Opportunities for Women in Renewable Energy Technology Use in Bangladesh (Phase I)

April 2004

Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) and Bank Netherlands Water Partnership Program (BNWPP)

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Preface

1. This report contains two volumes that detail an ongoing ESMAP and World Bank effort to use off-grid electrification alternatives as a vehicle to enhance economic development and the lives of women in rural Bangladesh. The main report includes the project Opportunity for Women in Renewable Technology Use in Bangladesh activities, lessons learned and forward looking strategies for women's empowerment and increasing economic opportunities through technology transfer. Annex E provides guidelines for renewable energy technology and gender in the public sector in Bangladesh, which can guide future programs. This action oriented project was implemented in Char Montaz, an isolated rural island off the southwestern coast of Bangladesh, which developed a model for community driven, private-public partnership mechanism for decentralized low-cost renewable energy services that also empowers rural poor women. The project trained women to establish and manage a cooperatively owned micro-enterprise that manufactures and sells energy products—battery-operated direct current (DC) lamps, batteries, battery-charging facilities, diesel-operated micro-grid electrification, and solar home systems. These services are in high demand in a region not likely to receive publicly provided grid electrification for decades. It has doubled income of the women entrepreneurs and increased their socio-economic status. The off-grid power provided by these lamps and solar panels has enhanced the productivity and income by 30 percent of businesses and households. It has allowed shops to keep longer hours, fishing boats to operate electrical devices, and children to spend more time with their school work at home. Most importantly, women value this energy services as it has increased their and household security, improved household air and lighting quality, access to mass media information (radio, television) and extended time for social/cultural and other networking events.

2. Hasna J. Khan and Asma Huque, directors of Prokaushali Sangsad Limited, assisted in designing and implementing the project as well as provided drafts for the report. South Asia Partnership-Bangladesh, an NGO working in Char Montaz was a partner during the initiation of the project activities. Douglas F. Barnes of South Asia Energy and Infrastructure Sector (SASEI) and Nurul Islam, Professor of the Institute of Appropriate Technology, Bangladesh University of Engineering and Technology (BUET), provided peer reviews. Marc Heitner (SASEI) and Dominique M. Lallement, Charles Feinstein, and Kazim M. Saeed of ESMAP provided useful comments on the draft. Nyra Naomi Guice and Marjorie K. Araya of ESMAP supervised the production, printing, distribution, and dissemination of this report. Esther Petrilli desktopped the report and The Grammarians, Inc. edited it. Nilufar Ahmad, South Asia Environment and Social Development Sector, was the task manager of the project.

Abbreviations and Acronyms

AC	alternating current
ADMD	Association for Disaster Mitigation
AH	Ampere hour
ASTRA	Application of Science and Technology to Rural Areas
BASIC	Bank of Small Industries and Commerce
BBS	Bangladesh Bureau of Statistics
BCS	Battery charging station
BRAC	Bangladesh Rural Advancement Committee
BSCIC	Bangladesh Small and Cottage Industries Corporation
BUET	Bangladesh University of Engineering and Technology
CEWDM	Coastal Electrification and Women's Development Microenterprise
char	Island
DC	Direct current
ECNEC	Executive Committee of the National Economic Council
ESMAP	Energy Sector Management Assistance Program
GAD	Gender and development
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
IDCOL	Infrastructure Development Company Ltd.
IT	Information technology
Kgoe	Kilogram of oil equivalent
kupi	Open kerosene lamp
kW	Kilowatt
kWh	Kilowatt hour
MFI	microfinance institution
MNES	Ministry of Nonconventional Energy Services (India)
MW	Megawatt
NGO	Nongovernmental organization
OECD	Organisation for Economic Co-operation and Development
PBS	Palli Bidyut Samity (Rural Electrification Committee
PCB	Printed circuit board
PDB	Power Development Board

PP	Project Pro-forma
PSL	Prokaushali Sangsad Limited
PV	Photovoltaic
REB	Rural Electrification Board
RET	Renewable energy technology
SAP-BD	South Asia Partnership Bangladesh
SASEI	South Asia Energy and Infrastructure Sector
SHS	Solar home system
SMEs	Small- and medium-size enterprises
STDI	Southwest Technology Development Institute
Tk	Taka, the local currency (US$1 = Tk50)
UNDP	United Nations Development Programme
UP	Union parishad (lowest tier of local government)
USAID	United States Agency for International Development
WHO	World Health Organization
WID	Women in development

Executive Summary

1. On Char Montaz, a rural island in Bangladesh, a remarkable social transformation is under way. For more than a year and a half, 35 women, who were given proper training and support, have been running a successful microenterprise and providing electricity services. The women have brought lighting and electricity to the area, perhaps decades before the country's grid system could have reached it. In the process, they have improved the quality of life for their families and their community. They have also risen above the traditional roles to which so many rural women have been confined. This document intends to illustrate how the unique Char Montaz project could be expanded, and how it could serve as a model for similar efforts elsewhere in Bangladesh and throughout the developing world.

Background and Context

2. Even among developing nations, Bangladesh's rural population lags behind. More than 100 million people—about 80 percent of the population—live in rural areas, where annual per capita commercial energy consumption averages less than 100 kgoe,[1] well below average international levels. [2] Bangladesh's urban 20 percent consumes 80 percent of the country's commercial energy. Most rural households are confined to using traditional forms of biomass for fuel, but account for nearly 70 percent of the country's total energy consumption. In effect, the rural population does not have access to commercial energy, and as a result they are not able to achieve their human development potential and economic prosperity. Apart from the need for a rural distribution system for commercial energy, there is also a lack of policy guidance and an institutional framework for integrating renewable and nonrenewable sources.

3. At present, economic opportunities for Bangladeshi women are extremely limited, especially in rural areas. Women are the major consumers of energy in the rural areas as they are responsible for gathering fuel for cooking and heating, however, they do not have any access to modern energy or technology. As a result, women are not able to play an important role in rural electrification, which is a key to economic and social development.

4. Bangladesh is not able to expand its rural electrification beyond the present low level (15 percent), due to various constraints.[3] As a result, millions of households, who can afford modern energy services remain unelectrified and not able to achieve their human development and economic potential. According to the national master plan, most of these households will not receive electrification within the near or

[1] Kgoe represents kilogram of oil equivalent or 42.7 megajoules of energy.

[2] The average per capita energy use among non-Organisation for Economic Co-operation and Development countries is 167 kgoe.

[3] Because of low consumption among rural households, new electrification projects fail to qualify for grid expansion in the absence of significant commercial, industrial, or irrigation loads.

medium term, because it is uneconomical to increase the rate of grid coverage to areas of low consumption density.

5. A recent study[4] has indicated that alternate supply sources and delivery mechanisms operated by private entrepreneurs, local nongovernmental organizations (NGOs), and private cooperatives could provide service to many areas currently neglected by the national grid. It seems that electrification in rural Bangladesh will depend on decentralized, off-grid solutions for a while. In many areas, privately owned diesel-powered microgrids are providing electricity services using nonrenewable fuels. [5]

6. There are two types of consumers for rural off-grid service: small shops in central markets and surrounding households. However, the high tariffs charged by private operators of diesel generators are usually beyond the budgets of the households. Therefore, diesel-powered microgrid services remain limited to the market centers, and most dispersed rural households would continue to spend their evening hours around kerosene lamps or in darkness. Battery charging stations (BCSs) also serve some rural villages, allowing owners of rechargeable batteries to operate direct current (DC) radio-cassette players or televisions. These are usually higher- and middle-income households.

