, Shingra of Natore, Kotalipara of Gopalganj, Moheshkhali, Kutubdia, Sandwip & St. Martins islands Project Status: Ongoing Project	As per the existing approved PP the total installed capacity will be about 0.3MW. This capacity may be reviewed & upgraded due to availability of more foreign fund commitment (Nearly Euro 10.2Million) from the German Govt PV Module wattage of different SHS are 46Wp, , 2x46Wp	As per the existing approved PP total connection target is 6000 which may be reviewed & upgraded.	REB/household commercial establishment religious, educational & social institutes, health center etc	GOB German Government (Committed)	A Total 6000 of consumers of different type & load category.
3.	Remote & off-grid areas of Pabna PBS-2, Serajganj PBS, Natore PBS-2, Barisal PBS-1, Cox's Bazar & Sunamganj PBS. Project Status: Ongoing Project	As per the proposed PCP total installed capaicy is nearly 0.6 MW. PV Module wattage of diffrent SHS are 36 Wp, 50Wp, 2x36Wp.	16000 SHS of differnet capacity	REB/Household, commercial establishment, religious, educational & social institutes, health center etc.	GOB IDA & GEF	A total of 16 000 SHS will served the people of the project area.

Source Renewable energy, REB, 2003

4.2.2 Solar electricity and Bangladesh Power Development Board:

Bangladesh Power Development Board (BPDB) generates electricity from both the renewable (hydro) and non-renewable sources (natural gas, furnace oil, diesel etc.). The present utilization of hydro power is only 230 MW at Kaptai Hydro Power Station. There are some places where solar photovoltaic is used for supplying electricity to lighting and communication equipment. BPDB is attempting to harness solar energy at the Chittagong Hill Tracts region. For this purpose, BPDB is conducting a feasibility study in that region and already floated tender to install solar photovoltaic units at Bilaichari. To further strengthen its commitment for environmentally benign renewable energy sources, BPDB has decided to float Bangladesh Renewable Energy Development Company Limited (BREDC), a subsidiary company with 100% ownership of BPDB, to streamlining, strengthening, popularizing and expanding renewable energy technologies throughout Bangladesh.

Bangladesh Power Development Board (BPDB), established in 1972, is responsible for planning, construction and operation of power generation and transmission facilities throughout Bangladesh and for distribution in urban areas except Dhaka and its adjoining areas. Total installed capacity of BPDB is 3603 MW (including 302 MW generated by Independent Power Producers). BPDB generates electricity from both the renewable (hydro) and non-renewable sources (natural gas, furnace oil, diesel etc.). There are some places where solar photovoltaic is used for supplying electricity to lighting and communication equipment.

But the present coverage is as low as 16%. Due to technical hurdles and cost, it is not justified to extend national electricity grid to many remote locations and offshore islands. BPDB is generating electricity from diesel power plants in these remote locations which is causing huge losses due to higher fuel cost, higher fuel transportation cost, pilferage of fuel, inaccessibility etc. These remote places are ideal for renewable energy utilization and BPDB is taking necessary steps for implementing renewable energy projects there.

Solar Photovoltaic Installations

At present BPDB has two major solar photovoltaic installations. These are -

- Rainfall Measuring Station, Kaptai
- East-west Interconnector, Aricha

Apart from these, there are some Transmission Towers (e.g. Transmission Tower at Karnaphuli river crossing, Chittagong) where solar photovoltaic is used for lighting purpose.

BPDB is also conducting solar energy feasibility study at Chittagong Hill Tracts region for serious solar energy program.

Rainfall Gauging Station, Kaptai

The Kaptai reservoir is a huge artificial reservoir, its capacity is 6.5 X 109 m3 and catchment area is 11,000 km2. It is very important to get the condition of the reservoir to generate electricity effectively and to warn flood in advance. To grasp the condition of the reservoir, it is necessary to collect rainfall and water level data immediately. For this reason, Rainfall and Water Level Telemetering System was installed at Kaptai lake by BPDB during the time of 4 and 5th unit extension project by Tokyo Electric Power Services Company (TEPSCO) ltd. of Japan.

The overall system is -

One telemetering supervisory/control at Kaptai power station for collecting, printing and display of rainfall and water level.

Eight sets of rainfall gauging station for measuring of the rainfall amount within the regions and for transmitting of the measured values to the KAPTAI master station via repeater station at -

- Rangamati
- Mahalchari
- Dighinala
- Langadu
- Belaichari
- Barkal
- Marisya
- Harina Bazar

One water level and rainfall station for measuring water-level changes in the reservoir and rainfall amount within the regions and for sending the measured data to the KAPTAI master station at Rangamati.

One repeater station for repeating measured data from gauge station to the Kaptai master station at Rangamati.

Due to remoteness, except the Rangamati all the other Rainfall Gauging Stations are powered by Photovoltaic Cells with Alkaline storage battery banks for un-manned operation.

East-west Interconnector, Aricha :

The East West Interconnector transfers electricity from the eastern part to the western part of the river Jamuna. It is 13.41 kilometer long comprising 11 towers of 111 meter high. The interconnector started functioning from 1983. For signaling purpose, solar photovoltaic lights are used which are automatically operated by photo switches.

Future Plans :

Solar energy's unique attributes of needing no fuel, high durability and reliability and being able to operate for prolong periods without maintenance, make it economical for all types of remote applications. These unique attributes also permit solar energy to be used in places where there is no grid system. In view of this, BPDB has plans to implement renewable energy projects of wind, solar and small hydro at remote locations of the country where the electricity grid has not yet reached.

Table-4.2: Status of Renewable Energies and Energy Efficiency related projects under PDB

[illegible]	[illegible]	[illegible]	[illegible]
1	Installation of 2x225 kw wind turbine powerplant at patenga, cox's Bazar, Feni and kuakata having total capacity 1800 kw (pp)	92 94	Approved by the government and waiting for foreign finance
2	Solar Power Plant at chittagong hill tracts (pcp)	105.30	Submitted for signature and approval to the MEMR on Oct .2001
3	Feasibility Study of Solar Electric Power plant (TAPP)	10 29	Submitted for signature and approval to the MEMR on Sep 14 ,1999
4	Energy Conservation pilot project by Intelligent motor controller(PCP)	98.1	Submitted for signature and approval to the MEMR on June 12 ,2000
5	Solar Electric Power Plant (PCP)	517.0	Submitted for signature and approval to the MEMR on June 26 ,2000
6	Energy Conservation pilot project (PCP)	70 99	Submitted to the Planning Commission Via MEMR on September 2, 2000
7	Centralized solar PV power Plant (PCP)	50.37	Submitted for Signature and approval to the MEMR
8	Renewable Energy Hybrid power plant(PCP)	1057 27	Submitted for Signature and approval to the MEMR on June 25,2001
9	Electrification of Saintmartins Island by Renewable Energies (PCP)	40 95	Submitted for Signature and approval to the MEMR on August 9, 2001
10	Electrification of Dohogram and Angorpota by solar Energy (PCP)	373.5	Submitted for Signature and approval to the MEMR on August 23, 2001.

Source Renewable energy, PDB. 2002

4.2.3 Solar electricity and Bangladesh Atomic Energy Commission: Bangladesh atomic energy commission (BAEC) launched a number of PV pilot projects to assess their technical feasibility and social acceptance and to determine the potential for local manufacture of balance of system components These applications included pumping, lantern and power for cyclone shelters, hospitals, mosques and a village System size ranges from a few watts to 2.3kWp. The results of the pilot projects were mixed with technical problems occurring with the lanterns and a pump, and cyclone damage at several other sites

Bangladesh Atomic Energy Commission installed the following Solar System in different areas of the country

Table-4.3: BAEC solar energy projects

Project location	Year	Watt Peak	Purpose	Present status
Savar	1985	1400	Pumping 18000 gallons/day	Running
Tangail	1988	480	Charging 100 rechargeable lanterns	Running at a new location
Sandwip cyclone shelter	1988	2162	TV, deep freeze, beacon lights, siren, flood lights charging units	Running
Sandwip hospital	1988	1880	Deep freeze, lights	Not running as batteries are not workable
Sandwip mosque	1988	47	Tube lights, microphones	Running
Maulavibazar	1989	2332	Irrigation of nurseries tea garden	Running
Sandwip livestock	1989	329	Deep freeze	Panels have been removed
Moheshkhali	1993	1000	TV, tube lights, deep freeze	Not operating due to battery faults
Madaripur	1994	160	Tube lights, public address systems	Running

Source: Ministry of Energy and Mineral Resources, 1997

The Institute of Fuel Research and Development (IFRD) of BCSIR has developed a low cost reflector type cooker. It is a spume aluminum parabolic reflector, which is easily made reflective by polishing. This cooker has been found economically feasible under condition in Bangladesh. IFRD has developed Solar Ovens, Solar Dryer and Solar Heater also.

4.2.4 Solar electricity and Grameen Sakti:

The main program of GS is its Solar Program. Under this program GS sells Solar Home System (SHS) in credit. It has a plan to install 8000 systems within next 3 years. For this purpose Shakti has already opened 38. It also opened 6 special branches through which Grameen Shakti will research on marketing policy. This network allows Grameen Shakti to quickly disseminate and commercialize any improvement in the technology. Since the systems are expensive for the rural people Grameen Shakti has introduced a soft financing systems for the customer. GS has linked this technology to some income generating activities as well.

Total Installed capacity:

Grameen Shakti has installed 14.161 Solar Home Systems till May 2003 with an installation capacity of 705 kWp. Its Current promotional rate is 700 SHS per month which will be 1000 by the end of 2003. For this purpose, Shakti has already opened 75 unit offices and has planned to open 25 more branches in rural Bangladesh.

The sales progress of SHS up to 2002 is shown below.

Table-4.4: Summary of solar energy installation under Grameen shakti

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tangail	95	74	186	273	377	166	1,193	56,022
Mymensingh	92	135	371	334	332	148	1,412	72,290
Sherpur	0	10	105	96	101	41	353	17,553
Comilla	20	24	71	175	491	261	1,042	45,170
Satkhira	0	54	148	207	211	116	735	39,151
Khulna	0	29	209	372	571	335	1,517	78,570
Sylhet	0	0	0	11	205	245	461	20,475
Cox'sbazar	0	0	0	25	127	71	223	10,868
Chittagong	0	0	0	4	217	241	462	23,910
Dhaka	21	43	19	48	112	36	279	17,562
Patuakhali-Barguna	0	4	91	162	407	247	911	46,632
Panchagar	0	0	0	53	45	24	122	6,134
Total	228	373	1202	1760	3,196	1,951	8,710	433,380

Source: Grameen Shakti, 2002.

Credit Policies of GS :
GS offer the following two credit modes for those who want to buy the system on credit.

Mode-1:

1. The customer has to pay 15% of the total price as down payment.
2. The remaining 85% of the cost are to be repaid within 36 months with 12% service charge.

Mode-2:

1. The customer has to pay 25% of the total price as down payment.
2. The remaining 75% of the cost are to be repaid within 24 months with 8% service charge.

Mode-3:
4% discount is allowed on listed price in case of cash purchase.

Uses of PV System

Customers of Grameen Shakti are using PV systems mainly for lighting and for recreational purposes (watching T.V). However, The solar system has created the possibility for income generating opportunities for small entrepreneurs. Grameen Shakti encourages entrepreneurs to apply PV systems for generation of income. Some examples of application of PV system for income generation are as follows:

- Education
- Charging Cellular Phone
- Lighting Rice mill
- Lighting Saw mill
- Lighting Tailoring shop
- Grocery shop
- Poultry farm
- Lighting cliuic
- Lighting restaurants
- Lighting shop

- Bazar/Market
- Micro-utility (selling power to neighboring shop)
- Radio/TV repairing shop

Production Unit of GS: From the research outcome GS has developed a production unit to fabricate the following components

- Lamp Inverter
- Charge controller
- AC-DC converter
- Mobile phone charger
- Inverter

Solar thermal program: Grameen Shakti is working in the field of solar thermal project. It is conducting research for the development of high quality solar water heater, Solar cooker, Solar drier etc. It has already installed a 1500 litre capacity solar water heater on the roof of a dormitory.

Solar Powered Computer Training Center: Remote areas do not have any access of electricity. So the people in the remote areas cannot use computer and Internet. To provide the computer facilities in remote places GS decided to install computer-training center powered by solar. Under this program GS already installed 6 computer education centers in Kutubdia, a remote island of Bangladesh, Shakhipur, Dacope, Kalihati, Patharghata and Cox's bazar. GS has plan to install 14 centers in near future.

Rural ICT: Grameen Shakti expanding its activities by some new ideas of modern technologies. ICT (information & communication Technology) is its new dimensional motivation towards the modern technology. This program will be helpful to bring the out come of modern facilities in front of the rural people.

Technical capacity of GS :

- Professional managers and engineers have been trained in Vietnam, China, Bangkok and USA in different areas of renewable energies.
- Marketing of the solar systems is done by qualified engineers. GS engineers design the systems according to the need of the customers. GS professionals also do installation and maintenance of solar systems.
- Similarly design and construction of bio-digesters are done by the engineers of GS.

4.2.5 Solar electricity and Infrastructure Development Company Limited (IDCOL) :

Provides GEF grants to lower initial investment cost of Solar Home Systems and technical assistance for institutional development of POs. Refinances loans for purchase of Solar Home Systems made by the Non Government Organizations /MFIs selected as POs and Provides technical assistance, loans and GEF grants to POs for development of sub-project (pilot on wind, hydro, and biomass power system).

Major functions of the Organization:

- Rural electrification through grid extension,
- Rural electrification through off-grid option, chiefly solar home systems (SHSs).
- IDCOL participates in the off-grid part of the Rural Electrification and Renewable Energy Development Project (REREDP) Rural Electrification Board (REB) participates in both "grid" and off-grid" parts.

4.2.6 Solar electricity & Center for Mass Education in Sciences (CMES) : A Regional Research and Dissemination Programme.

1. Location of Project/Installation:

- Chirirbandar, Dinajpur.
- Khanshama,Dinajpur.
- Kaharul,Dinajpur.
- Pirgasa,Rangpur.
- Amtoli,Borguna.
- Fatiksari, Cittagong

2. System Capacity: 2.85KWp

3. Type of Project Project/Installation: Pilot Project

4. Expected outcome of the project:

The main expected outcome of the project has been to vitalize the use of solar PV by clearing the way to take it directly to the people who need it most, in a manner which will both be affordable to them and will satisfy their basic needs including the need for enhancing the income. The major contribution was to set the way with appropriate technology and appropriate strategies to reach the target group in a commercial manner and logical standards and procedures.