7. Solar home systems (SHSs) could become a potential off-grid alternative, offering the added benefit of using nonpolluting, renewable energy. Although limited by their high initial cost, decentralized solar photovoltaic (PV) systems are suitable for serving dispersed rural households where conventional power is economically out of reach. But such an unconventional effort will require government policymakers, energy delivery entrepreneurs, and financial institutions to develop a financial scheme and distribution mechanism for SHS, which can be affordable to majority of rural households.

Objectives

8. This project was undertaken to address the problems described above. It has piloted a community-driven, decentralized rural electricity delivery service, operated as a microenterprise that is cooperatively owned by women. Its objectives remain (a) increasing opportunities for women in the commercial energy sector; (b) improving the quality of life in remote, marginalized areas by creating employment and income opportunities through technology transfer and electrification; and (c) providing an expandable, replicable business model for off-grid service delivery. To a great extent, these objectives have been met by the project's three principal activities: (1) helping the rural women to develop and operate their microenterprise, (2) training and networking Bangladesh's professional women in renewable energy technologies (RETs), and (c) preparing a guideline for future project development in public sector using RET.

[4] *Feasibility Study of Solar Home Systems Project within the Context of Alternative Options for Rural Electrification*, by Prokaushali Sangsad Ltd., March 2000.

[5] The microgrids also could operate with renewable energy, possibly in hybrid form with wind or photovoltaic (PV) as well as diesel power.

Coastal Electrification and Women's Development Microenterprise (CEWDM)

9. This project's location is Char Montaz, [6] a coastal island of approximately 2,800 households. There, 35 rural women have been trained in energy technology, who established the Coastal Electrification and Women's Development Microenterprise (CEWDM), for manufacturing DC lamps and providing electricity services. Initially, a needs identification survey was conducted in Char Montaz, and the project was designed based on the following findings: (a) many households already own radio-cassette players, televisions, or other appliances using rechargeable batteries and are interested in using DC lamps powered by batteries, if the lamps are locally available; (b) users of the appliances need to be able to charge batteries regularly at affordable rates; (c) households near rural markets electrified by diesel microgrids will use such services if affordable tariffs are offered; and (d) households that are not near either a charging station or a rural market would remain unelectrified unless affordable SHSs are made available to them.

10. Based on the survey findings, the CEWDM was established by 35 trained women, who have undertaken the following activities:

- Assembly and sale of DC lamps[7]
- Operation of BCSs on the islands of Char Montaz and Char Rangabali
- Operation of a microgrid for rural market electrification on Char Montaz
- Planning for future SHS services to dispersed households

Development of Training Modules

11. Decentralized electrification demands special training, and this project has developed different training modules to serve the women's needs. It has provided six weeks of intensive technical instruction on DC lamp construction and six months of follow-up supervision. It has conducted training sessions on operating a BCS and its systematic maintenance. The project has instructed the women in business skills for operating and developing the microenterprise - CEWDM. It has introduced them to the principles of microcredit for battery sales and has provided all the women—as well as some men—marketing skills training to help accelerate DC lamp sales. Member of CEWDM have elected eight group leaders, who are responsible for everyday management. These women have attended a special course on accounting and bookkeeping.

[6] Char Montaz is located in Galachipa Thana/Upazila, in the Patuakhali district off the southern coast of Bangladesh.

[7] The DC lamps are efficient fluorescent lamps operable with batteries of 8 or 12 volts.

Operational Performance

12. Within six months of establishment, CEWDM has sold more than 770 DC lamps and 235 small batteries for lighting households, shops, mosques, and fishing boats. Lamps continue to be sold through various media, including a sales outlet on Char Montaz, as well as by marketing agents and retailers on several nearby islands. The lamps are priced competitively with others available in local markets. Lamps sold by the CEWDM cost Tk325 (approximately US$6.50), less expensive than all other domestic and imported lamps, which range from Tk650 to Tk1200 (between US$13 to US$24). The lamp sales, BCS, microgrid operations, and other activities have been reasonably profitable. Furthermore, continuing diversification of products, promotion and marketing efforts are expected to expand the CEWDM , as is the future SHS business.

Social Outcomes

13. This project, the first of its kind, has demonstrated not only that the private sector can make a significant contribution to rural electrification in Bangladesh, but also that such efforts can be operated by rural women and provide good service at an affordable price. The project on Char Montaz has empowered the CEWDM members, as evidenced by their increased income and knowledge, use of modern technology and business management practices, change in traditional gender roles, enhanced decisionmaking authority in their households and community, and performance in production, marketing, and sales. Among these women, none had graduated from high school and none had previous employment experience. Fifty-four percent had completed education no higher than the grade 8, and the rest had completed no higher than the grade 5. Now they work in the CEWDM for half a day and six days a week. Their husbands share household duties so the women are able to work outside home. This shift in traditional gender roles has given the women greater confidence and improved their status in the community. The women's average daily incomes have increased by about Tk100 (approximately US$2). Electrification and modern household lighting have enhanced productivity and security of the families. Families are able to work and study longer and more efficiently in an illuminated environment. They have gained increased access to radio and television, which can expand their awareness and knowledge. The project's low-cost solution for improved indoor lighting also has reduced indoor air pollution and fire hazards. It has demonstrated that women need not be passive beneficiaries of social progress. Rather, they, themselves, can be agents for social transformation.

Electrification Options as a Function of Household Income

14. The CEWDM conducted a market assessment in 2000 to identify potential consumers of DC lamps and SHSs in the Char Montaz area. The survey sample included 488 households. Figure 1 shows the distribution of electrification options as a function of

household income.[8] About 40 percent of the households earn less than Tk2,000 (US$40) per month. They represent the poorest of the poor, similar to those surveyed by the Household Expenditure Survey.[9] They cannot even afford kerosene-fueled hurricane lamps for lighting. Instead, they spend less to purchase one or two kupis (open kerosene lamps), but pay more in kerosene for poorer lighting quality. As a result, the poorest households tend to spend inefficiently on lighting, but the same is true for other households. Table 1 compares the cost and performance (quality of light) of a DC lamp manufactured and sold by the CEWDM with a kerosene lamp from the local market. For a DC lamp, a household has to invest nearly nine times more in capital cost than for a hurricane lamp. However, the DC lamp provides about 100 times more light output. Although the poorest households cannot afford any of the lighting options currently offered by the CEWDM, social programs providing financial assistance could easily overcome this shortfall.

Table 1: Cost and Performance Comparison: DC Lamp vs. Kerosene Lamp

Type	*Capital cost, Tk (US$)*	*Operating cost for 20 hours of service, Tk (US$)*	*Light output, lumens per watt*
Kerosene hurricane	150 (3)	15 (0.30)	0.02–0.05
DC lamp and battery	1,325 (26.50)	20 (0.40)	20–35

Costs of Rural Lighting and Electrification

15. Households within each income stratum have different demands for energy. Their willingness to pay for meeting their demands also varies. Through this project, the capital expenditure required for modern lighting has been reduced to the equivalent of US$26, and the monthly cost for battery charging is US$1.50 to US$2.40.[10] It is expected that a larger number of households can be served through this scheme. A total of 10,000 households from all six of the nearby islands could be electrified using the same methods. However, without dedicated microcredit funds for batteries, sales volumes and growth are expected to remain modest. More rapid expansion of service will require the local NGOs to initiate microcredit schemes for household electrification.

[8] The data also correspond to the Market Assessment Survey done for Solar PV in Bangladesh (*Feasibility Study of Solar Home Systems Project within the Context of Alternative Options for Rural Electrification*, by Prokaushali Sangsad Ltd., March 2000.

[9] *Household Expenditure Survey 1995–96*, by the Bangladesh Bureau of Statistics.

[10] Charging cost for a battery of 20 ampere hour (AH) is Tk20 (US$0.40). The frequency of charging depends on the energy usage rate. Because there are 6W, 8W, and 10W lamps, monthly costs will vary accordingly.

Figure 1: Distribution of Energy Options for Lighting as a Function of Household Income in Rural Bangladesh

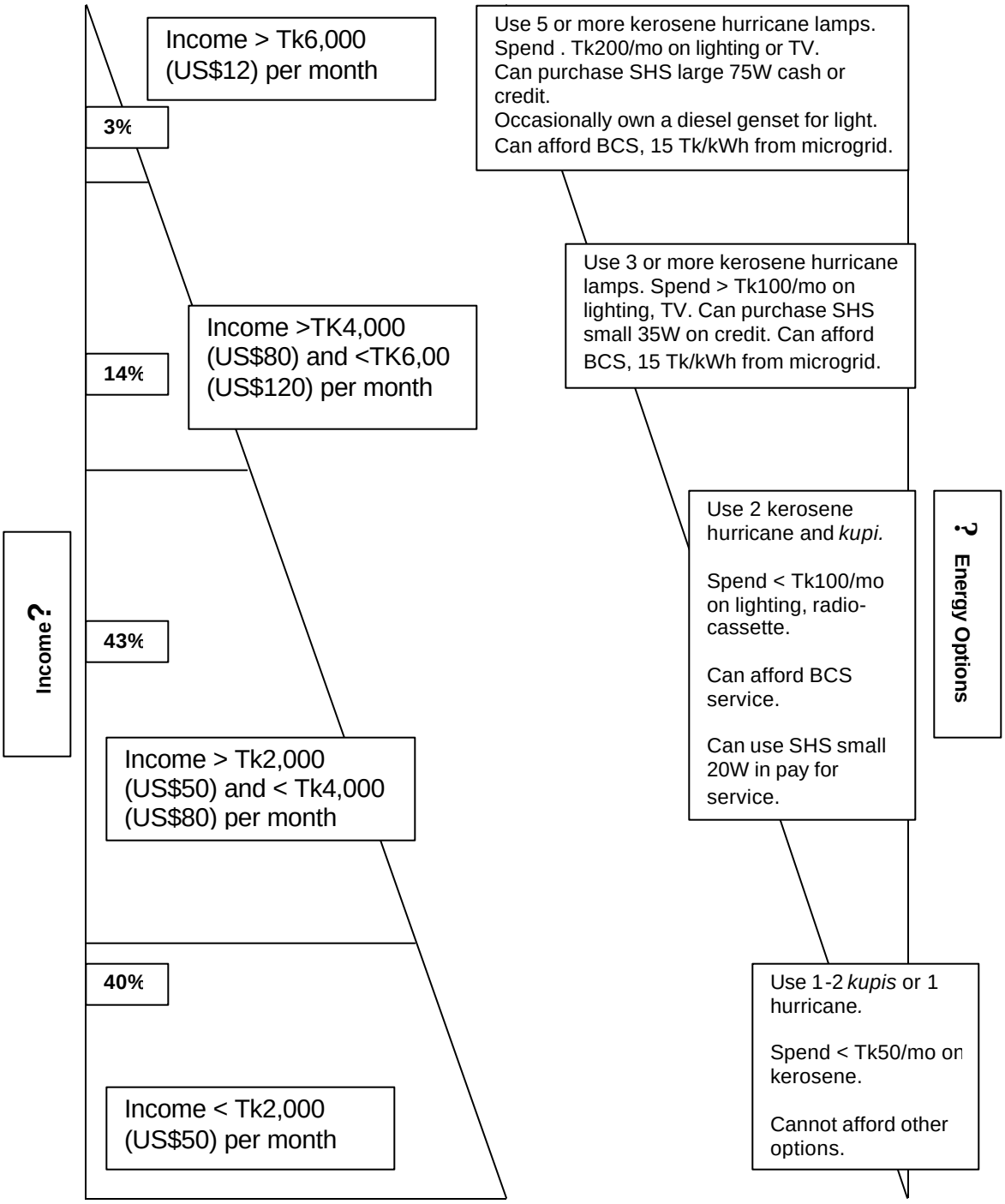
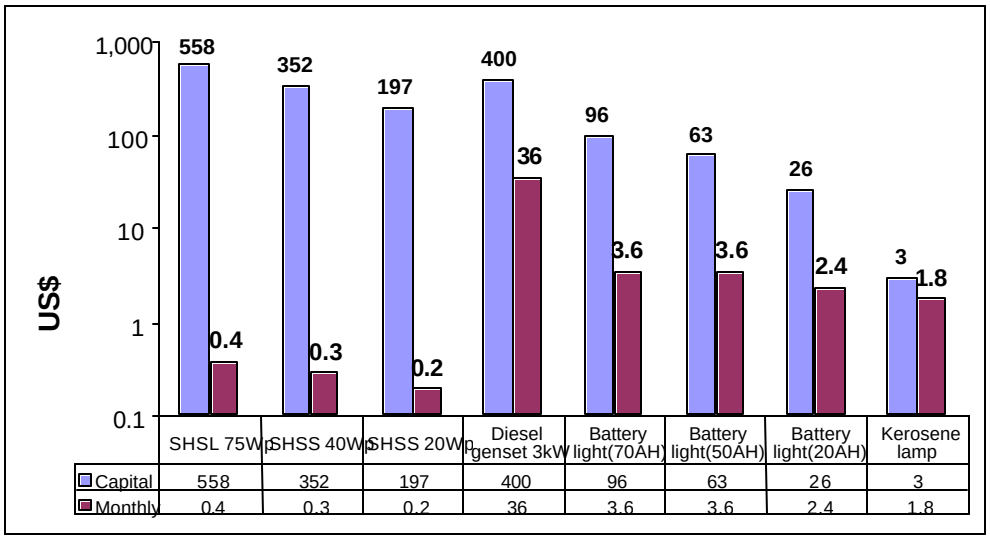


Figure 2: Cost of Energy for Lighting (for Daily Four Hours of Service)



Sustainability Issues

16. A reliable source of battery charging is essential for the continued growth of the market for and use of DC lamps. Private entrepreneurs need to be encouraged to appreciate the business potential for investing in BCSs and creating a sustainable service infrastructure. Regularly carrying batteries to BCSs for recharging is difficult, thus many dispersed rural households have not purchased DC lamps. For these households, access to solar modules is of greater interest as a more convenient source of battery charging. The number of households with access to modern lighting will be linked directly to the ability of rural consumers to pay for DC lamps and battery charging, by either diesel generators or solar modules.

17. As in many rural electrification programs, more rural households need to be provided with partially subsidized capital funds for the CEWDM to extend its services. Such funds make off-grid services more affordable. However, the CEWDM has already helped some households to overcome the lack of subsidies by sharing the risk and cost of the services (see next section). This allows consumers to make small and affordable expenditures and climb higher on the ladder of energy choices.

18. Sustainability of the CEWDM also will depend on efficient management. To achieve this goal, systematic records of financial data are kept for revenues, expenditures, depreciation of capital equipment, and financial ratios.

The Role of Microcredit in Off-Grid Market Growth

19. There is a significant role for microcredit for the off-grid rural electrification infrastructure of Bangladesh. This option can be offered by several agencies, including the local NGOs, rural banks, cooperatives, or even the Palli Bidyut Samities (Rural Electrification Committee [PBSs]). The microcredit, once secured, should result in rapid growth of the off-grid electrification market, because more unelectrified rural households will be able to procure lamps and batteries. When the local NGOs are prepared to spend dedicated funds for household lighting, the CEWDM envisages that a sizable rural population can be approached in the future with appropriate offers. Meanwhile, the CEWDM has already sold 122 batteries through their own microfinance facility.