5. Cost of Installation (Optional): SHS = Tk. 500. per watt.
Micro-utility = Tk. 455. per watt.

6. Project Objective: Promotion and dissemination of PV technology based applications in the country.

7. Appliances used: Charge Controller, Ballast, DC-DC Converter, Solar panel, Battery, Cable etc.

8. Beneficiaries/Communities: Shopkeeper & businessman of the Micro-utility and family member of Solar Home System (SHS).

9. Observation: The consumers are quite satisfied with the performance of system.

10. System Present Condition: All systems are working well except for some minor difficulties. No major complaint about the system. This is because of the well designed, effective monitoring, proper use and maintenance.

Table-4.5: System Description of Solar Project of CEMS

Solar Home System (SHS)	• Type of Module (Brand)	Siemens
	• Consumers	House holder.
	• Module Capacity	50Wp
	• Battery Capacity	12V,100Ah
	• Controller Brand & Capacity	Solar Charge Controller ,10Amp
	• Load Category (Appliances used)	Light, B/W Television, Cassette Player.
	• No of Load	4 fluorescent tube light, one 15"TV,one Cassette player.
	• Load Capacity of each Appliances	Light (7 W) each, Television (15W) Cassette (5W).
	• Uses hours per Day	5 hours per day.
	• Total Load (Kwh/day)	0.15 KW/day
Micro Utility	• Type of Module (Brand)	Siemens
	• Consumers	Shopkeepers, businessmen.
	• Module Capacity	350 Wp
	• Battery Capacity	12V,700Ah
	• Controller Brand & Capacity	Solar Charge Controller ,10Amp.
	• Load Category (Appliances used)	Light, B/W Television.
	• No of Load	24 fluorescent tube light. r.
	• Load Capacity of each Appliances	Light (7 W) each, Television (15W) Cassette (5W).
	• Uses hours per Day	5 hours per day.
	• Total Load(Kwh/day)	0.84KW/day

4.2.7 Solar electricity and Micro Electronics Ltd

Micro Electronics has been working in Manufacturing, designing, marketing, supplying and installation of solar products for various types of uses e g Household lighting, Community lighting, Small Industries, Market, Railway signaling, Rural Clinic, Remote area communication etc Till date, Micro Electronics has been Commercially Provided Solar Home Lightings System & Total Capacity estimated 39.310 kWp

4.2.8 Solar electricity & Siemens Bangladesh Ltd.

SIEMENS Bangladesh Limited is related to promotion of Renewable Energy with producing Solar Modules, Switchboard, BOS System Manufacture, Marketing & Sale.

Table-4.6: Solar energy installation of Siemens Bangladesh Ltd.

Renewable Energy Sources	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Solar	SHS	1000	50 Wp	All over the country	Functioning
Solar	Health Care	1	450Wp	Dhaka City	Functioning
Solar	Health Care	1	360Wp	Mirpur, Dhaka City	Functioning
Solar	Lighting	1	75Wp	Comilla	Functioning
Solar	Lighting	1	230Wp	Tangail	Functioning
Solar	Lighting	1	150Wp	Khagrachari	Functioning

4.2.9 Solar energy and Local Government Engineering Department:

The summary of solar energy demonstration under Sustainable Renewable Energy program of LGED is showed below:

Table4.7: Sustainable Renewable Energy program of LGED

Sl.	[illegible]	[illegible]
1	• Project Name . Solar Home Lighting System • Installation Year ; 1999 • Location : Villages of Bahadanga, THAKURGAON DISTRICT • Capacity Installed 2625 • Beneficiary : 35 Household	2625
2	• Project Name : Centralized Solar Electrification (AC) for Growth Centre • Installation Year : 1999 • Location · Gangutia Growth Center, Sailkupa, JHENAIDAH DISTRICT • Capacity Installed · 1800 Wp • Beneficiary . 50 Shops. 2 small industries and a mosque	1800
3	• Project Name : Cluster Village Solar Electrification, Sherpur • Installation Year . 1999 • Location .Vill : Boradubi, Nalitabari, SHERPUR DISTRICT • Capacity Installed . 1725 Wp • Beneficiary . 60 Family (Home less People)	1725
4	• Project Name : Solar PV System for Gaznee Tourist Spot • Installation Year . 1999 • Location .Goznee, Jhenaigati, SHERPUR DISTRICT • Capacity Installed : 150 Wp • Beneficiary Tourists	150
5	• Project Name : Solar Water Purifier at LGED HQ • Installation Year · 1999 • Location LGED HQ, Agargaon, DHAKA DISTRICT • Capacity Installed ; 150 Wp • Beneficiary · Safe drinking water for LGED officials	150
6	• Project Name : Solar Electrification in Rural Clinic • Installation Year · 2001 • Location :Kamarul. Terokhada, KHULNA DISTRICT • Capacity Installed .1500 Wp • Beneficiary : Rural peoples at Kamarul, Khulna (30000 people)	1500
7	• Project Name · Solar Electrification at Ambaria UP Complex Bhaban • Installation Year : 2001 • Location ·Ambaria Union Parisad (Local Governance Office)Complex. Khoksha, KUSHTIA DISTRICT • Capacity Installed ·600 Wp • Beneficiary Chairman of UP (Local Governance), Members to facilitate effective and efficient governance at the local level,	600
8	• Project Name : Solar Home Lighting System for Tribal Community & Bhudda Temple • Installation Year · 2001 • Location .Digholibag, Rangamati Hill District, RANGAMATI • Capacity Installed :1080 Wp • Beneficiary : 15 Tribal family and a Buddhist Temple	1080
9	• Project Name : Solar Electrification for IT development • Installation Year · 2001 • Location :Kutubdia Upazila Engineer's Office, COX'S BAZAR DISTRICT • Capacity Installed ·375 Wp • Beneficiary · Upazila Engineer's Office	375
10	• Project Name : 5 kW Centralized (Largest in Bangladesh) Solar AC System for Fishermen Communities • Installation Year . 2002 • Location . Sairakhali, Jaladaspara . Chakaria COX'S BAZAR DISTRICT • Capacity Installed .5000 Wp • Beneficiary Coastal Fishermen Communities	5000

4.3 Summary

A number of Government organizations (LGED, REB, PDB, BAEC) , Not for profit Organizations (BRAC, Grameen Shakti, Centre for Mass Edncation in Science) and Private Organizations (Rahim Afrooz, Siemens Bangladesh, IDCOL etc) have been implementing projects for the promotion of Solar PV Technology in commercial and semi-commercial terms. About 4000 user with total installed capacity of 300 kw have been covered by different projects.

Mainly the beneficiaries of these projects are inhabitants of remote and isolated rural areas, local manufacturer, shop-keepers of hat & bazaar, students, social institutions, health center etc. Through the socio-economic changes of the beneficiaries, they will contribute positively towards the national development. Local manufacturer/suppliers are contributing to the national economy throngh their boosted bnsiness activity/new income- generating activity. Socio-economic changes and reduction of enviroumental pollution have been observed in the project area. Some solar culture has developed with in the consumers. They think that their PV system is better than the grid system as it is within their control and there is no fear of unwanted load shedding. Customers are using PV systems mainly for lighting and for recreational pnrposes (watching T.V). However, the solar system has created the possibility for income generating opportunities for small entrepreneurs. Solar Electricity has also opened a wide door to the inhabitants of the projects areas through TVs and Radios. Now they can encounter information on the same day about what has happened in the world. They can now learn many new things such as life styles, civilizations, cultures, languages, etc. They now have a new means of information and entertainment. In a word, in the solar project area the quality of life of rural people is improving day by day.

Chapter-5

Description of the study area

Chapter-5

Description of the study area

5.1 Description of the study area

Solar energy has been in use in the rural areas for some time. Solar electrification was introduced to villages which could not be reached by the network of normal electricity grid. Solar electricity was first introduced in Anjamkhor village of Thakurgaon district in 1998 and in Guliara village of Dinajpur district in 1997. Physical and economic developments of these villages were nearly stagnant, before the introduction of solar electricity. These villages under went marked transformation with regard to working hours, economic activities, cropping pattern, vigilance of the area, etc.

Two villages in Dinajpur district and two villages in Thakurgaon district were selected for investigating whether villages showed marked transformation after the introduction of solar electricity or otherwise remained unchanged because of the lack of it. Selected rural areas were similar in respect of topography, income level, literacy, communication system, cropping pattern, business pattern and other conveniences where some areas are provided with the solar energy and some are not. The two villages from Thakurgaon are Rotnay and Anjamkhor and the two villages from Dinajpur are Guliara and Manikmati.

5.1.1 Solar Electrified Rotnay Village: Rotnay is a very small village in Baliadangi Thana of Thakurgaon District. The village is located in a very remote area and it is near the border line of our country. Here in many houses solar home system has been introduced. The village encompasses an area of about 5 sq. km.

5.1.2 Non-Electrified Anjamkhor Village: Anjamkhor is also a very small village in Baliadangi Thakurgaon District. This area is beside Rotnay village. Its area is also around 8 sq. km. It is also very remote and is also situated near the border line of Bangladesh and India. The village has no electricity at all.

Infrastructural development of the village is very negligible. It is one of the most deprived areas of Bangladesh.

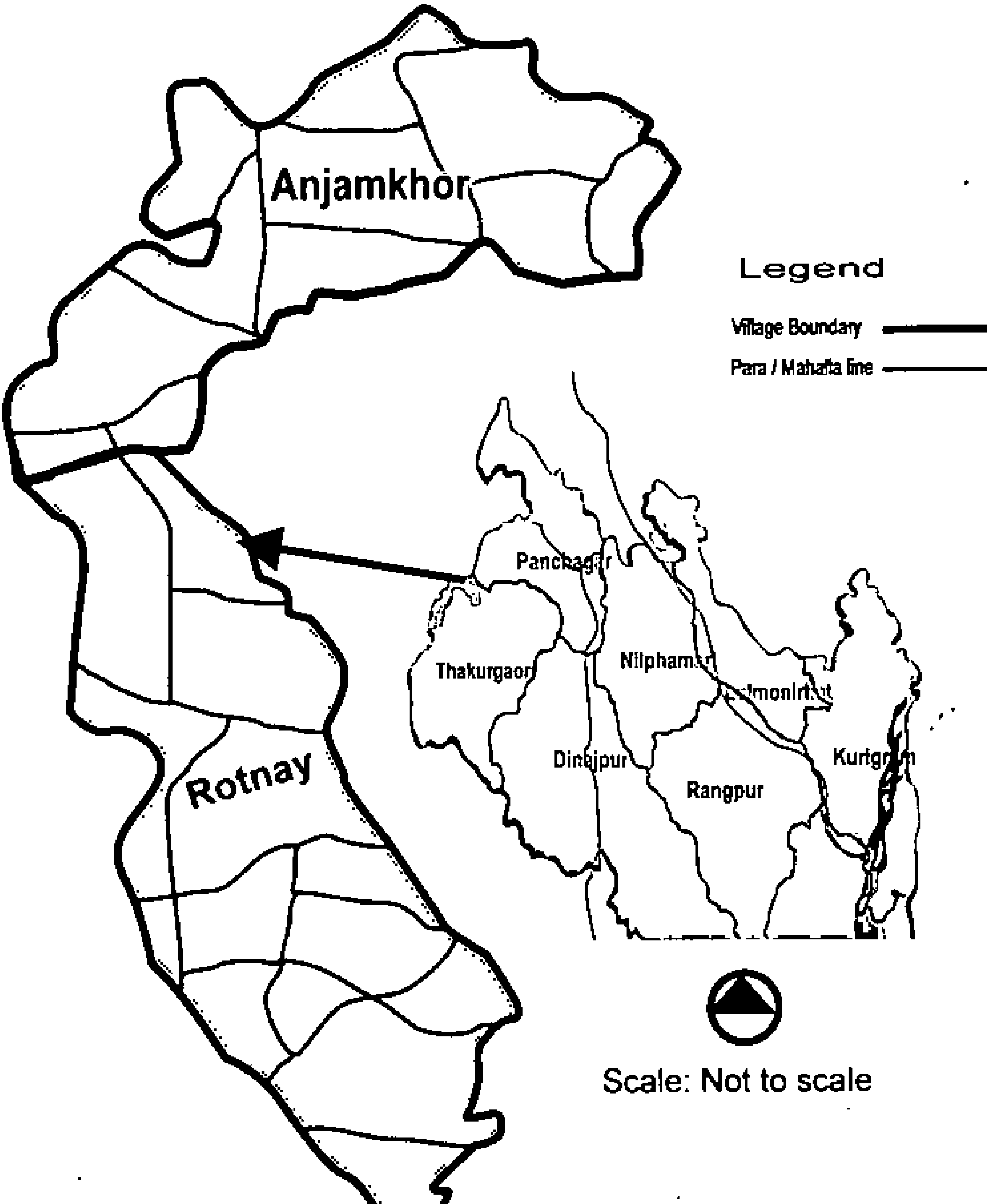
5.1.3 Solar Electrified Guliara Village: This solar electrified village is in the Khansama thana of Dinajpur district. Its area is about 6 sq. km. It is mainly an agricultural area.

5.1.4 Non-Electrified Manikbati Village: Manikbati is a small Village of Ranirbondor Thana of Dinajpur district. It is fully non-electrified area. This area is also very deprived in respect of infrastructural development. Its area is about 7 sq. km.

In respect of topography, income level, communication system, cropping pattern, business pattern and other conveniences Rotnay and Anjamkhor are similar Guliara and Manikbati are similar.