20. No funds are yet available for private investors to get involved with RETs, especially at this early stage of development. There is a potential risk that failure to obtain development funds will continue to restrain the scope of this potential commercial business. For any realistic progress in providing access to off-grid electrification through the private sector, small- and medium-size enterprises (SMEs) and cooperatives will require dedicated funds. The newly established Infrastructure Development Company Ltd. (IDCOL) would be a suitable agency for filling this gap.

Networking and Capacity Building for Professional Women

21. This project has trained 33 professional women from 18 different government organizations and NGOs in the principles of RETs. As a result, these women have formed a network to share knowledge and disseminate information. It is envisaged that these women's network, with proper technical assistance could assume leadership roles in developing and implementing future RET use.

A Guideline for RET and Gender by the Public Sector

22. A guideline for equitable use of RET was prepared within this project. It is intended to enhance the incorporation of energy alternatives and gender issues within future programs undertaken by the sector ministries. The guideline provides recommendations for a policy framework that can integrate RETs and energy efficiency into planning activities, and it identifies institutional requirements. For example, the guideline recommends that the Planning Commission, in coordination with the cells of the sector ministries, focus on

- Forming an apex organization to oversee renewable energy activities,
- Enacting a final policy paper on renewable energy,

- Granting priority to national programs and activities using RETs, and
- Identifying projects to be included the Sixth Five-Year Plan of the government of Bangladesh.[11]

[11] *Revised Draft of Renewable Energy Policy of Bangladesh*, Ministry of Energy and Mineral Resources, Government of the People's Republic of Bangladesh, 1999, prepared by the Power Cell.

1

Introduction

Background

1.1 Bangladesh has an agriculture-based economy with a population of more than 130 million people, of whom 80 percent (more than 100 million) live in rural areas. Electrification in these rural areas is vital to enhance economic development, improve the standard of living, and encourage children's education in the rural areas. About 80 percent of the urban households in Bangladesh have access to electricity but this is the case for only 15 percent of rural households.[12] Various constraints, [13] including dispersal of much of the rural population among offshore islands, hampers electrification coverage from increasing in the near or medium term. It would not be cost effective to extend conventional grid coverage to areas with low consumption density.

1.2 In this context, decentralized, off-grid electrification has a significant role to play in rural economic development in Bangladesh. There are three types of rural consumers for off-grid electrification services: (1) small shops in rural markets, (2) rural households, and (3) small entrepreneurs and industries. Providers of off-grid electrification include private entrepreneurs, local nongovernmental organizations (NGOs), private cooperatives, and the Rural Electrification Cooperative or Palli Bidyut Samities (PBSs).

1.3 Three off-grid service options are currently available for expanding electrification in rural Bangladesh:

1. central battery charging stations (BCSs),
2. diesel-powered microgrid services, and
3. solar home systems (SHSs).

1.4 The first two types of services are popular and available. They are used on a limited scale and offered by private entrepreneurs. Households use BCS services mainly to run televisions and radio-cassette players because direct current (DC) lamps are

[12] . World Bank and Asian Development Bank 2002, Bangladesh Public Expenditure Review.

[13] As a result of low energy consumption among the rural households, new rural electrification projects fail to qualify for grid expansion in the absence of significant commercial, industrial, or irrigation loads.

usually not available for household lighting. Some households located close to rural markets are being served by microgrids and enjoy the convenience of standard, alternating current (AC) lighting.

1.5 The third type of service, SHSs, is limited to only a very few locations because the initial cost is high and only a few agencies are providing these services. A recent study[14] of potential alternatives for off-grid electrification found that SHSs using renewable energy could be a promising means of lighting in rural households. Bangladesh has already gained some experience in recent years with solar systems, such as Grameen Shakti and the Bangladesh Rural Advancement Committee (BRAC) in the nongovernmental sector, which are gaining popularity among rural households of higher income. In the public sector, the Rural Electrification Board (REB) gained some experience—albeit with mixed results—by electrifying about 800 households on an island in the Narshingdi district.[15]

1.6 Cash or credit purchase of SHSs is not yet an affordable option for most middle- and lower-income households because of either the high initial investment required or lack of credit mechanisms. These options will require interest and commitment by financial institutions, as well as further design refinement, before they can be made affordable to rural households of all income groups. If SHS providers can offer suitable financing arrangements, it may popularize the use of solar panels for household battery charging and direct power applications. A recent study [16] sponsored by the World Bank found that about 500,000 rural households in Bangladesh would be willing to pay for and use SHSs, provided that SHSs and required equipment are available and that financial assistance, maintenance, and warranty services are in place.

The Potential for Women

1.7 Women are an effective force for economic development and they can play an important role in rural electrification as users and providers.[17] At present, opportunities for Bangladeshi women as energy service providers are extremely limited, and therefore the potential remains unfulfilled.[18] Yet rural women are a natural choice for such services as they represent the largest rural energy user of biomass fuel for daily cooking. Furthermore, the socioeconomic status of many rural women could be enhanced by increasing their opportunity and participation in alternative energy service delivery. This goal could be accomplished through appropriate training and modest funding support.

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[14] *Feasibility Study of Solar Home Systems Project within the Context of Alternative Options for Rural Electrification*, by Prokaushali Sangsad Ltd. (PSL) for the World Bank, March 2000.

[15] *Survey of Solar PV Applications in Rural Electrification: Narshingdi Solar PV Project*, by PSL, June 1998.

[16] *Market Assessment Survey of Solar PV Applications in Bangladesh*, by PSL, a World Bank report, July 1998.

[17] *Women and Energy, The International Network: Policies and Experience*, a resource guide by ESMAP.

[18] *Bangladesh Strategies for Enhancing the Role of Women in Economic Development*, a World Bank Country Study, 1992.

1.8 In a related matter, few professional women in Bangladesh have been encouraged to attain the necessary qualifications and skills to manage an energy services enterprise. Professional women are also usually urban based, with limited linkage with rural women and their needs. These shortcomings can be overcome by appropriate skill and organizational training and networking between professional and rural women. By networking and creating synergy among their activities, these women could assume leading roles in developing and using renewable energy technology (RET) alternatives.

ESMAP Involvement

1.9 In the context (a) that it is uneconomical to extend conventional grid coverage to areas with low consumption density, (b) that there is a need and willingness of Bangladesh's rural population to pay for off-grid electricity, and (c) that there is a need to create opportunities so that women can play significant roles in developing and operating the necessary infrastructure for such services, the Energy Sector Management Assistance Program (ESMAP), a joint program of the World Bank and the United Nations Development Programme (UNDP), has funded this project since October 1999. The project's title is Opportunity for Women in RET Use in Bangladesh. This project was implemented by Prokaushali Sangsad Limited (PSL) with technical guidance from the South Asia Environment and Social Development (SASES) and South Asia Energy and Infrastructure Sector (SASEI) of the World Bank.

Rationale

1.10 The rationale of the project is to assist poor people to use alternative or renewable energy technology efficiently to expand rural electrification. This project is intended to be a unique prototype, demonstrating how energy technology can act as an economic vehicle to enhance women's lives in developing countries.

Project Goals

1.11 The goal of the project is empowerment of poor women through technology transfer, networking, and development of a business model for community-driven off-grid energy systems. Specific objectives are (a) creating employment and income opportunities for poor women through microenterprise development and networking with professional women; (b) developing an expandable, replicable business model for community-driven off-grid service delivery; and (c) improving social inclusion and quality of life in remote, marginalized areas as part of poverty reduction efforts.