The various information of the four villages are discussed in the next page in tabular form:

Map - 1: Base map o Solar Electrified Rotnay and Non-Electrified Anjamkhor Village of Thakurgaon District



Map 2: Base Map of Solar Electrified Guliara and Non-Electrified Manikbati Village of Dinajpur District

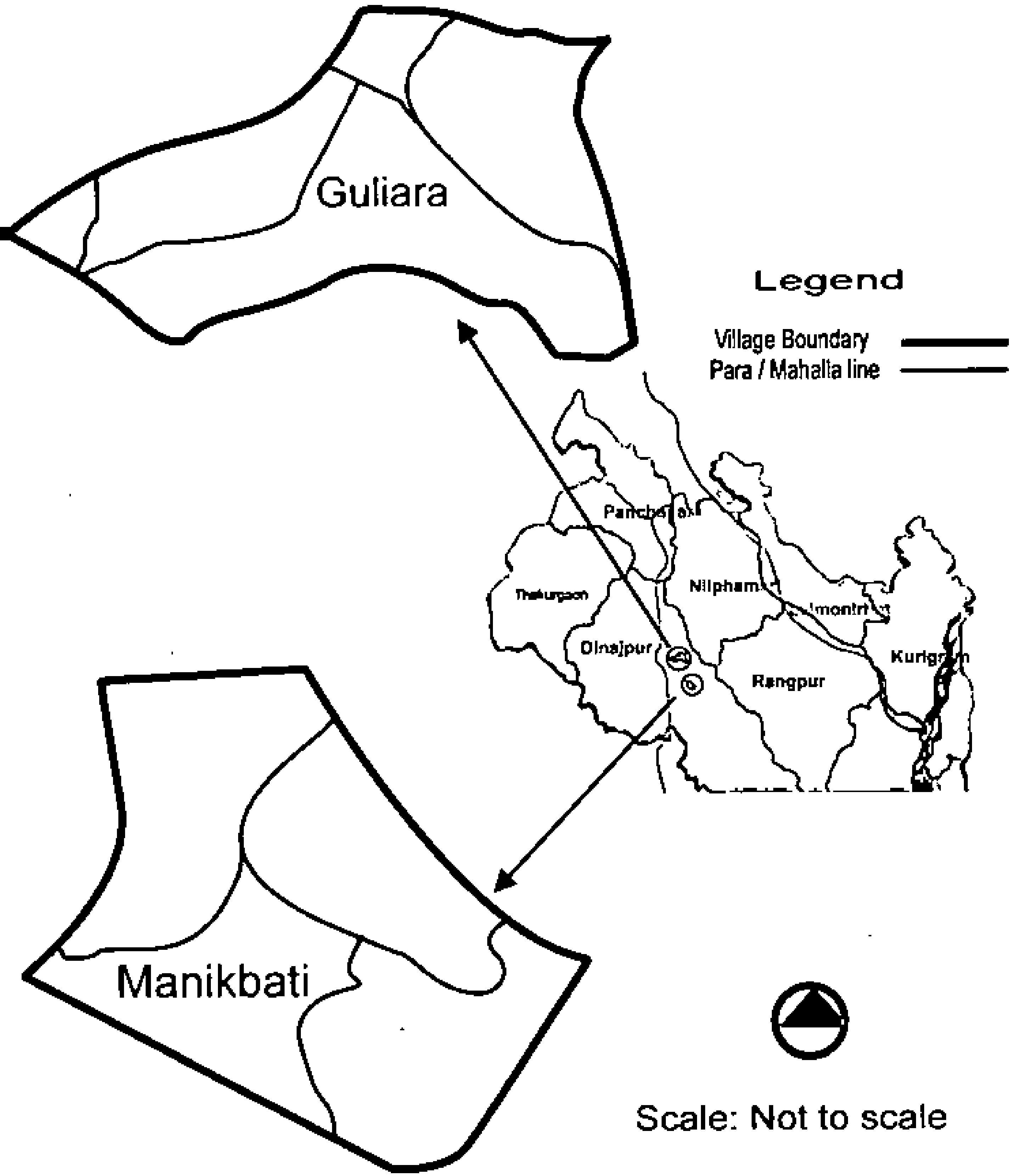


Table-5.1: Comparative physical description between solar-electrified and non-electrified study area of Thakurgaon District

Physical and Social Aspect	Rotany Village (Solar electrified area)	Anjamkhor Village (Non-electrified area)
Location	Thakurgaon District	Thakurgaon District
Area	5.00 skm	8.00 skm
Land use Pattern	Agriculture: 70% Water body: one river and 12 govt. ponds and 20 private ponds. Fruit garden: Total 45 Mango and Litchi gardens (govt. and private) Open space: 1 Eidgah field: 2 Bamboo and trees: 10% Mosque: 6 Temple: 5	Agriculture: 65% Water body: One river and 3 (three) ponds. Fruit garden: Total 8 Mango and Litchi gardens (govt. and private) Open space: 1 Eidgah field: 2 Bamboo and trees: 6 % Mosque: 2 Temple: 3
Topography	No hilly area Totally plain land and very high from sea level.	No hilly area Totally plain land and very high from sea level.
Meterology	Heavy rainfall in rainy reason as the area is very near to the India Border and Siligori of India is very close to the area. Weather is very hot (average 29°C) in Summer season and very cold (average 19°C) in winter season.	Heavy also rainfall in rainy reason Weather is also very hot (average 29°C) in Summer season and very cold (average 19°C) in winter season.
Geology	Plain land, Sandy Loam soil.	Plain land, Sandy Loam soil.
Groundwater	30 to 35 feet below from ground level.	Same as Rotnay village.
Communication	Road: Katcha: 100% Pucca: None Water way: None Railway: None Telephone/Telex/Internet: None Mobile phone: Available	Road: Katcha road: 100% Pucca: None Water way: None Railway: None Telephone/Telex/Internet: None Mobile phone: Available
Houses	Total: 300 Katcha house: 70% Pucca house: 20% Semi-Pucca: 10%	Total: 250 Katcha house: 85% Pucca house: 5% Semi-Pucca: 10%
Population	Male: Female = 52: 48 Birth rate: 2.17 Death rate: 1.98	Male: Female = 52: 48 Birth rate: 3.20 Death rate: 2.01
Social & Welfare Institution	Primary school: 2 (Two) High school: 1(one) Madrasha: 1 (one) Maktab: 5 (five) Adult literacy Centre: 2 (two) (Islami Youth Development Academy) NGO Literacy Centre: 2(two)	Primary school: 1(one) High school: 1(one) Madrasha: 1 (one) Maktab: 2 (two) Adult literacy Centre: 2 (two) (Islami Youth Development Academy) NGO Literacy Centre: 2(two)

(Contd.)

Literacy rate	Literacy rate: 35% Age-wise literacy rate: Below 20: 60% Age group 20 to 30: 35% Age group 30 to 40: 25% Age group 40+: 20%	Literacy rate: 20% Age-wise literacy rate: Below 40: 45% Age group 20 to 30: 20% Age group 30 to 40: 10% Age group 40+: 5%
Health Related Information	Govt. Health Care Centre: 01 Govt. Veterinary Centre : 01 Diseases: Fileria: 30% Hydrocel: 40% Others: 30% Drinking water by tube well: 100% Sanitation: Bamboo made: 80% Pucca Latrine: 10% Katcha Latrine: 10%	Govt. Health Care Centre: None Govt. Veterinary Centre : None Diseases: Fileria: 25% Hydrocel:70% Others: 15% Drinking water by tube well: 100% Sanitation: Bamboo made: 85% Pucca Latrine: 05% Katcha Latrine: 10%
Law and Order	Theft: None Robbery: None Killing: None.	Theft: 2, in May and August, 2002 Robbery: 1, in November, 2001 Killing: None.
Cropping Pattern	Paddy (Aman +China): 90% land Wheat: 90% land Lentils: 10% land Potato: 10% land Meize: 5% land Winter vegetables: 5% land	Paddy (Aman +China): 90% land Wheat: 70% land Lentils: 5% land Potato: 10% land Meize: 2% land Winter vegetables: 5% land
Irrigation system	Shallow Machine: 500 Power Tiller: 50 Drainage System: Earthen. Cow and Plough: 100% Agricultural input: Cow dung, chemical fertilizer.	Shallow Machine: 200 Power Tiller: 20 Drainage System: Earthen. Cow and Plough: 70% Agricultural input: Cow dung, chemical fertilizer.
Professional People	Farmer: 80% Doctor: None Engineer: None Professor: 3 persons. Potters: 200 persons. School teacher: 30 persons.	Farmer: 90% Doctor: None Engineer: None Professor: None Potters: 40 persons. School teacher: 20 persons.
Income level (Monthly)	Below 2000 TK.: 30% 2000 TK. To 4000 TK : 30% 4000 TK. To 5000 TK : 25% 5000 TK. To 6000 TK : 15%	Below 2000 TK.: 50% 2000 TK. To 4000 TK : 30% 4000 TK. To 5000 TK : 15% 5000 TK. To 6000 TK : 05%
Employment opportunity	Livestock: 70% family. Fisheries: 40 Projects (2 by BRAAC and 38 by Private initiative) Pottery: 200 family	Livestock: 60% family. Fisheries: 20 Projects Pottery: 50 family

Source: Baliadangi Upazila Office (2004).

Table-5.2: Comparative physical description between solar-electrified and non-electrified study area of Dinajpur District

Physical and Social Aspect	Guliara Village (Solar electrified area)	Manikbati Village (Non-electrified area)
Location	Dinajpur District	Dinajpur District
Area	6.00 skm	7.00 skm
Land use Pattern	Agriculture: 70% Water body: 16 govt. ponds and 26 private ponds. Open space: 1 Eidgah field: 1 Bamboo trees: Enough Mosque: 6 Temple: 2	Agriculture: 65% Water body: 5 govt. ponds and 12 private ponds Open space: 1 Eidgah field: 2 Bamboo trees: Enough Mosque: 4 Temple: 1
Topography	No hilly area Totally plain land and very high from sea level.	No hilly area Totally plain land and very high from sea level.
Meterology	Heavy rainfall in rainy reason Weather is very hot in Summer season and very cold in winter season. Weather is very hot (average 31°C) in Summer season and very cold (average 20°C) in winter season	Here also heavy rainfall in rainy reason Weather is very hot in Summer season and very cold in winter season. Weather is very hot (average 31°C) in Summer season and very cold (average 20°C) in winter season
Geology	Plain land, Sandy Loam soil.	Plain land, Sandy Loam soil.
Groundwater	25 to 35 feet below from ground level.	Same as Guliara village.
Communication	Road: Katcha: 100% Pucca: None Water way: None Railway: None Telephone/Telex/Internet: None Mobile phone: Available	Road: Katcha road: 100% Pucca: None Water way: None Railway: None. Telephone/Telex/Internet: None. Mobile phone: Not Available
Houses	Total: 600 Katcha house: 70% Pucca house: 20% Semi-Pucca: 10%	Total: 400 Katcha house: 60% Pucca house: 30% Semi-Pucca: 20%
Population	Male: Female = 51: 48 Birth rate: 2.14 Death rate: 1.78	Male: Female = 51: 49 Birth rate: 3.18 Death rate: 2.02
Social & Welfare Institution	Primary school: 2 (Two) High school: 1(one) Madrasha: 1 (one) Maktab: 4 (four) Adult literacy Centre: 03	Primary school: 1(one) High school: 1(one) Madrasha: 1 (one) Maktab: 2 (two) Adult literacy Centre: 03
Literacy rate	Literacy rate: 39% Age-wise literacy rate: Below 20: 65% Age group 20 to 30: 35% Age group 30 to 40: 26% Age group 40+: 20%	Literacy rate: 26% Age-wise literacy rate: Below 40: 54% Age group 20 to 30: 22% Age group 30 to 40: 18% Age group 40+: 10%

(Contd.)

Health Related Information	Govt. Health Care Centre: 1 Govt. Veterinary Centre : 1 Drinking water by tube well: 100% Sanitation: Bamboo made: 60% Pucca Latrine: 15% Katcha Latrine: 25%	Govt. Health Care Centre: None Govt. Veterinary Centre : None Drinking water by tube well: 100% Sanitation: Bamboo made: 70% Pucca Latrine: 05% Katcha Latrine: 25%
Law and Order	Theft: No Robbery: No Killing: No	Theft: 5 (five) Robbery: 2 (two) Killing: No.
Cropping Pattern	Paddy (Aman + China): 80% land Wheat: 75% land Dal: 10% land Potato: 15% land Bhutta: 5% land Winter vegetables: 15% land	Paddy (Aman +China): 80% land Wheat: 70% land Dal: 15% land Potato: 10% land Bhutta: 2% land Winter vegetables: 5% land
Irrigation system	Shallow Machine: 700 Power Tiller: 65 Drainage System: Earthen. Ox and Plough: 100% Agricultural input: Cow dung, chemical fertilizer.	Shallow Machine: 300 Power Tiller: 06 Drainage System: Earthen. Ox and Plough: 75% Agricultural input: Cow dung, chemical fertilizer.
Professional People	Farmer: 70% Doctor: None. Engineer: None. Professor: 10 persons. Potters: 36 persons. School teacher: 31 persons.	Farmer: 90% Doctor: None. Engineer: None. Professor: 3 persons. Potters: None. School teacher: 20 persons.
Income level (Monthly)	Below 2000 TK.: 20% 2000 TK. to 4000 TK : 20% 4000 TK. to 5000 TK : 20% 5000 TK. To 6000 TK : 40%	Below 2000 TK.: 30% 2000 TK. to 4000 TK : 40% 4000 TK. to 5000 TK : 15% 5000 TK. to 6000 TK : 05%
Employment opportunity	Livestock: 65% family. Fisheries: 40 Projects	Livestock: 15% family. Fisheries: 5 Projects

Source: Khansama and Ranirbondor Upazila Office (2004).

Chapter-6

Impact of Solar Electricity on the study area.

Chapter-6

Impact of Solar Electricity on the study area.

6.1 Social Impact

The access of rural people to the solar electricity has changed not only their habits, but also their life style, traditions, work schedule, way of thinking and to some extent social norms and values too. In both the solar electrified villages of Thakurgaon and Dinajpur District, the main social impacts of the solar electricity are given as follows:

6.1.1 Change in Daily Work Schedule

Before the introduction of Solar Home System, in general, daily works in the villages started with sunrise and finished at sunset. As for the lighting, kerosene was only one option and which would be bought from the market located far from the village or would be paid for at high cost if bought in nearby shops. Thus the consumption of kerosene also depends upon the level of income and priority of the work to be done at night.

Every extra minute of time for the use of kerosene lamp cost more money and generally due to this reason, most of the work was done during daytime. But after the SHS was introduced into the village, the use of extra time at night costs no more extra money and people are free to plan and manage their work according to their needs, and not as regulated by daylight or night. But in the non-electrified villages of both districts, there is no change in daily work schedule. In below the change of activity wise daily average time (between 6 PM and bed time) spent after sunset in rural areas of both districts is given :

Table-6.1: Activity wise daily average time (between 6 PM and bed time) spent after sunset (Dinajpur)

	Solar Electrified Village, Guliara (Average hour per night)			Non-electrified Village, Manikbati (Average hour per night)		
	Before Solar	After solar	Change	Before one year	After one year	Change
Study	2.00	4.00	Increase	3.00	3.00	No change
Sewing	0.30	2.00	"	0.50	0.50	"
Teaching kids	1.00	3.00	"	1.00	1.00	"
Watching TV	1.50	4.00	"	2.00	2.00	"
Radio	4.00	5.00	"	4.00	4.00	"
Business	3.00	5.00	"	3.00	3.00	"
Net making/ Banket making	1.00	2.00	"	0.50	0.50	"
Attending socio-cultural functions.	-	1	"	-	-	"
Performing religious activities	1	2	"	1	1	"
Cooking Eating Cleaning utensil	2	4	"	3	3	"
Rickshaw/van pulling at night	3	5	"	2	2	"

Source: Household survey, 2004

Table-6.2: Activity wise daily average time (between 6 PM and bed time) spent after sunset (Thakurgaon)

	Solar Electrified Village, Rotnay (Average hour per night)			Non-electrified Village, Anjamkhor (Average hour per night)		
	Before Solar	After solar	Change	Before one year	After one year	Change
Study	3.00	4.00	Increase	2.5	3	Almost same
Sewing	0.30	3.00	"	0.50	0.50	No change
Teaching kids	1.00	2.50	"	1.00	1.00	"
Watching TV	2.00	4.00	"	2.00	2.00	"
Radio	4.00	5.00	"	4.00	4.00	"
Business	3.00	4.50	"	2.00	2.00	"
Net making	1.00	2.50	"	0.50	0.50	"
Attending socio-cultural functions.	-	1.00	"	-	-	"
Religious activities	1.00	2.00	"	1.00	1.00	"
Cooking Eating	2.50	4.00	"	3.00	3.00	"
Rickshaw/van pulling	3.00	5.00	"	2.00	2.00	"

Source: Household Survey, 2004.

6.1.2 Longer working hours:

Before solar electricity there was nothing to do after taking evening meal other than sleeping, so sleeping time was somehow longer before electricity arrived. Now they can do some more interesting and more important works rather than sleeping.

Table- 6.3: Average working hours of the two villages of Thakurgaon District

Solar Electrified Village, Rotnay (Average hour per night)				Non-electrified Village, Anjamkhor (Average hour per night)		
	Before Solar	After solar	Change	Before one year	After one year	Change
Sleeping hour	10	8	Decrease	9.5	9.5	No change

Source: Household survey, 2004.

Table- 6.4: Average working hours of the two villages of Dinajpur District

Solar Electrified Village, Guliara (Average hour per night)				Non-electrified Village, Manikbati (Average hour per night)		
	Before Solar	After solar	Change	Before one year	After one year	Change
Sleeping hour	10	7.50	Decrease	10	10	No change

Source: Household survey, 2004.

So the sleeping hours have considerably decreased. But in the non-electrified villages of both districts, there is no change in the case of sleeping hours of the inhabitants.

6.1.3 Access to Information and Entertainment

Solar Electricity has opened a wide door to the inhabitants of solar electrified village of both districts through TVs. Now they can encounter information on the same day about what has happened in the world. They can now learn many new things such as life styles, civilizations, cultures, languages, etc. They now have a new means of information and entertainment. In the solar electrified villages of both districts the no. of TVs has increased than their non-electrified condition. But in the non-electrified villages of both districts the no. of TVs has not changed than their earlier condition.

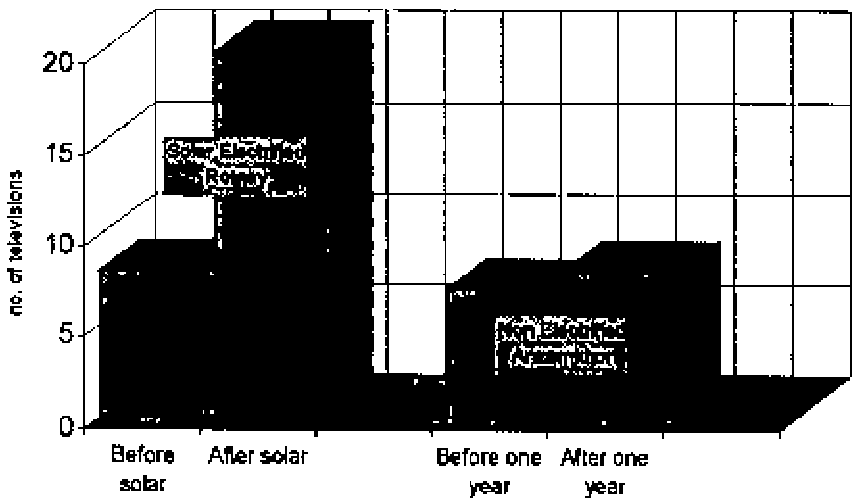


Fig-6.1: Comparison of no. of Televisions for access of information and entertainment between two villages of Thakurgaon

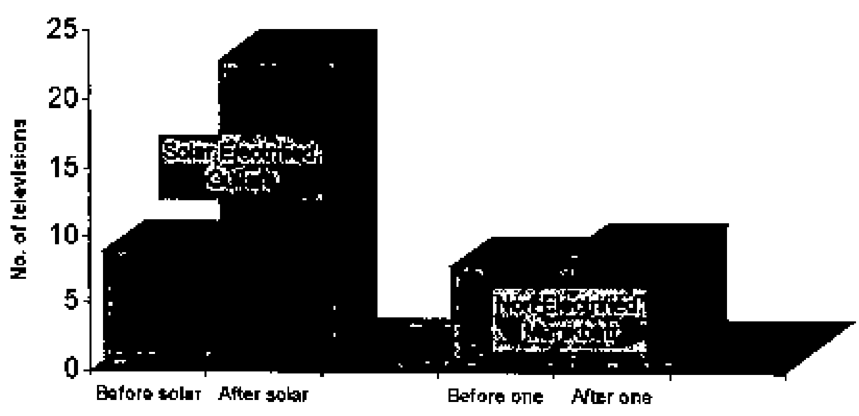


Fig-6.2 Comparison of no. of TVs for access of information and entertainment between two villages of Dinajpur.

So, in the solar electrified villages of Thakurgaon and Dinajpur districts the access to information and entertainment is very high than their non-electrified counterparts.

6.2 Economic Impacts

Economic impacts are not less important than social ones in rural areas. Social impacts are urged by the society and sometimes individuals are more influenced by economic benefits and incentives than social ones as economic matters are directly related to their survival. The majority of the people in most of the villages are still struggling for survival because they still do not have sufficient income for basic needs. So without addressing economic interests of such people, no programme can fulfill its objective. In line with this, implementation of SHS in rural areas has a considerable amount of economic impacts in rural livelihoods, as follows:

6.2.1 Promotion of Small Enterprises

This is not a completely new thing started by the impact of solar energy but they were comparatively low in number and scale as opening hours were limited basically to daylight hours. Even they used kerosene for lighting, but their sales during the evening were limited, because potential costumers of their business generally did not come to them. Now as the people go to the bed late in the evening, they have more time to sell their things. Apart from that, some small enterprises based on local resources have been initiated using solar energy only for lighting.

But in the non-electrified villages of both districts, there is no sign about the promotion of small enterprises.

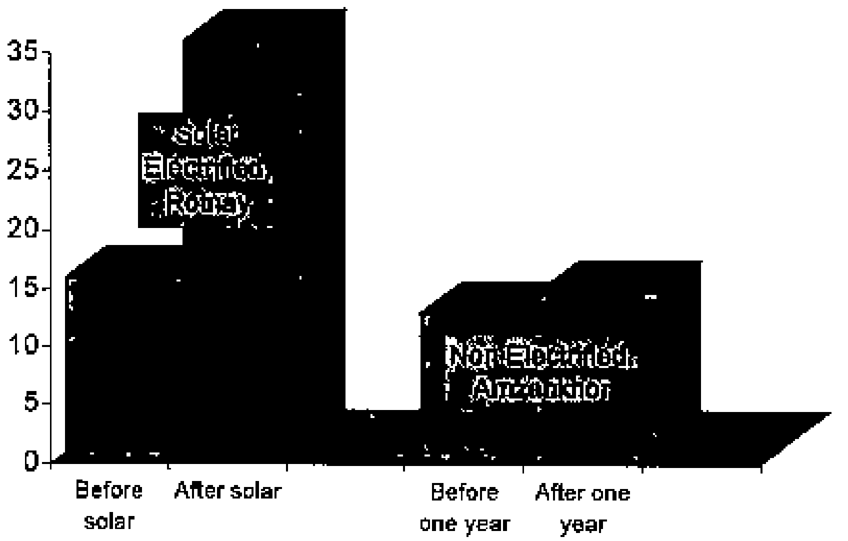


Fig-6.3: Comparison of no. of small enterprises between two villages of Takurgaon.

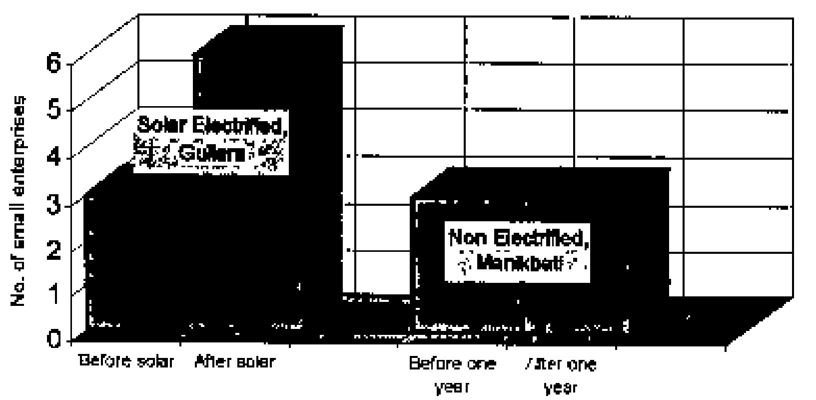


Fig-6.4: Comparison of no. of small enterprises between two villages of Dinajpur district

Table- 6.5: No. of small enterprises of the two villages of Thakurgaon District

	Solar Electrified Village, Rotnay			Non-electrified Village Anzamkhor		
	Before Solar	After solar	Change	Before one year	After one year	Change
Number of small enterprise (shops nearby home)	14	36	Increase	8	8	No change

Source: Household survey, 2004

Table-6.6: No. of small enterprises of the two villages of Dinajpur District

Solar Electrified Village, Guliara				Non-electrified Village, Manikbati		
	Before Solar	After solar	Change	Before one year	After one year	Change
Number of small enterprise	15	35	Increase	12	14	Almost same

Source: Household survey, 2004.

6.2.2 Income Generating Activities

Now the people can utilize their leisure time not only in sleeping but also in other income generating activities such as sewing, knitting, handicrafts, etc. which, on the one hand, increases their source of income and, on the other hand, provides an opportunity to use local resources in terms of money, materials and human resources, allowing them to enhance their skills for economic well-being

But in the non-electrified villages of both districts, there is no vital scope for income generating activities.

Table- 6.7: No. of income generating activities of the two villages of Thakurgaon District

Solar Electrified Village, Rotnay				Non-electrified Village Anzamkhor		
Income generating activities	Before Solar (In no. of houses)	After solar (In no. of houses)	Change	Before one year (In no. of houses)	After one year (In no. of houses)	Change
Sewing	13	80	Increase	12	13	Almost same
Business	5	25	"	4	4	No change
Net making	10	30	"	11	11	"
Mat/Basket making	9	45	"	10	12	Almost same
Rickshaw/van pulling at night	18	51	"	11	12	"
Poultry/dairy rearing	9	30	"	7	8	"

Source: Household survey, 2004.

Table- 6.8: No. of income generating activities of the two villages of Dinajpur District

Solar Electrified Village, Guliara				Non-electrified Village, Manikbati,		
Income generating activities	Before Solar (In no of houses)	After solar(In no. of houses)	Change	Before one year (In no of houses)	After one year (In no. of houses)	Change
Sewing	9	25	Increase	-	-	No change
Business	8	27	,,	3	3	,,
Net making	9	26	,,	-	-	,,
Mat/Basket making	8	15	,,	-	-	,,
Rickshaw/van pulling at night	20	35	,,	16	15	,,
Poultry/dairy rearing	15	30	,,	8	8	,,

Source: Household survey, 2004

6.2.3 Reducing transportation cost for Kerosene and Battery purposes:

As the rural areas are located very far from city centers and market centres, the cost of kerosene and batteries is very high due to high transport costs, sometimes more than four / five times that in cities. But in the non-electrified villages of districts, Kerosene and battery consumption for various purposes is same as earlier

Because of solar electricity the use of kerosene and batteries considerably decreased thus the transportation cost in this regard decreased. But in the non-electrified villages of both districts, there is no effect on the transportation cost as earlier.

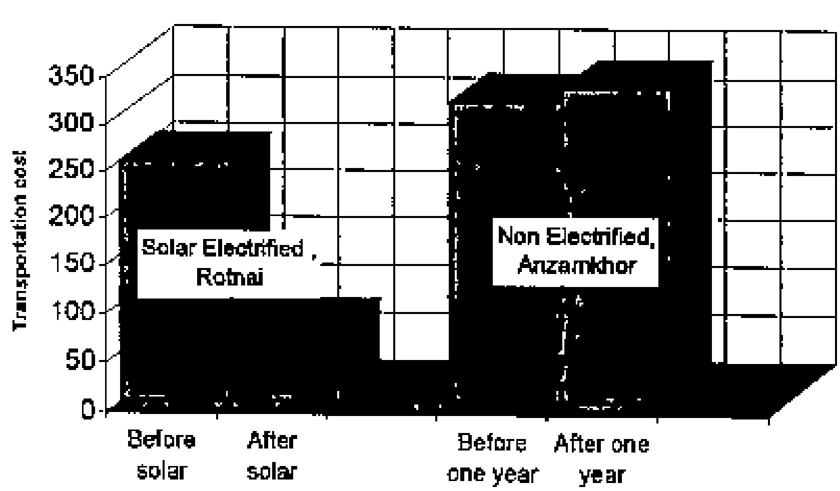


Fig-6.5: Comparison of Transportation cost for kerosene and batteries among two villages of Takurgaon.

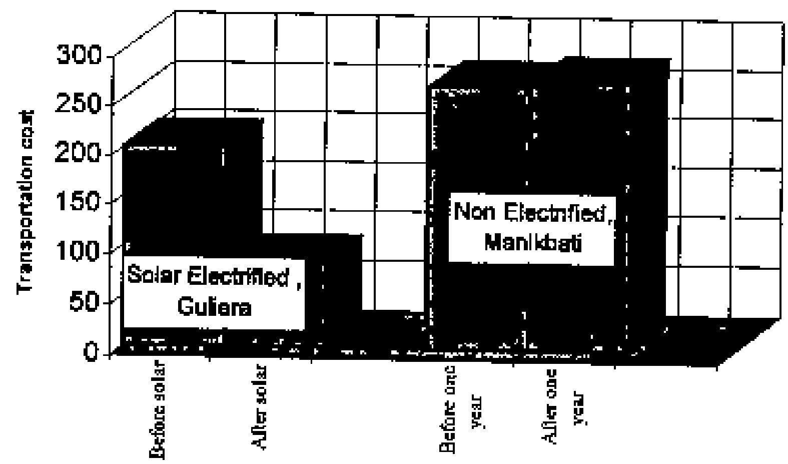


Fig-6.6: Comparison of Transportation cost for kerosene and bateries among two villages of Dinajpur.