Implementation of the Project

1.12 The project is being implemented in two phases.

1.13 *Phase I:* This phase aimed to empower women in the unelectrified remote areas of Bangladesh and improve their quality of life through technology transfer and

energy service delivery. For the past two years, this pilot project—the first of its kind—has been operating in Char Montaz, one of the many islands off the south coast of Bangladesh. Bangladesh's national electricity grid is not expected to reach these coastal islands in the next 20 years. This project was initiated so that households in remote areas can have access to modern lighting at prices that are affordable to a significant percentage of the population, including the moderately poor. In this regard, the following initiatives were undertaken on Char Montaz:

- Baseline survey: A survey of 488 households was conducted to find out their energy usage pattern.
- Training: Thirty-five rural women were trained on DC lamp construction, quality control, business development, and marketing.
- Establishment of women's microenterprise: The 35 trained women formed a cooperative named "Coastal Electrification and Women's Development Microenterprise" (CEWDM). The microenterprise activities include assembly and sale of DC lamps. [19], [20]
- Capacity building among professional women: The project trained 33 professional women from 18 governmental organizations and NGOs on RET so that they can form a network with rural women and provide technical support.
- Institutional capacity building: A guideline for mainstreaming RET and gender issues in policy planning and to build awareness among government decisionmakers has been developed. It is envisioned that this project would provide a basis for expanding the scope of RET use through Bangladesh's Sixth Five-Year Plan. Volume II of this report contains guidelines for Bangladesh's government institutions on how to accelerate use of RETs and how to enhance women's participation.

1.14 *Phase II:* A second phase of the Char Montaz project is now under way. It aims to expand off-grid energy services in the coastal and other remote areas by making SHSs affordable to the poor households with the assistance and involvement of microfinance institutions and technological innovations. The activities include:

- expansion of a network to sell low-cost, off-grid lighting to rural markets situated on six additional islands; and

[19] DC lamps are efficient fluorescent lamps using DC batteries of 8 or 12 volts.

[20] The design of the DC lamp was completed outside the scope of this project by PSL and Energy Systems, with participation by Bangladesh University of Engineering and Technology (BUET). The lamp design has been made available to this women's microenterprise project.

- expansion of its SHS activity.

Organization of the Report

1.15 This report presents the activities, findings, and lessons of phase I of the project. Chapter 1 is the introduction, and chapter 2 presents the profile of Char Montaz and the survey results on the usage pattern of off-grid electrification in Char Montaz. Chapter 3 discusses the activities undertaken by the CEWDM, and chapter 4 consists of a description of the performance of those activities. Chapter 5 discusses the socioeconomic impact of the microenterprise operation, and chapter 6 discusses the growth potential, sustainability, and lessons learned from the microenterprise. Chapter 7 presents the training of women professionals on off-grid electrification. Finally, Chapter 8 summarizes the outcome and impact of the project and puts forward recommendations.

Photo by Drik Sameera
Visit of ESMAP manager, Dominique Lallement, to Char Montaz, November 2000.

2

Profile of Char Montaz and Its Demand for Off-Grid Electrification: A Survey Finding

2.1 The coastal islands, called chars, are distributed along the Bay of Bengal in the southern part of the country. These islands are at a higher risk of natural calamities such as cyclone, tidal waves, and so forth because of their geographic locations. Salinity of water limits the yield of agricultural production in these coastal regions, and fishing is the main source of earning for a population of nearly 1 million. Moreover, because of the dispersed nature of these islands, which are separated by large rivers, basic infrastructure development is difficult and costly. Land transportation is almost nonexistent in these regions, and the only means of communication is water transport. The general lack of infrastructure also prevents adequate public resource allocation to these coastal regions.

Socioeconomic Profile of Char Montaz

2.2 There are about 2,800 households in Char Montaz, which has a population of 18,000, almost equally divided between males and females. There are 13 primary schools, one of which is run by the government. There is only one high school and no government or private health facility.

2.3 Char Montaz is surrounded by an 18-foot embankment that protects the inhabitants from cyclone and tidal waves, a regular feature of the Bay of Bengal. It also protects the island from salinity intrusion, and as a result crop production has increased. After the embankment was built in the last decade, settlement on this island increased rapidly, but infrastructure is still lagging. There is no concrete or paved road, and there are no utility services.

2.4 Fishing is the main source of income for the Char Montaz population, along with some agricultural activities and trading, but the bay's proximity and salinity of water limit agriculture and water supply. Drinking water is collected from hand-pumped, deep-tube wells that are dispersed over the island, with an average density of one well per 100 persons. The nearest electrified city is Galachipa, headquarter of Golachipa Thana/Upazila, a 5 to 6 hour motor boat ride from Char Montaz, and the nearest health center with modern facilities (such as x-ray facilities) is located 8 to 10 hours away in

Patuakhali city, headquarter of Patuakhali district. More information on Char Montaz is provided in table 2.1.

2.5 Part of Galachipa Thana in Patuakhali district is an aggregation of scattered islands, including Char Montaz, lying outside the national grid service. Grid-based electrification of this area is not economically viable, at least not within the national plan for next 20 years. To avoid depriving the residents of these islands of modern electrification facilities, which are key factors for improved human development and economic growth, there is a need for off-grid electrification and the availability of DC lamps.

Table 2.1. Information on Char Montaz

Number of households	2,793
Population	Male, 6,805; female, 5,440; children, 5,735; total, ~ 18,000
Economic activity	Agriculture, fisheries, small trading, and other businesses
Per capita income	Tk1,483 (US$30)
Local government office	Union Parishad
Other government office	Forest Office
NGOs	Red Crescent, Association for Disaster Mitigation (ADMD) South Asia Partnership Bangladesh SAP-BD
Infrastructure	5 cyclone shelters
	1 high school
	1 *madrashah* (religious school)
	1 government primary school
	5 registered, nongovernment primary schools
	7 unregistered nongovernment primary schools
	178 deep-tube wells (~ 1 tube well per 100 persons)
	Sanitation: 62% have access to sanitary latrines

Survey in Char Montaz

2.6 A survey was conducted of Char Montaz to find out the usage pattern of off-grid electricity and potential demand for it. The survey was also intended to assess the potential market for DC lamps, as well as RETs using SHSs. The rationale of the survey was to design a demand-driven project that is reflective of the economic situation of the rural households. The survey size was 488 households drawn randomly (20 percent of Char Montaz households).

2.7 The survey shows that there is significant demand for modern lighting for the benefit of health, education, and economic and commercial activities, in addition to improved quality of life of the population. The poorest households (40 percent), which are earning less than Tk 2000 per month (US$50) and spending less than Tk50 (US$1) for lighting, will not be able to afford modern electrification. Poor and marginal households earning between Tk2000 and Tk4000 (US$50 and US$80) and spending nearly Tk100 (US$2) will be able to afford a 20-watt (20W) SHS with microfinance services. Households with incomes above Tk5000 (US$100) will be able to afford 35W SHS with cash or credit payment. This chapter details the characteristics of the consumers of Char Montaz and their potential demand for household lighting and SHSs.