Table-6.9: Transportation Cost for Kerosene and Batteries of the two villages of Thakurgaon and Dinajpur District

	Solar Electrified Village, Rotnay (Thakurgaon)			Non Electrified Village, Anzamkhor (Thakurgaon)			Solar Electrified Village, Guliara (Dinajpur)			Non- Electrified Village, Manikbati (Dinajpur)		
	Before Solar	After solar	Change	Before one yaer	After one year	Change	Before solar	After solar	Change	Before one year	After one year	Change
Transportation Cost for Kerosene and Batteries	230	75	**Decrease**	315	330	**Almost same**	200	85	**Decrease**	265	270	**Almost same**

Source. Household survey, 2004.

6.2.4 Some other income generating activities in narrow scale:

In very narrow scale PV system is using for heating a soldering iron for repairing radio, television etc in both the solar electrified study area. Carpenter has extended his working hours after the sunset using solar system enabling him earning more than before. Saw mill owner has extended his working hours as well by installing solar system.

Some members of Grameen Bank in the solar electrified study area of both districts can communicate with her relatives working in towns and cities of home and abroad. This communication facility through this phone can be availed by other villagers of locality on making payment to the member of Grameen Bank and thus they are making a significant income.

Thus it may be said that the world has been shorted so far as communication is concerned. But the entire credit goes to the solar system, which is the only source of charging the battery of the mobile phone. Before introduction of solar system it was rather unthinkable to have a telephone communication with the rest of the world standing in a remote village of Bangladesh.

6.2.5 Poverty reduction activities

Not only solar system has helped in bringing electricity to the solar electrified villages of two districts, but it has also helped in reducing poverty among them by allowing:

- Increased business activities.
- Private coaching and tuition opportunity of children after sunset.
- Extra income generating activities, e.g.mobile phone charging shops,
- Providing neon light traps for attracting and destroying insects,
- Social gathering for watching TV.

On the other hand though it is difficult to prove the direct relationship between poverty and availability of extra time, nonetheless better use of available extra time may act as a catalyst in poverty reduction. Effective use of time can help in creating avenues for eradicating income-poverty as well as human poverty, as revealed in the following figure:

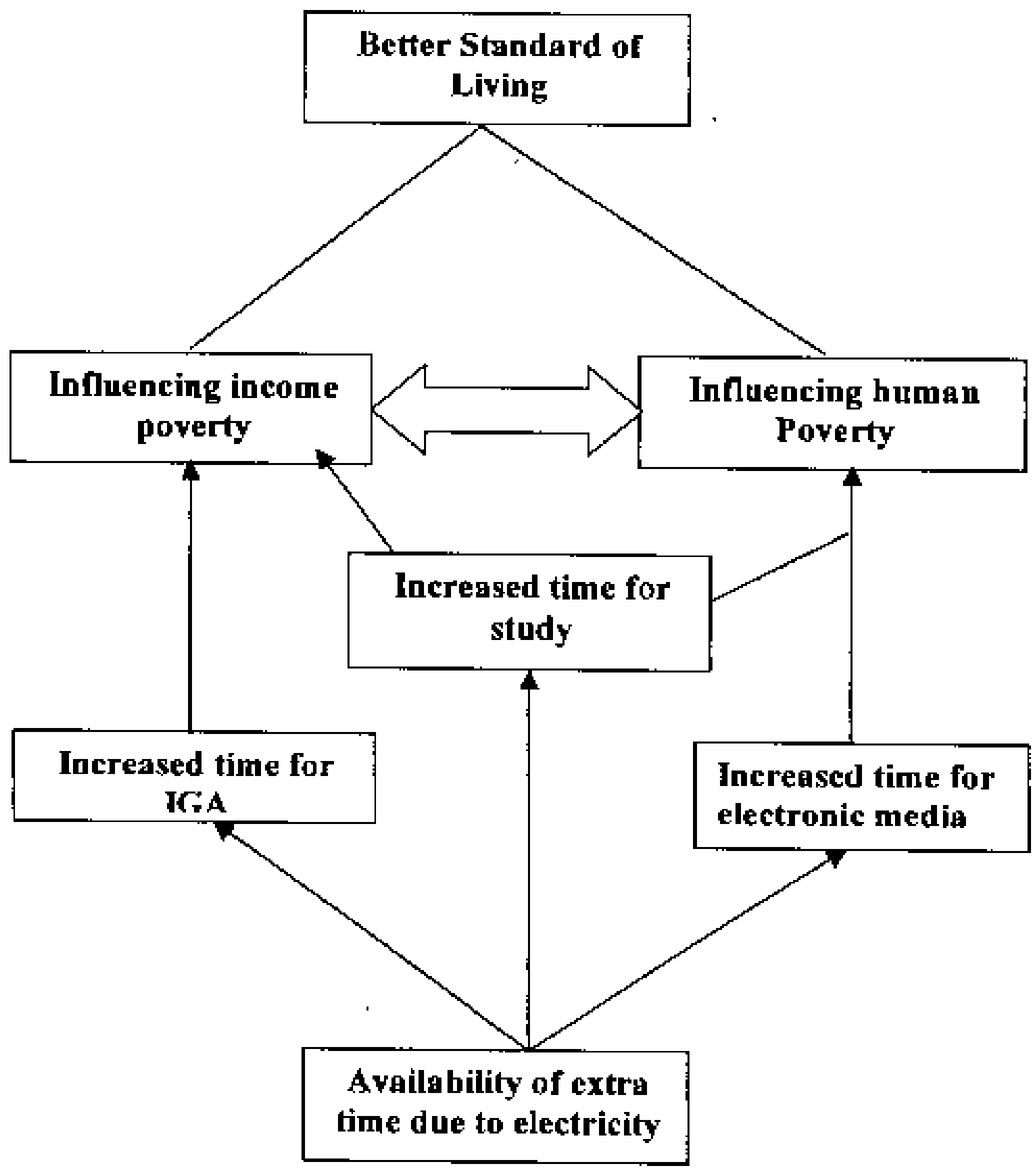


Fig-6.7: Impact of solar electricity on better standard of living

6.2.6 Effect of Solar Electricity on the Rural Market

In Dinajpur district there are many rural markets which are fully solar electrified. In below the solar electrified rural markets are given below: This markets were fully non-electrified before solar electricity. The total no. of shops increased in all categories in each solar electrified rural market.

Table-6.10: Solar Electrified Rural Markets scenario in Dinajpur District

Name of the Markets	Type of shops	Before Solar		After Solar	
		No. of shops	Total Shops	No. of shops	Total Shops
Bottali Bazar	Stationary and Pharmacy	5	33	6	43
	Electric and Electronics	5		7	
	Grocery and related shops	12		15	
	Readymade garments	5		7	
	Others (saloon, furniture, jewellery etc.)	6		8	
Chinibasdanga Bazar	Stationary and Pharmacy	3	17	5	30
	Electric and Electronics	2		4	
	Grocery and related	6		10	
	Readymade garments	3		6	
	Others (saloon, furniture, jewellery etc.)	3		5	
Chalk Sannasi Bazar	Stationary and Pharmacy	3	20	5	35
	Electric and Electronics	2		4	
	Grocery and related	8		14	
	Readymade garments	3		6	
	Others (saloon, furniture, jewellery etc.)	4		6	
Horihorpur Canal Bazar	Stationary and Pharmacy	6	33	7	43
	Electric and Electronics	3		4	
	Grocery and related	13		16	
	Readymade garments	5		8	
	Others (saloon, furniture, jewellery etc.)	6		8	
Canal Bazar	Stationary and Pharmacy	5	35	7	45
	Electric and Electronics	3		4	
	Grocery and related	13		17	
	Readymade garments	7		9	
	Others (saloon, furniture, jewellery etc.)	7		8	
Bagpur Chourangi Bazar	Stationary and Pharmacy	4	30	6	43
	Electric and Electronics	4		6	
	Grocery and related	10		15	
	Readymade garments	6		7	
	Others (saloon, furniture, jewellery etc.)	6		9	

(Contd.)

Sundarban Kachari Bazar	Stationary and Pharmacy	4	35	7	49
	Electric and Electronics	6		7	
	Grocery and related	15		20	
	Readymade garments	4		7	
	Others (saloon, furniture, jewellery etc.)	6		8	
Kalitola Bazar	Stationary and Pharmacy	6	34	7	45
	Electric and Electronics	4		6	
	Grocery and related	14		18	
	Readymade garments	4		7	
	Others (saloon, furniture, jewellery etc.)	6		7	
Chakla Bazar	Stationary and Pharmacy	5	25	6	43
	Electric and Electronics	5		7	
	Grocery and related	14		15	
	Readymade garments	5		7	
	Others (saloon, furniture, jewellery etc.)	6		8	
Toler Bazar	Stationary and Pharmacy	8	50	11	67
	Electric and Electronics	6		9	
	Grocery and related	19		24	
	Readymade garments	8		11	
	Others (saloon, furniture, jewellery etc.)	9		12	
Korakhi Dealir Bazar	Stationary and Pharmacy	3	25	6	35
	Electric and Electronics	3		5	
	Grocery and related	9		11	
	Readymade garments	4		6	
	Others (saloon, furniture, jewellery etc.)	6		7	

Source: Rural Market Survey, 2004.

The shop owners, who had shops before there was electricity, opined that, among others, business was dull in those days compared to now. They were asked as to how much money they used to make daily before there was electricity and how much they are making now. They observed that, in the past they used to make on the average Tk. 1,251 daily which is now approximately Tk. 2,947. i.e. 2.36 times increase in daily sales with solar electricity in the shop.

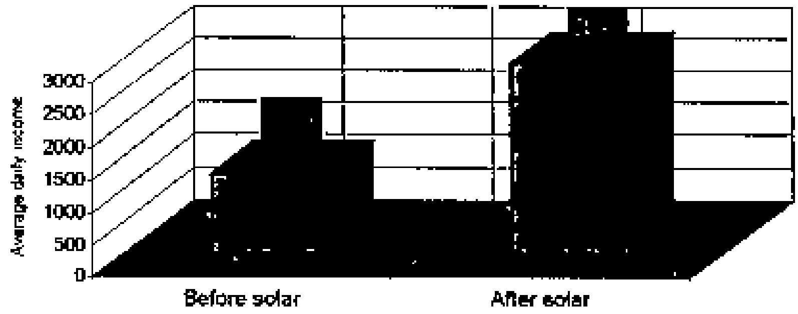


Fig-6.8 :Comparision of daily income of village shopkeeper among the solar electrified and non-electrified condition of his shop

The shop owners implied that this staggering change is mainly because of solar electricity and concomitant factors.

Impact on Business Hours:

Average business hours in solar electrified shops are 14 7 hours and in non-electrified condition this was 12.0 hours.

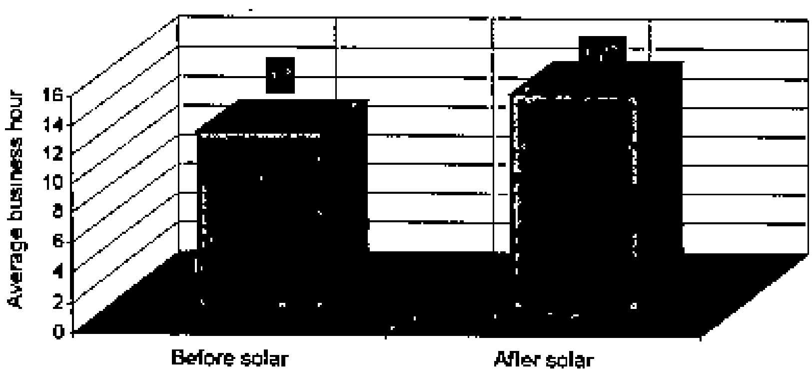


Fig-6.9: Comparision of average business hour among solar electrified and non-electrified condition.

The respondents were asked as to how long they keep their shops open after sunset and how long they used to keep their shops open when there was no electricity.

It appears that on an average electrified retail shops are open for 3.2 hrs after the sunset while in their non-electrified condition this was 1-1.5 hrs. Therefore solar electrified retail shops remain open 1.7 hrs more after sunset than those without electricity.

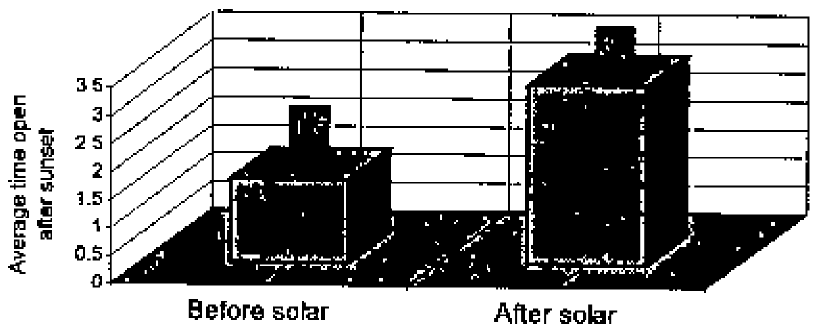


Fig-6.10: Comparision of daily average time open the village market shops after sunset among the solar electrified and non-electrified condition

It has been seen that elsewhere and in focus group discussion that sale is brisk in the evening, particularly after sunset Therefore a clear advantage is visible among the solar electrified shops than their non-electrified condition

Table-6.11: Comparison of cost of lighting of shops before and after solar electricity

Condition	Night time	Cost per unit	Total cost per month
Non-electrified	From 6 pm to 11 00 pm	Per night kerosene = 1/4 liter = 8.00Tk	8 00*30 = 240.00
Solar-electrified	From 6 pm to 11.00 pm	Per night 5.00 Tk	5.00*30=150.00
Difference	**90.00 Tk. was more needed per night for lighting purposes than present solar electrified condition.**		

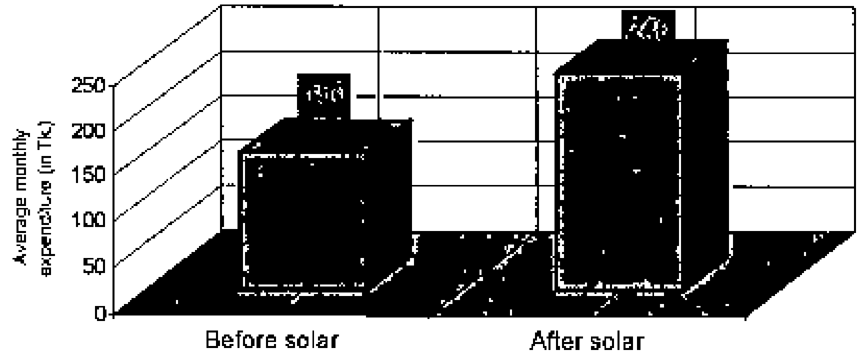


Fig-6.11: Comparision of daily cost of lighting purposes of village shopkeeper among the solar electrified and non-electrified condition of his shop

6.2.7 A Comparison of Cost of different types of energy use (solar electricity, grid-electricity and kerosene)

1010 53

A) Non-electrified houses (using kerosene)

Purpose of use	Component	Per unit cost (in Taka)	Cost after five (5) years (in Taka)	Sub-total (Tk.)	Total (Taka)
TV Viewing	TV Battery	A TV Battery costs of Tk. 2000 And its longevity is 5 years.		2000	14,900
	Battery Charge	25.00 Tk per week	25 X 52 X 5 = 6500	6500	
	Liquid Change	20.00 Tk. per month	20 X 12 X 5 = 1200	1200	
	Transport cost for battery charging	20.00 Tk. per week	20 X 52 X 5 = 5200	5200	

(Contd.)

Listening to Radio	4 (Four) Battery is needed for a Four Band Radio.	Each battery costs of Tk. 12.50 and lasts for one month 4 X 12.50 = 50.00 Tk. is required per month	50 X 12 X 5= 3000	3000
Mobility at night	Generally Three (03) batteries are needed for torchlight and each battery costs of Tk. 12 and lasts for one month.	3 X 12 = 36	36 X 12 X 5=2160	2160
Household chores	Generally 7.50 litre kerosene is needed for lighting kupis (traditional lamp) purposes of a middle class village family per month.	Per litre kerosene costs of Tk. 30.00	7.50*30*12*5 = 13,500	13,500
Cost of Hurricane Lamp	Generally Three (03) hurricanes are needed for lighting purposes for daily activities at night for a village family.	Each Hurricane costs of Tk. 50 and lasts for 6 (six) months.	50 X 3 X 2 X 5 =1500	1500
Expenses for cleanness	For the use of kerosene cleanness is required. For this purposes two bars of soaps are required for per week.	For the use of shops extra 25 Tk. is required per week.	25.00X 52 X 5 = 6500.00	6500
Total Cost after Five (05) years				**41, 560**
Total Cost after twenty (20) years (41560*4)				**16,6240**

Source: Field survey, 2004.

B) For solar electrified household

Component	**Total Cost**	
Option for Four (4) Solar Bulb, one Solar fan , one (Black & White) Television and one Cassette player/Radio.	Total Consolidated Cost for 20 years (Solar electricity provided by CMES/ LGED)	**35,000.00**
Total Cost after twenty (20) years		**35,000.00**

Source: Sustainable Rural Energy Project, LGED, 2004.

C) For electrified household

Purpose of lightings	**Component**	**Per unit cost**	**Cost after five (20) years**	**Sub-total**	**Total**
For lighting purposes	Generally Four (04) bulbs are needed for lighting purposes for a middle class family. Each Bulb lasts for six month.	Each electric Bulb costs of Tk. 20.00 So, Total 20*4 = 80 Tk. is required for buying electric Bulbs.	80*2*20 = 3200	3200.00	
Electric bill for four (4) bulb+ TV + Fan + Radio	240.00	240*12=2880	2880*20	57,600.00	60,800.00
Total Cost after twenty (20) years					**60,800.00**

Source: Rural Electrification Board, 2004.

6.2.8 Generation, transmission and distribution expenses between solar electricity and Conventional Grid system

A) Conventional Grid system

<table>
<tr><td rowspan="3">Electricity generation, transmission & other expenses</td><td>Generation</td><td>10,911.00</td><td rowspan="3">14,416.00 core Tk.</td></tr>
<tr><td>Transmission</td><td>3.413.00</td></tr>
<tr><td>Others</td><td>92.00</td></tr>
<tr><td colspan="3">Distribution expenses</td><td>46.00 core Tk.</td></tr>
<tr><td colspan="3">Total generation, transmission and Distribution expenses</td><td>14,462.00 core Tk.</td></tr>
<tr><td colspan="2">Per consumer generation and transmission cost</td><td>36,654.00 Tk</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Per consumer distribution cost</td><td>12,323.00 Tk.</td></tr>
<tr><td colspan="3">Per consumer generation, transmission and distribution cost</td><td>48,977.00 Tk.</td></tr>
<tr><td rowspan="4">Annual Operation and Maintenance expense</td><td>O & M</td><td>19,278,689</td><td rowspan="4">79,932,171.00</td></tr>
<tr><td>Depreciation</td><td>16,444,508</td></tr>
<tr><td>Interest</td><td>12,718,829</td></tr>
<tr><td>Power cost</td><td>31,490.145</td></tr>
<tr><td colspan="2">Per Consumer annual O & M expense for grid</td><td colspan="2">516</td></tr>
</table>

B) Solar Photovoltaic Projects

Solar PV generation and transmission cost	0.00 Tk	
Total distribution cost (material, installation & execution)	83,333,333.00 Tk	
Per consumer generation, transmission and distribution cost		31,250.00 Tk.
Annual total Operation and Maintenance expense		896,000
Per Consumer annual O & M expense for grid		**336**

In Summary

- Solar PV per consumer capital cost compared to grid consumer = **36%**
- Solar PV per consumer annual O & M expense compared to grid consumer = **35%**

Source: Renewable Energy Cell, REB, 2002..

6.3 Impact on Education:

Education forms the knowledge base of economic development. Recognizing 'education' as a cornerstone to human and capital formation (T.Schultz and G. beeker), 'education' as a means to human capability building through that to human life, and 'education' as a key to human development- adequate emphasis has been made in this study to reveal the educational status of the members of solar-electrified and non-electrified households. Attempts are made to underscore the role of solar-electricity in improving the educational status of people. In doing so, the following areas were covered:

i) Overall Literacy and adult literacy
ii) Enrolment ratio
iii) Quality of education.

6.3.1 Literacy rate: The overall literacy rate was found much higher in the solar-electrified households (38-39%) compared to that in the non-electrified (25%) households of both districts. It is showed in figure

This is similar in case of male and female literacy rate

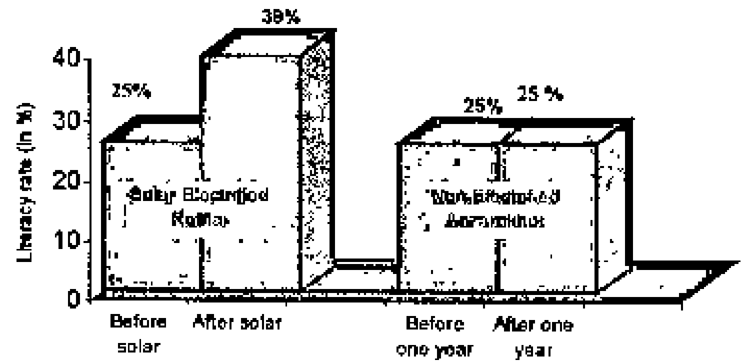


Fig-6.12: Comparison of overall literacy rate between two villages of Thakurgaon.

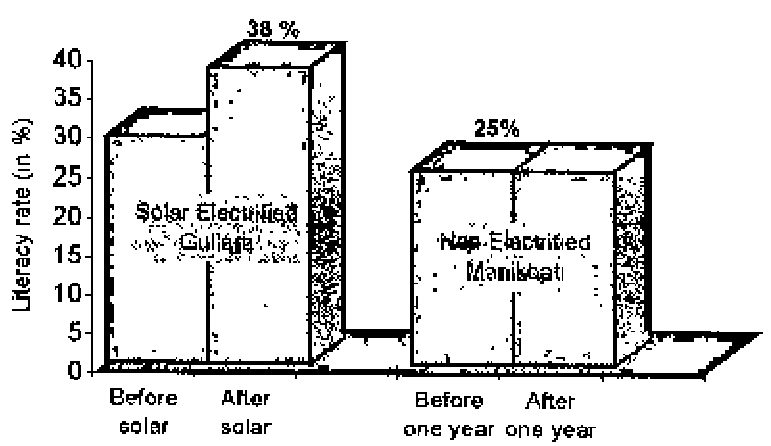


Fig-6.13: Comparison of overall literacy rate between two villages of Dinajpur.

Table-6.12: Overall Literacy Rate of the two villages of Thakurgaon and Dinajpur District

	Solar Electrified Village, Rotnay (Thakurgaon)			Non Electrified Village, Anzamkhor (Thakurgaon)			Solar Electrified Village, Guliara (Dinajpur)			Non- Electrified Village, Manikbati (Dinajpur)		
	Before Solar	After solar	Change	Before one year	After one year	Change	Before solar	After solar	Change	Before one year	After one year	Change
Overall Literacy rate (in %)	25	39	Increase	25	25	Almost same	25	38	Increase	25	25	Almost same

Source: Household survey, 2004.

Adult literacy rate: It is one of the major indicators of human development. The adult literacy rates by sample categories, economic groups (land) and by sex show the similar pattern as was evident in the case of overall literacy rates. The pattern of adult literacy rate for electrified households as compared to non-electrified ones is characterized by relatively high rate for both male and female.

6.3.2 Enrollment Ratio: Primary education is free all over Bangladesh, and all girls in the rural areas receive stipends at the secondary level of education. Thus, primary enrollment is supposed to be high. Around 94 % of the respondents of the electrified households reported all children (6 to 15 years) go to school. The corresponding proportion is also high but comparatively less for the non-electrified households.

6.3.3 Quality of education and associated reasons: Whether household's access to electricity influences quality of education or not was studied using following parameters.

- Expenditure on education
- Marks (grades) obtained in the last final exam.
- School drop-outs.
- School attendance rate.
- Educating the adult people through Electronic media.

6.3.3.1 Expenditure on education: The per capita average annual expenditure on education in the solar electrified household was Tk. 800 for male and Tk. 7,00 for females before solar system and Tk. 1000 for male and Tk. 7,50 for females after solar system in the Thakurgaon district. The corresponding expenditure in the household of non-electrified villages was Tk. 800 (male) and Tk. 600 (female) in one year earlier and Tk. 900 (male) and Tk. 600 (female) in one year later.

Table- 6.13: Expenditure on education (for male and female) of the two villages of Thakurgaon and Dinajpur District

	Solar Electrified Village, Rotnay (Thakurgaon)			Non Electrified Village, Anzamkhor (Thakurgaon)			Solar Electrified Village, Guliara (Dinajpur)			Non-Electrified Village, Manikbati (Dinajpur)		
	Before Solar	After solar	Change	Before one year	After one year	Change	Before solar	After solar	Change	Before one year	After one year	Change
Expenditure on education (in TK.) for male	800	1000	Increase	800	800	Almost same	900	1100	Increase	900	950	Almost same
Expenditure on education (in TK.) for female.	700	750	Increase	600	600	Almost same	650	850	Increase	600	600	Almost same

Source: Household survey, 2004.

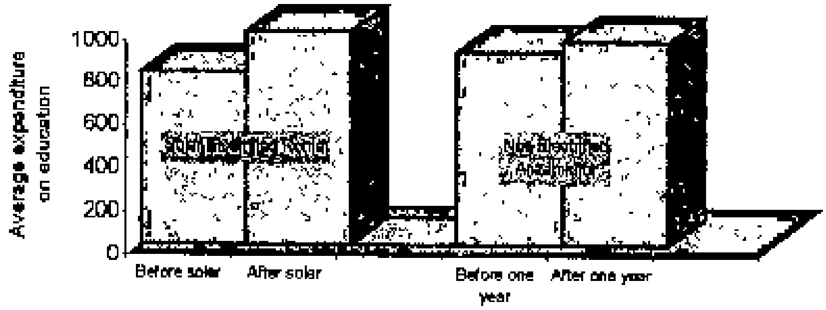


Fig-6.14: Comparison of average expenditure on education for male between two villages of Thakurgaon.

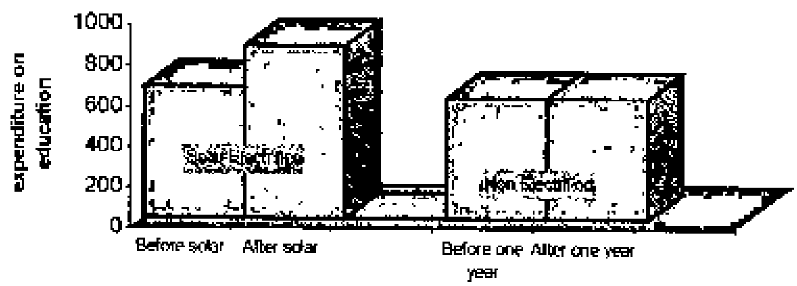


Fig-6.15 Comparison of average expenditure on education for female between two villages of Dinajpur

Thus, the solar electrified households fare better than the non-electrified household in terms of income's share to education, overall expenses on education, as well as per capita educational expenditure and especially that for female students. It is almost same for the solar- electrified and non-electrified village in Dinajpur District.

6.3.3.2 Educational Attainment: In terms of educational attainment measured through marks obtained in the last final examination, both boys and girls in the electrified households reported to be better-off than their counterparts, in all the classes Average marks obtained by the students in the electrified did not vary much by boys and girls. However, the difference was much pronounced for the students in the non-electrified households. This difference is much pronounced in the higher grades (VII-X).

6.3.3.3 School Attendance Rate: The average school attendance rate was reported slightly higher in the electrified households (85-90%), compared to that in the non- electrified households (65-75%) in both the rural areas of both the districts.

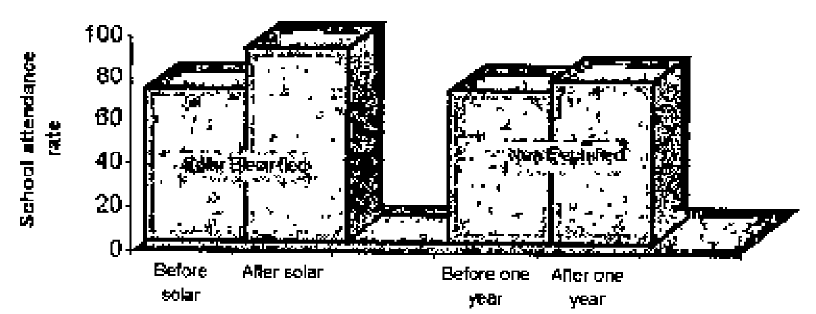


Fig-6.16 Comparison of school attendance rate between two villages of Thakurgaon

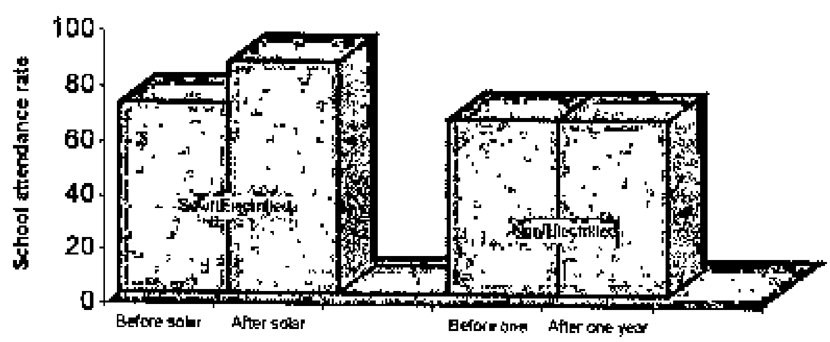


Fig-6.17: Comparison of school attendance rate between two villages of Dinajpur.