Energy Usage Patterns of Rural Households by Income Level

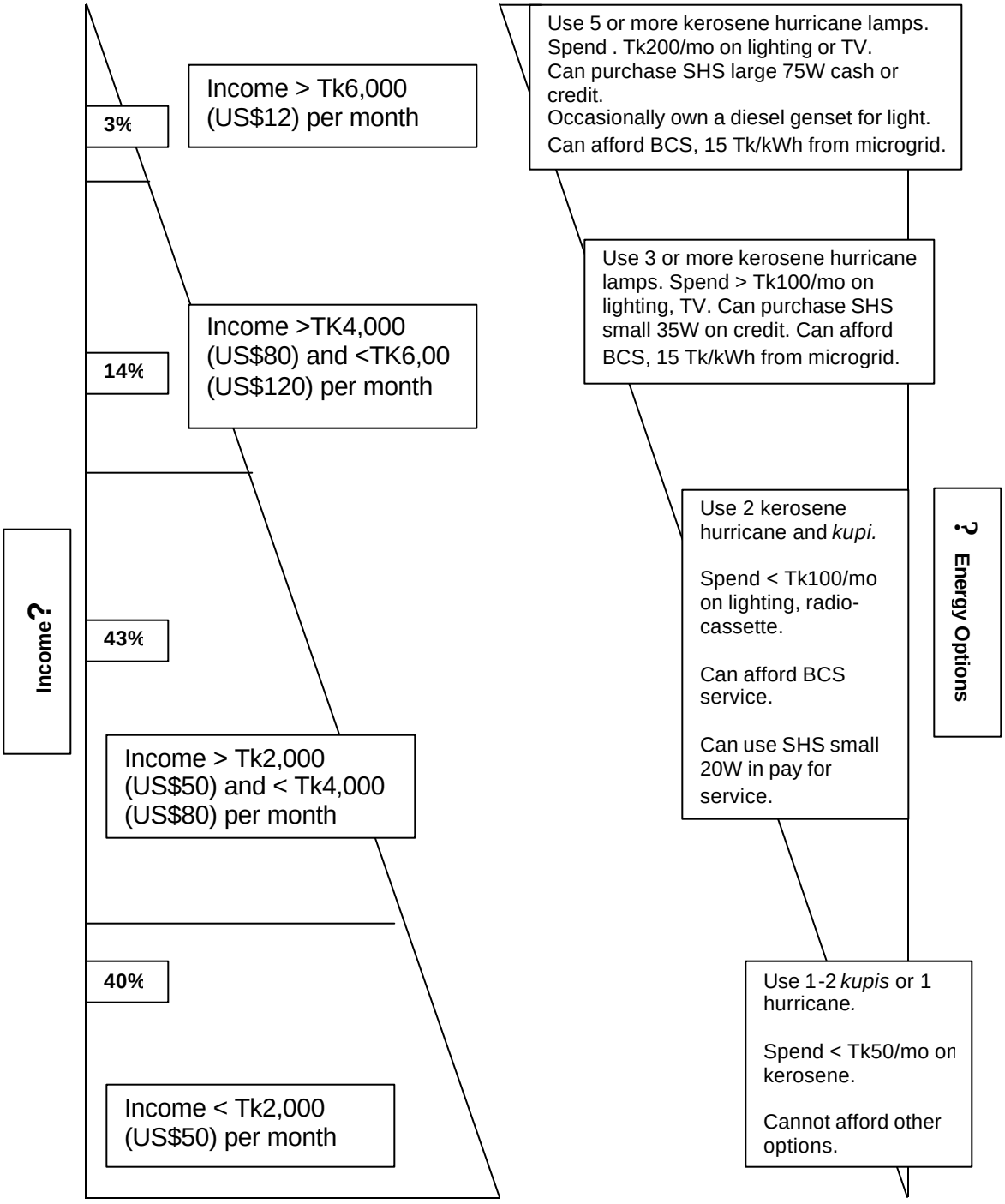
2.8 Figure 2.1 shows the distribution of electric lighting options as a function of household income. According to the survey, the highest income group encompasses only 3.4 percent of the households, whose monthly earnings generally exceed Tk6,000 (approximately US$120). Households in this income category could use battery-powered televisions and DC lamps. They also have the capacity to buy SHSs that cost between US$197 and US$560 with cash, or to spend Tk300 per month to lease SHSs, although they generally would prefer to own their systems.

2.9 According to the survey, 14 percent of the households have incomes between Tk4,000 and Tk6,000 per month (US$80–120). These households could afford to purchase solar systems with credit or pay a monthly leasing charge for a 35W SHS, large enough to provide power for four hours of lighting from two DC lamps and an equivalent amount of viewing on a black-and-white television. Households that do not own televisions are likely to use three DC lamps and a radio-cassette player.

2.10 The largest fraction of households, constituting 43 percent of the survey, earns more than Tk2000 but less than Tk4000 per month (US$40–80). These moderately poor and marginal households spend about Tk100 Taka per month on kerosene, which is used to light hurricane lamps, and on battery charging for radio-cassette players using small batteries. However, unless these households are located near a battery charging station, or are provided access to affordable SHSs, they probably will not use modern lighting.

2.11 Forty percent of the households—the poorest—earn less than Tk2,000 per month. This group cannot afford any of the above options and does not even use kerosene lamps. They use *kupis*, which are small cans of kerosene that illuminate by burning wicks inserted into them. Although the *kupis* cost less to purchase than kerosene lamps, they are relatively more costly to operate because the wicks provide inferior lighting. This confirms the fact that poorer households in rural Bangladesh spend more money for inferior lighting. This type of lighting increases indoor air pollution and has serious health costs to household members, and it is also a fire hazard.

Figure 2.1: Distribution of Energy Options for Lighting as a Function of Household Income in Rural Bangladesh



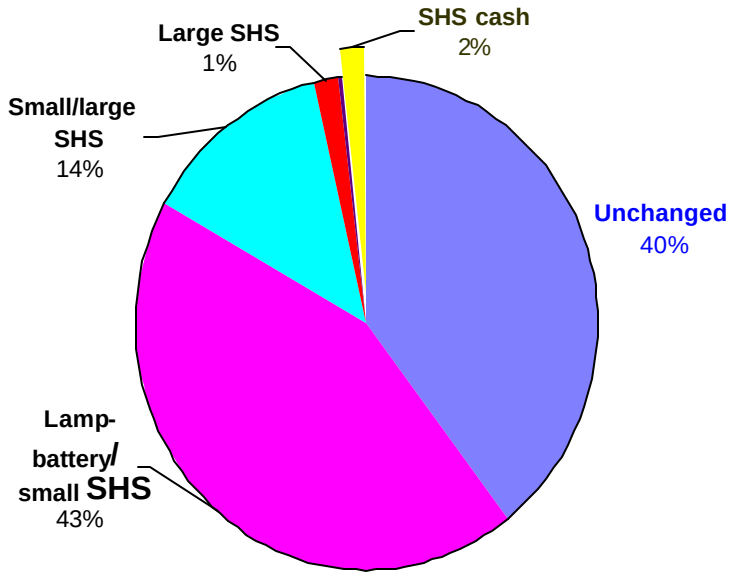
Potential Energy Usage Pattern of Rural Households

2.12 Nearly 47 percent of those surveyed expressed an interest in purchasing DC lamps. Forty-nine percent indicated a willingness to use batteries for household lighting. At present, however, the costs of the appliances and recharging services remain beyond the capability of lower-income households. In addition, residents of remote rural areas are unwilling to accept the inconvenience or pay for the transport of batteries to and from a BCS. Hence they may be better served by affordable SHSs.

2.13 The survey reveals that 85 percent of the respondents have heard about the solar systems. In addition, they said they would be willing to use SHSs for lighting their houses. The main reason for preferring SHSs was to avoid the inconvenience of battery transport for recharging. Only 9 percent indicated that they would not be interested.

2.14 However, in terms of affordability and purchase method of the SHSs (Figure 2.2), the survey reveals that nearly 60 percent of respondent households would be willing to lease a 20W SHS for a monthly fee of Tk160 (US$3). This 60 percent consists of (a) 3 percent of the households that are capable of purchasing SHSs, which cost between US$197 and US$560, with cash; and (b) 57 percent of households that could purchase SHSs with credit. Of the total households surveyed, the remaining 40 percent could not afford the cost of SHSs without either direct subsidies or the opportunity to lease or purchase in small installments.