Table- 6.14: School Attendance Rate of the two villages of Thakurgaon District

	Solar Electrified Village Rotnay			Non-electrified Village Anzamkhor		
	Before Solar	After solar	Change	Before one year	After one year	Change
School Attendance Rate	70%	90%	Increase	70%	75%	Almost same

Source: Household survey, 2004.

Table- 24: School Attendance Rate of the two villages of Dinajpur District

	Solar Electrified Village Guliara			Non-electrified Village Manikbati		
	Before Solar	After solar	Change	Before one year	After one year	Change
School Attendance Rate	70%	85%	Increase	65%	65%	Almost same

Source: Household survey, 2004.

6.3.3.4 School drop-outs: It is a major indicator of the quality of education. Dropout rates were reported to be higher in schools where solar electricity has not be provided and this drop out was higher among boys than girls.

Dropout rate has been as high as 25% and 30% before solar electricity was introduced Rotnay and Guliara respectively. The drop-out rates declined to 15% after solar electricity was provided. However, in the non-electrified villages of Manikbati and Anjamkhor this rate increased from 25% to 30%.

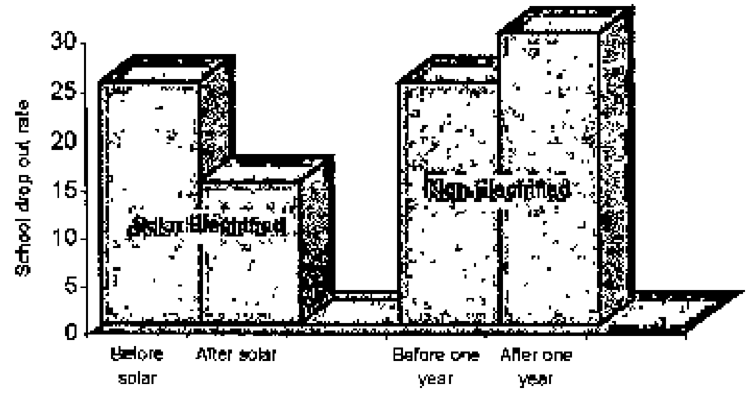


Fig-6.18 Comparision of school drop-out rate between two villages of Thakurgaon.

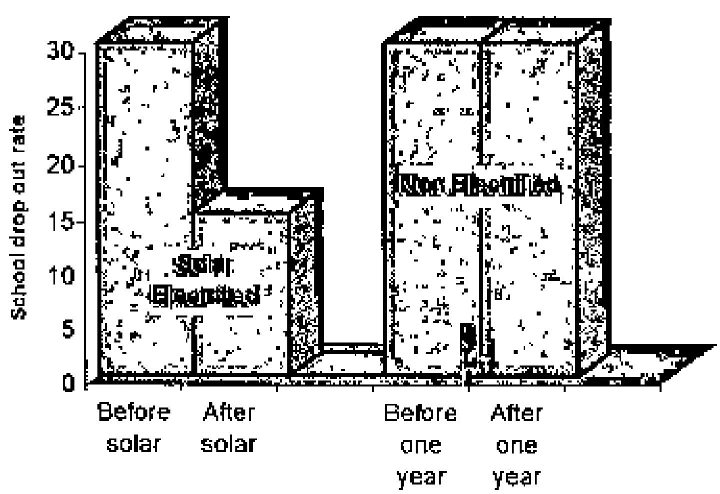


Fig-6.19: Comparision of school drop-out rate between two villages of Dinajpur.

Table- 6.15: School drop-outs of the two villages of Thakurgaon Distrcit

	Solar Electrified Village Rotnay			Non-electrified Village Anzamkhor		
	Before Solar	After solar	Change	Before one year	After one year	Change
School drop-outs	25%	15%	Decrease	25%	30%	Increase

Source: Household survey, 2004.

Table-6.16: School drop-outs of the two villages of Dinajpur District

	Solar Electrified Village Guliara			Non-electrified Village Manikmati		
	Before Solar	After solar	Change	Before one year	After one year	Change
School drop-outs	30%	15%	Decrease	30%	30%	Almost same

Source: Household survey, 2004.

6.3.3.5 Educating the adult People: Illiteracy among adults in rural areas is still very high despite the enormous effort of governmental and non-governmental organizations to reduce the illiteracy rate in the village. It is very difficult to convince adults to attend school. As electricity was introduced in the village and people have become more aware by listening to the Radio and watching the TV and they gradually feel the necessity of being literate. Even those who are illiterate can acquire knowledge by hearing various awarness program from radio and TV.

Thus, Radio and TV are playing active roles in educating people. Though there were some radios and cassette players in the village even before there was electricity, only richer people could afford these. Even if they had it, they could not use them for longer periods due to the cost of batteries. Now they are free to use such appliances - no fear of expenditure for batteries. Now the students need not worry about the kerosene costs while reading at night. They can read and write at night as much as they like. People are being educated on health and sanitation, on family planning and maternity, on social and political matters, on inventions and achievements of science and technology, etc by means of TV and radio at home. Previously it was very difficult to educate the people on such things. The introduction of solar energy in rural areas has a significant impact on family planning and population growth by sensitizing them about the negative impacts of rapid population growth through radio and TVs on one hand and providing them with an extra means of entertainment during the evening.

6.4 Impact on Awareness of Human right , Health, Hygiene and Sanitation

In terms of knowledge about the crucial public health issues respondents in the solar electrified households were reported to be much more aware than those in the non-electrified households. Out of 20 public health issues, on average, the respondents in the solar electrified households reported awareness about 12.8 issues, those representing in non-electrified households 4.5 issues.

The (poor) landless in the solar electrified households was found more knowledgeable (61%) about the public health issues than even the rich (large landowner) in the non-electrified villages (59%). This also means, in terms of knowledge-poverty, the economically poor people become knowledge rich if electricity is ensured.

A much higher proportion of child delivery (last birth) in the solar electrified households were assisted by medically trained persons (36%) as compared to that in the non-electrified households (13%). In terms of assistance in child delivery by medically trained persons, the solar-electrified households show a much better situation.

One of the most spectacular influences of solar electricity was found on the infant morality rate. The infant morality rate in the solar electrified households is 40/1000 live births; in the non-electrified households is 60/1000 live births.

The full immunization coverage among children aged 12-23 months was significantly higher in the electrified households (60.7%) than that in the households of non-electrified villages (36.5%).

One of the most notable findings in the study is related to the use of hygienic latrines. 61% of the solar electrified households reported use of hygienic latrines (sanitary, sealed closed), while the corresponding figures for non-electrified households is 25%.

There has been distinct cultural changes in the hygienic practices due to solar electrification. Abont 66% people used soap for personal cleanliness and hygiene in the solar electrified honseholds while only 33% people used soap in the non-electrified households.

Solar electricity has contributed significantly in promoting the use of soap/ash (mud) as hand-washing materials after defecation (which is televised frequently). In terms of all hygienic behavior and practices, the solar electrified households depict a much higher standard than the non-electrified households, and that especially as compared to the non-electrified households.

6.5 Impact on reducing some human diseases:

Replacing kerosene lamps with solar-powered lights mitigates the risks and health problems associated with using kerosene. In surveys people reported that the following diseases occur in the non-electrified honseholds than their solar-electrified counterpart.

- Eye irritation,
- Coughing and
- Bronchial diseases

These diseases are fully associated with the use of kerosene lamps. In both the non-electrified villages about 40 % people has the above problems but their solar electrified counterpart has not so.

In addition to emitting pollutants with known respiratory impacts (such as carbon monoxide, nitrogen oxide, and hydrocarbons), kerosene lamps are a source of fire hazard. Furthermore a substantial number of children reportedly die of accidental kerosene poisoning every year.

6.6 Impact on gender dimensions: women's empowerment, changing status.

Solar electrification has contributed to the positive development on women's socio-economic status. Solar electricity has left a profound impact on woman mobility, participation in income generating activities, decision-making, freedom in using income and savings, better utilization of credit, knowledge about gender quality issues, household work plan according to convenience, changes in attitude in terms of reducing healthcare disparities, increase in overall years of schooling for both boys and girls, preference to send girls to schools, awareness about negative impact of dowry, etc.

Although, women in the non-electrified villages are working inside and outside home, they have less control over utilization of their earnings, decision-making; and their level of awareness of fundamental rights is low. One of the significant facts, that emerged is that if electricity is provided to them these women can benefit substantially with more power or status.

6.7 Impact on Protective Security:

Almost everyone (98%), irrespective of access to solar home system, agreed that protective security has increased due to solar electrification at the houschold level. The reasons reported include

- Light available throughout the night (mentioned by 83%),
- Reduction in the incidence of theft and robbery became difficult (73%),
- Availability of light at front side and backyard (36%).

The fact that security of mobility at night has increased due to electricity was expressed by all respondents (98.4%), irrespective of availability of electricity in their households. The reasons for confirming this statement include "everything distinctively visible"(reported by 97% respondents) and "less fear of snakes and other reptiles and insects" (36%).

6.8 Impact on reducing out-migration towards urban area:

In many developing countries, migration from rural to urban areas is creating tremendous social and ecological problems. People move to the city for jobs and to gain access to electricity and other modern amenities. While it is unlikely that electricity alone will stem the tide of rural to urban migration, it is possible that solar electrification in rural areas can help by improving the quality of life there.

Many have said that, because of electricity, new income activities have emerged, which has created more employment opportunities, and that, in turn, gave impetus for people not to go nearby urban area for work from solar electrified villages. The occupational pattern has changed in the solar electrified villages. In addition, due to the availability of various improved facilities people are also attracted toward electrified villages. These have been instrumental in reducing out-migration for job from electrified villages aud in increasing in migration (both temporary/seasonal and permanent) to electrified from non-electrified villages.

6.9 Impact on environmental protection

Not only are PVs environmentally superior to kerosene and dry cells, they also have advantages over other electricity supply options. PV modules generate electricity without emitting local air pollution or acid rain precursor gases, water pollution, or noise. The modules are typically roof-mounted or require very little ground space, so PV based rural electrification also avoids the disruptive land use impacts associated with power lines and some methods of electricity generation.

Since stand-alone PV systems provide electricity without power lines, their use in protected forest areas and buffer zones can be particularly valuable for ecosystem preservation. Power line corridors can open access for the development of forested areas, change the diversity of species within ecosystems, and cause ecosystem fragmentation. Furthermore, power-line construction and maintenance activities themselves can be quite disruptive.

6.10 Summary:

The **working hour** of household with solar electricity has increased than the non-electrified honsehold of the study area.

The **average annual income** of households with solar electricity is higher than that in the non-electrified honsehold. The average annual household expense for education in solar electrified households was also higher in expenditure than that in their non-electrified counter pan.

The average income of the shop keepers of solar electrified rural markets is higher than the non-electrified condition of those markets.

From the point of long term use **the cost of solar electricity** is considerably less than the cost of kerosene and Solar PV per consumer capital cost is 36% less compared to grid consumer and Solar PV per consumer annual O & M expense is 35% less compared to grid consumer.

The **adult literacy rates** for solar electrified households as compared to non-electrified ones are characterized by relatively higher literacy for both males and females.

The **quality of education** measured in terms of household expenditure on education, marks (grades) obtained in final examinations, school attendance and drop-out rates, and time spent for study by students at night was found to be better in the solar electrified households.

Solar Electrification has contributed to the positive development of **women's socio-economic status**. Electricity has left a profound impact on women's mobility, decision making, freedom in using income and savings, knowledge about gender inequality issues, awareness of legal issues (for example, marriage for girls at 18 and boys at 21), and awareness about negative impact of dowry.

A new phenomenon of **in-migration into electrified villages** has been reported. New employment opportunities have emerged in solar electrified villages, which attract people from non-electrified villages.

Chapter-7

Recommendation and Cenclusion

Chapter-7

Recommendation and Conclusion

At the current time 85% of the total people, mostly in rural areas of Bangladesh are without access to electricity from centralized grid. They have to live inadequate economic and social condition and in an environment of poverty, deprivation and low quality of life. Electrification by solar photovoltaic has emerged as a viable technical option for meeting lighting and other rural development indicators for the people living in remote areas of Bangladesh. In our study area the impact of solar energy on various rural development aspects has proved this. The quality of life between solar electrified and non-electrified has proved that impact.

7.1 Problems and hurdles:

But this solar energy has some constraints. The constraints to dissemination of use of solar energy are discussed below:

A) Imperfect information about solar energy

B) Low income of people

C) Constraint on private Research and Development (R&D):

D) Higher initial cost in conventional sense.

E) Shortage of data and information and trained manpower

F) Absence of incentives and price supports.

G) Lack of continuity and co-ordination.

7.2 Recommendations:

Considering the above problems and hurdles the following is a package of recommendations arising from the study. These recommendations are the result of an assessment of the experiences collected in this study, enriched with other discussions and inputs. Government of Bangladesh and Other Non-

Government Organization can take following measures to flourish the solar technology in rural areas:

7.2.1 Making solar electricity cost lower:

Solar electricity cost should be made lower so that village people can be attracted to solar electricity rather than use of kerosene.

7.2.2 Providing correct information:

Buyers and sellers must have enough information to make rational decisions. Yet, most individuals and business do not even know the basic concepts of use of solar energy in Bangladesh. Even experts in those fields often have difficulty-determining the relative efficiencies of competing products or the costs of alternative energy sources. Diffusion of solar energy use will not occur if business and consumers do not make informed decisions. So perfect information about the basic concepts of use of solar energy should be provided to buyers and sellers.