Figure 2.2: Distribution of Potential Consumers of SHSs



3

Coastal Electrification and Women's Development Microenterprise (CEWDM)

Background

3.1 A major objective of the ongoing project at Char Montaz has been economic empowerment of women through technology transfer and capacity enhancement. Women have always been perceived as passive beneficiaries of services, but not as managers and providers of energy services outside households. The project began a gender mainstreaming approach, which would break down rigidly defined, gender-based division of labor; make women providers of modern energy services; and make them important decisionmakers in the development process. Given the general lack of business experience among the women, it was decided to establish a women's microenterprise for electricity services delivery at Char Montaz, instead of individually operated businesses, to capitalize on the efficiency of group instruction and operation. This women's microenterprise at Char Montaz is named Coastal Electrification and Women's Development Microenterprise (CEWDM) and it is enjoying organizational and financial success through its various activities. ESMAP's significant contribution to this women's microenterprise has been training in the manufacture of DC lamps and the operation of microgrid electrification.

3.2 The CEWDM is undertaking a demand-driven approach in providing off-grid electrification in the Char Montaz area. Its preparation is based on certain observations pertaining to current energy usage patterns found from the survey described in chapter 2:

- Many households in this area already own radios, televisions, or other appliances using rechargeable automotive batteries. Availability of DC lighting will encourage them to shift toward modern lighting.

- Rural households will also be favorably motivated to use DC lamps with batteries for lighting if the products are locally manufactured and readily available in the villages.
- Satisfactory operation of the DC lamps will require affordable and reliable battery charging stations (BCSs)
- Clustered shops in unelectrified rural markets are suitable candidates for diesel-powered microgrid services. Households near rural markets can also avail themselves of such services if rates are affordable.

Licensing of the Microenterprise

3.3 The microenterprise for women has received formal registration with the Ministry of Women and Children Affairs and has received a local trade license from the Union Parishad office of Char Montaz.

Microenterprise Operations

3.4 Thirty-five women of Char Montaz were trained and formed a cooperative with a written constitution. The cooperative has selected a five-member management committee to operate the CEWDM. The constitution also calls for an advisory body to be established. Representatives from the cooperative, local businesses, the community, and the local government will compose its membership. (see annex D, figure D.1).

3.5 All financial transactions are handled by the management committee through the local bank in Galachipa Upazilla. The commercial banks are currently not in a position to extend credit to the business of rural electrification, and the microenterprise is seeking capital financing from varied sources, including loans from development banks.

3.6 Trained technicians from PSL continue to assist the cooperative with maintenance services and marketing. There is also an emphasis on involving the husbands in support services, marketing, and sales. The women are encouraged to bring their husbands to the monthly meetings to discuss business matters, which facilitated change in gender-based roles and enhanced gender equality in sharing information and decisionmaking.

Activities of the CEWDM

3.7 The core activity of the CEWDM is to construct and sell DC lamps as an essential component of off-grid home electrification. This microenterprise is a local organization and offers easy access to its services; hence it has been well received as a provider of energy services. The microenterprise has also established a diesel-powered BCS in the vicinity of the market in Char Montaz, creating a convenient location for

recharging DC batteries. The charging station is owned by the CEWDM and is operated with technical supervision. To expand and diversify its energy service activities, the CEWDM has also established a diesel-powered microgrid serving the central markets of nearby Char Bestin and Char Rangabali.

3.8 The current list of activities of CEWDM includes:

- manufacture and sale of DC lamps in the Char Montaz factory;
- sale and extension of microcredit for DC battery sales;
- operation of BCSs on Char Montaz, Char Rangabali, and Char Bestin;
- operation of diesel-powered microgrids for market and household electrification on Char Montaz, Char Bestin, and Char Rangabali; and
- development of SHS systems for dispersed households.

3.9 Further background on the business development plans of the CEWDM is given in Appendix A.

Training

3.10 The concept of decentralized and off-grid electrification for household lighting was something new to this region. Therefore, information dissemination and training in both the technology and specific business management had to be undertaken. PSL conducted an information and demonstration campaign of DC and SHS in the markets and community of coastal islands (see table A.3 in annex A). During these campaigns, women were requested to apply for training. About 300 women applied, and 35 were selected through written and verbal tests. The selected women were married, within the age bracket of 25 to 40 years, and had between grade 3 and grade 8 education. Furthermore, some had already gained experience in microfinance activities from NGOs. At the beginning of the project, these 35 rural women were trained to undertake and manage the microenterprise's various activities. They were provided with training for manufacturing DC lamps, as well as training for business and marketing of DC lamps.

Technical Training for Manufacturing DC Lamps

3.11 The participants' technical training in DC lamp assembly began on Char Montaz on December 1, 1999. Trainees were taught how to identify electronic components and tools, prepare the printed circuit boards (PCBs), and conduct quality control and product testing. They received in-class instruction on DC lamp assembly, accompanied by hands-on training with hardware. The women were taught the role of the electronic components in an integrated electronic circuit and its operation. Their training was supplemented with posters illustrating the lamp components. For the first time, the women were exposed to tools, electronic components, meters, and soldering irons. Each participant was assigned a set of appropriate tools in a tool bag, individually identified by

her name and stored on the factory premises. Trainees were supplied with a user's booklet identifying the tools and illustrating their functions with sketches. Written procedures, with some technical background, were also provided for individual reference. The women had to pass a written and practical test to ensure that their technical skills were adequate to handle reliable manufacturing of the DC lamps.

3.12 The women learned the use of printed screens, chemical etching, and electric drills to prepare the PCBs. Sample test boards were also provided for quality control and testing.

Business and Marketing Training for DC Lamp Sales

3.13 Training in business operations and marketing began in April 2000. The program included developing marketing plans, interacting with customers, identifying target markets, locating competition, and estimating demand. Extensive training in accounting and bookkeeping began in June 2000 for the group leaders of the production facility. A series of 28 lectures, beginning in September 2000, gradually introduced the women to other business operations. As a result, today the members of the CEWDM are able to manage daily balance sheets covering production, sales, and factory overhead with minimum supervision from PSL.

Manufacturing and Marketing Operations of DC Lamps

Manufacturing DC Lamps

3.14 The DC lamp manufacturing facility is limited to the 35 technically trained women. Each receives a labor fee of Tk50 (US$1) for each lamp manufactured. The manufacturing facility for the DC lamps is a rental space from a local NGO, where a 3 kilowatt (kW) generator is used for lighting and to power soldering and drilling operations. At present, the CEWDM has developed the capacity to manufacture nearly 600 lamps per month. Lamp designs include 6W, 8W, and 10W versions, compatible with 8-volt (8V) and 12V batteries. The completed lamps are stored at the BCS or taken to regional sales centers when needed.

Marketing Strategy for DC Lamps

3.15 Within Char Montaz, DC lamps are sold in three ways: (1) from the central BCS, which also serves as the major outlet center; (2) by direct sales from the members of the CEWDM; and (3) from 17 retailers selling the lamps at various locations on other islands. All the CEWDM members are encouraged to market the lamps and batteries individually and without limit. The women can earn a sales commission of Tk30 per lamp sold. In addition, five women act as independent marketing agents within their village communities, which are located within five-kilometer radius of the BCS. They have been successful in using public transportation to send orders and receive batteries and lamps at their locations, eliminating the need to travel back and forth to the BCS.