7.2.3 Increasing private Research and Development (R&D):

Private research, development and marketing of solar devices in Bangladesh are very limited. Only two private companies, Ananda and Grameen Sakti are engaged in research and development activities. They are trying to make popular solar devices that can be made with locally available materials. Rahimafrooz, another private company is engaged in only marketing of photovoltaic cells. Most of the projects taken by these companies and marketing of solar devices are not much successful because of various economic and social factor. So, Research and Development (R&D) on solar technology should be increased.

Research is further needed to assess the replicability of promising PV applications and the conditions under which they are successful; and to develop approaches for assessing their Cost/ Benefit ratio.

Further research efforts are required for the optimization of PV systems for agricultural use in order to develop complete services or product packages, e.g. optimized irrigation systems (panels, electronics, pumps and drip-irrigators) for economic irrigation and fertilization; such packages should be adapted to local agronomic, soil and water and ecosystems and should be accompanied by adequate training packages.

Research should also include the development of quality standards, e.g. for agricultural applications, in combination with mechanisms to implement these standards;

7.2.4 Stopping financial subsidy to grid power: Financial subsidies to grid power and isolated diesel generation have to be stopped.

7.2.5 Making easy Repayment system: In view of the high costs of iuvestment in solar energy to the consumer compared to the option of receiving grid supply, some innovative financial engineering has to be done to design repaymeut terms and amortization schedules to match the cash flow of the consumer.

7.2.6 Making solar energy economical: The environmental benefits of solar energy and applicability in remote locations have also to be captured in energy planning models in an economically objective way.

7.2.7 Educating people about solar energy: It is important to let people know more about ways to use solar energy. Education on environmental pollution and use of different renewable energy sources can help dissemination of use of this technology.

7.2.8 Making PV marketing system easier: PV system marketing organizations should develop more flexible and easier financing scheme for system buyers.

7.2.9 Giving financial incentives to non-governmental organizations: Government should give financial incentives to private and non-governmental organizations to come forward with innovative PV programs for rural areas.

7.2.10 Making Resourceful Renewable Energy Fund: A resourceful-Renewable Energy Fund -may be created to mobilize resources for this sector so that private and non-government sector may receive fund at a reasonable cost for expansion of renewable energy programs.

7.2.11 Role of NGO in Solar Issue: Non-government development organization may encourage people to use solar energy in the following way:

- Credit should be given with easy repayment system to the members of the NGO's to buy solar devices. Credit policies of Grameen Shakti may be followed by other NGO's.

- Environmental consciousness should be developed among people through education program.

- It is very much important to give information about the existence and benefits of solar devices to people.

- More research and development work is to be conducted by private organizations for development and marketing of solar devices in Bangladesh.

7.3 Conclusion

The access of rural people to the solar electricity has changed not only their habits, but also their life style, traditions, work schedule, way of thinking and to some extent social norms and values too. Before solar electricity there was nothing to do after taking evening meal other than sleeping, so sleeping time was somehow longer before solar electricity arrived. Now they can do some more interesting and more important works rather than spend their time in sleeping.

Now the people can utilize their leisure time not only in sleeping but also in other income generating activities such as sewing, knitting, handicrafts, etc. which, on the one hand, increases their source of income and, on the other hand, provides an opportunity to use local resources in terms of money, materials and human resources, allowing them to enhance their skills for economic well-being.

Solar Electricity has opened a wide door to the inhabitants of solar electrified village of both districts through TVs. Now they can encounter information on the same day about what has happened in the world. They can now learn many new things such as life styles, civilizations, cultures, languages, etc. They now have a new means of information and entertainment

Illiteracy among adults in rural areas is still very high despite the enormous effort of governmental and non-governmental organizations to reduce the illiteracy rate in the village.

It is very difficult to convince them to read and write. As solar electricity enters into the village and people started to use radio and TVs in their home, they are gradually sensitised to the necessity of being literate. Even those who do not know how to read and write are gradually learning many new things from radio and TV. On the other hand this solar electricity is playing an indirect role on awareness of Human right, Health, Hygiene and Sanitation, redncing some human diseases, women's empowerment, changing status, protective Security, reducing out-migration towards urban area. In a word solar electricity plays an enormous role in the overall rural development. In my study it is proved in many ways.

So, it therefore necessary to take positive steps from the govt. and private sectors to increase the solar electricity the other rural areas of the country in an effective way which will ultimately introduce the new horizons of rural development.

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Appendices

Bangladesh University of Engineering and Technology
Department of Urban and Regional Planning

Questionnaire for
Impact of utilization of solar energy in some selected rural areas of Thakurgaon and Dinajpur District

(For Research Purpose only) **Identification No.**

1. IDENTIFICATION

Name of the Household Head ....
House no.......... ....
Union ....
Village ....
Name of the Respondent .... Relation with Head ....

Household Electrified status. Solar Electrified ☐
Non-electrified ☐

2. FAMILY INFORMATION (For Both Solar electrified and non-electrified area)

Sl no.	Age	Sex	Marital Status	Education	Occupation	
					Main	Secondary
	1	2	3	4	5	6
1						
2						
3						
4						
5						

Column-2 : i)Male ii) Female
Column-3 : i) Married ii) Unmarried iii) Widow/Widower iv) Divorced v) Seperated
Column-4: i) Illiterate ii) Signature only iii) Primary iv) Secondary v) S.S.C vi) H.S.C vii) Degree & Above.
Column-(5+ 6) . i) Owner cultivator ii) Tenant farmer iii) Agriculture labour iv) Non-agricultural v) Service holder vi) Petty traders vii) Transport worker viii) Business ix) Carpenter x) Rickshaw/van puller. xi) Fisherman xii) Boatman xiii) Blacksmith xiv) Tailor xv) Driver xvi) MBBS xvii) Village Doctor/Quack xviii) Homepath xix) Imam xx) Retired service holder xxi) Student xxii) Umbrella Repairer xxiii) Other.

3. HOUSEHOLD ACTIVITIES (For Both Solar electrified and non-electrified area)

1. For lighting home what is used?

Kerosene lamp ☐
Hurricane ☐
Charger ☐
Solar Electricity ☐

2.If kerosene is used, how much kerosene per week is needed for lighting purposes?

----------------------- litre

3. Do you have any radio?

Yes ☐

No ☐

4. How radio is run?

Solar electricity ☐

Battery ☐

5. If battery is used, how much money is needed for battery purposes to run radio?

--------------------------Tk

6. Do you have any television?

Yes ☐

No ☐

7. How television is run?

Solar electricity ☐

Battery ☐

8. If battery is used, how much money is needed for battery purposes to run television?

--------------------------Tk.

9. Do you have any torchlight?

Yes ☐

No ☐

10. Household allocation of time (just one usual day: average of last one week)

Members	Time between (6.00 pm and sleep)	Type of Activity and allocation of time for each activity		Allocation of time for activity After SHS		Activities new after SHS		Activities which generate income		Ammount of extra hours/time available after SHS
1	2	3		4		5		6		7
		Activity	Time	Activity	Time	Activity	Time	Activity	Time	
HH head										
Spouse										
Senior most male student										
Senior most female student										

Columns 4-7 are not applicable, if no electricity in the household.

Activity codes: Study = 01, Sewing = 02, Teaching kids = 03, Watching TV= 04, Late night news BTV(11.00-11.30) = 05, Radio = 06, Business = 07 Net making = 08, Threshing = 09, Mat/basket etc making = 10, Weaving and related = 11, Attending socio-cultural functions = 12, Performing religious activities = 13, Cooking = 14, Eating = 15, Cleaning utensils = 16, Bed preparation = 17, Visiting neighbors = 18, Gossiping = 19, other = 20

4. HOUSEHOLD INCOME (Both Solar electrified and non-electrified area)

Sl no	Source of income	Present status (Solar electrified/ non-electrified condition)		Past status (non-electrified condition)	
		Number	Market value	Number	Market value
1	Crop agriculture				
2	Wage labour agriculture				
3	Wage labour non-agriculture				
4	Livestock				
5	Poultry				
6	Trees/Nurseries				

7	Kitchen/home gardening				
8	Fruits/ vegetables				
9	Pisiculture/fisheries				
10	Business/shops				
11	Rent: house, shop				
12	Salaried employment				
13	Transport: van, rickshaw, boat, motorcycle, cycle.				
14	Cottage industry				
15	Plantation on Khas land				
16	Others				

5. INCOME GENERATING ACTIVITIES (Solar Electrified village)

1 Apart from doing household work, do you do any other IGA?

Yes ☐
No ☐

2. What are those activities?

----

3. How much did you earn last year?

---------------------- Tk. (cash and kind combined)

4. Who takes decision as to spend the money earn by you (her) ?

Yourself only ☐
Husband only ☐
Jointly ☐

5 Do you think that your workload for household chores has reduced due to solar electricity?

Yes ☐
No ☐

6.Do you have more free (leisure) time before solar electrification?

Yes ☐
No ☐

6. MODERNIZATION EFFECT THROUGH RADIO AND TV (For solar electrified area)

1. Do you listen to radio more now a day than before SHS?

Yes ☐
No ☐

8. Do you watch TV now a days more than before SHS?

Yes ☐
No ☐

9 Do you assist children with their education now more than before SHS?

Yes ☐
No ☐

10 Do you listen to TV?

Yes ☐
No ☐

11 How long do you listen TV? ------------ minutes per day

12. What do you listen to TV?

Folk song ☐
Modern song ☐
News ☐
Drama ☐
Health-Nutrition ☐
Agr. related ☐
Cinema ☐
Other entertainment ☐
Not applicable ☐

13 Which cultural programs do you enjoy most, which are shown on the TV?

Bangla drrama/drama serial ☐
Flim ☐
English drama/drama serial ☐

14. What are the areas (subject/issues) you have learnt from TV watching and subsequently (Knowledge gained) used/practiced/disseminated (Which are found useful in life) ?

- Value of good health ☐
- Value of education ☐
- Value of female education ☐
- Utility of family planning ☐
- Development of knowledge base through national/international news ☐
- Improvement in agricultural practice ☐
- Knowledge about modern fishing. ☐
- Knowledge about integrated pest management ☐
- Govt. program about distribution of khas land ☐
- Prohibition of dowry ☐
- Laws about divorce ☐
- Legal tools to combat violence against women ☐
- Local governance issues ☐
- Women's Right issues ☐
- Issues of human rights ☐
- Equal rifghts for boys and girls through Mina Cartoon ☐
- Others (specify) ----------------------------------

15. Whether knows about the following and main/major source of information?

Sl. no	Items	Wheter Knows or Not Know	Source of information
1	Equality of man and women in terms of access to resources		
2	Equality of men and women in terms of employment, wage (non-discrimination)		
3	Women trafficking: punishable criminal offense		
4	Child trafficking: punishable criminal		

	offense		
5	Acid throwing : punishable criminal offense		
6	Informed choice in family planning use		
7	Equal rights of men and women to vote and participate in election		

Column-2: i) Know ii) Not Know

Column-3: i) Radio ii) TV iii) Neighbor/relative iv) NGO v) Govt-worker. vi) other

16. Was there any marriage event in your household during the last 5 years?.

Yes ☐

No ☐

17. Who was given marriage to and where?

	Yes	No	Electrification status of household	
			Solar electrified	Non-electrified
Boy/son				
Girl/daughter				

18. If you are to arrange marriage for your son or daughter, other things being equal (eg. economic status, educational qualification, employment status etc) what type of household you will choose-electrified or non-electrified.

	Solar electrified	Non-electrified
For son		
For daughter		

7. EDUCATION (LITERACY, ENROLMENT AND QUALITY)

[For Both Solar electrified and non-electrified area]

	Total No.	Can read Bangla alphabets, write name and have basic numeracy	Primary	Secondary	Tertiary and higher
5 years and above					
15 years and above					

Marks obtained in the last final examination: boy and girl(age 10-18)

Boy: Class --------, Marks obtained ------------ (out of ----------)

Girls: Class--------, Marks obtained ------------ (out of ----------)

8. LIGHTING FOR MOSQUE (For both solar-electrified and non-electrified areas)

1. How mosque is lighted at night?

Hurricane ☐
Candle ☐
Charger ☐
Solar light ☐

2. What is the opinion of prayer man about lighting?

Satisfaction ☐
Dissatisfaction ☐
No opinion ☐

9. LIGHTING FOR COMMUNITY MEETING (Both electrified and non-electrified areas)

1. How community meeting is lighted at night?

Hurricane ☐
Candle ☐
Charger ☐
Solar light ☐

2. What is the opinion of the participant about lighting for the community meeting?

Satisfaction ☐
Dissatisfaction ☐
No opinion ☐

Bangladesh University of Engineering and Technology
Department of Urban and Regional Planning

Questionnaire for
Impact of utilization of solar energy in some selected Solar Electrified Rural Market of Dinajpur District

A. General:

1. Name of the rural market

2. Address

3. Electricity Status:

B. Site, Building and Surrounding

1. Adjacent land use

Residential ☐
Commercial ☐
Residential-Commercial ☐
Others ☐

2. Name and distance from nearest

	Name	Distance (in ft)
City center		
Police station		
Fire station		
Hospital/Clinic		
Public telephone		

3. Nearest Rural Highway
.... ft wide, ... ft distant from shopping center.

C. Physical Aspect of the Building

1) Types

1. Pucca ☐
2. Semi pucca ☐
3. Kutcha ☐
4. Jupri. ☐
5. On the ground. ☐

2) Land occupied (percent) --------------

D) Basic Amenities

1. Availability of water supply system

1. Yes ☐
2. No ☐

2. Mode of transportation

1. Cooli. ☐
2. Rickshaw ☐
3. Van ☐
4. Truck. ☐

3. Market has

Overhead water tank	Gal
Water reservior	Gal
Electricity generator	K.w

(E) Shopping Environment

1. No. of shops

Types of shops	No
Grocery	
Stationery	
Tea stall	
Pharmacy	
Electric goods	
Confectionary	
Ready made garments	
Bedding shop	
Saloon	
Furniture	
Crocary shop	
Jewellery shop	
Phone-Fax shop	
Battery charge shops	
Mobile charge shop	
Fancy item	
Books	
Others	

2. Shops are

1. Private
2. Leased
3. Owned

3. Crowd

	10-12 am	12-5 pm	5-10 pm
No. of customers			
No. of shopkeepers			
Window shoppers			
Hawkers			
Others (specify)			

(F) Questionnaire for Wholesales & Retailers

1. For how many years the shop is electrified? Since-------------------

2. When the shop was not electrified what was your monthly sale --------(Tk.)

3. Monthly sale is now ------------ (Tk.)

4. How long the shop remains open after the sunset?
Before solar electricity--------------- Now----------Total opening hour ....

5. What were the disadvantages when your shop was not electrified?

i) Sales was lower
ii) Less profit
iii) Fewer customers
iv) Others

6. How much your average monthly expenses for lighting purposes?