Cost Structure

3.16 The cost structure of a DC lamp is shown in table 3.1.

Table 3.1: Cost Structure of 6W, 8W, and 10W DC Lamps of 8 and 12V

Cost	Tk295
Materials	Tk225
Labor	Tk50
Overhead and transport	Tk15
Savings	Tk5
Price at BCS outlet	Tk325
Profit	Tk30

Price Comparison

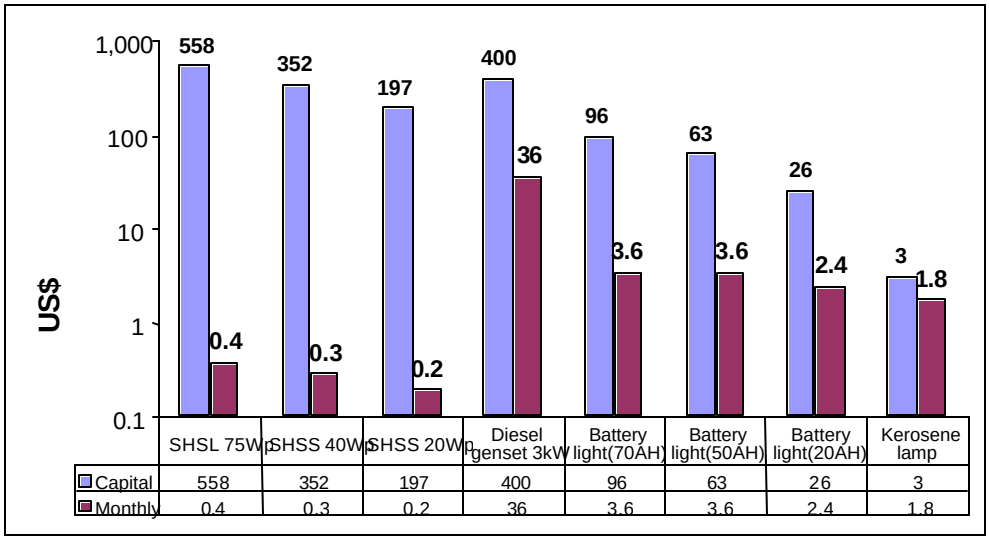
3.17 The CEWDM's basic strategy for improving rural household lighting is to sell DC lamps to replace existing kerosene lamps and kupis. However, these traditional devices have been used in rural homes for generations. Marketing efforts must anticipate this practice and motivate potential customers toward the advantages of replacement. A comparison of DC lamps made by the CEWDM with kerosene lamps is shown in table 3.2.

Table 3.2: Cost and Performance Comparison: DC Lamp vs. Kerosene Lamp

Type	*Capital cost, Tk (US$)*	*Operating cost for 20 hours of service*	*Light output, lumens per watt*
Kerosene hurricane	150 (US$3)	Tk15 (US$0.30)	0.02–0.05
DC lamp and battery	1,325 (US$26.50)	Tk20 (US$0.40)	20–35

3.18 Although the quality of the light from a DC lamp is attractive, and environmental improvement of the household is measurable, long discussions are needed at each marketing session to persuade potential customers to adopt this modern product. The price of a DC lamp is Tk325 (US$6.50). Total investment, including the smallest battery (with 20 hours of service capacity), is Tk1,325 (US$26.50), with a monthly expenditure of Tk120 (US$2.40) for charging.

Figure 3.1: Cost of Energy for Lighting (for Four Hours of Service Daily)



3.19 The price of similar DC lamps that are produced elsewhere in Bangladesh or imported into the country range from Tk450 to 950 (US$9–19), with 80 percent of the products priced above Tk500. The microenterprise produces the DC lamps at Tk325 without any subsidy. Therefore, the Char Montaz CEWDM is producing lamps at a highly competitive price against locally available products (table A.1, annex A). Moreover, many of the brands available in other parts of the country are unavailable in coastal islands, and even if they were shipped to the island, they would cost more than the Tk325 DC lamp of produced by the CEWDM.

3.20 More details on marketing the DC lamps can be found in table A.2 of annex A. Specific marketing demonstrations of the lamps in various locations are described in table A.3 of annex A.

Battery Charging Station (BCS) Operations

3.21 The use of DC Lamps for household lighting is strongly dependent on the availability of a reliable BCS, but there were no BCS providers on Char Montaz, and the local battery users had to carry batteries to the Galachipa town center—a six-hour motor boat ride away. Therefore, the CEWDM established a BCS on Char Montaz for improved access in the remote area, and it began operating soon after the beginning of the project.

3.22 This BCS serves all of Char Montaz and its surrounding area as a profitable business venture. In addition to charging batteries, the BCS is the major sales outlet for the DC lamps manufactured by the microenterprise.

3.23 The activities of the BCS include

- selling DC lamps,
- selling batteries,
- providing battery charging services by use of a diesel generator,
- leasing batteries for DC lamps, and
- selling other electrical items, such as cables, switches, and spare parts, and demonstrating and selling SHSs to potential customers.

Market

3.24 The target market for the BCS includes both households and businesses that are willing and able to spend between Tk100 and Tk150 (US$2.00 and US$3.00) per month for battery charging. These potential consumers are currently spending Tk75 (US$1.50) per month or more on kerosene for lighting. Previously, batteries were used by only some of the households on Char Montaz for watching television and listening to radio-cassette players; however, the manufacture of DC lamps has encouraged many households to use batteries for lighting.

3.25 The newly built and well-managed BCS in Char Montaz has made battery charging a convenient activity for both the residents and the fishing community. A significant number of BCS customers are fishing trawlers that carry batteries to power their radios. Adequate battery charging services are not yet available on most of the other islands where DC lamps are being marketed.

3.26 In view of this potential demand, the women's microenterprise has co-invested in another diesel BCS at Rangabali island, which is operated by a private entrepreneur but owned by the women's microenterprise. PSL has provided technical training to the co-investor to ensure proper recharging procedures and good performance of the DC lamps served by the facility. The CEWDM also owns a new BCS in Char Bestin. These BCSs also serve as sales outlet for the DC lamps.

Pricing Strategy

3.27 A comparison between the price charged by the CEWDM for battery recharge and that charged by other providers is required to see the competitiveness of its operation. In and around the islands of Char Montaz, there are no BCS providers that use a diesel generator, but there are BCS providers using different power sources in the Galachipa town center—again, a six-hour motor boat ride away.

3.28 The cost of the BCS services from the CEWDM is Tk10 per kilowatt hour (kWh), equivalent to US$0.20/kWh. Where grid electricity is available, the commercial rate is Tk4.5/kWh (US$0.09/kWh) if connected to the Palli Bidyut Samity (PBS) grid or Tk2/kWh (US$0.04/kWh) if connected to the Power Development Board (PDB) grid.

3.29 At a first glance, the BCS services run by the CEWDM would appear to be more expensive. However, the time and inconvenience of transporting the batteries to the Galachipa town center must be added to the cost of the electricity. The rates for battery charging can become quite expensive as the distance from the grid service increases. Therefore, the price of BCS service on the islands is dictated by the availability of alternatives for battery charging at the nearest locations with grid supply.

Microgrid Operations

3.30 The newest activity of the CEWDM is the operation of a diesel-powered microgrid service on Char Montaz and Rangabali. The women's microenterprise provides this service to three distinct groups of consumers in Char Montaz:

1. 24 shops-cum-residences that are permanently located in a close cluster,
2. 3 other households, located near this clustered area, who are regular customers for electrification; and
3. 70 temporary shops in the weekly market.

3.31 The total area covered by the service grid is about 0.5 square kilometer. The daily tariffs for 4.5 hours of evening lighting for the three groups have been designed to subsidize household customers. The daily tariffs are, respectively, Tk3 for the households, Tk5 for the permanent shops, and Tk10 for the weekly shops. The local market committee collects payments from the shop owners on behalf of the microenterprise.

SHS Operations

3.32 On a smaller scale, the cooperative has undertaken its SHS sale operation. So far, it has been able to sell five SHSs.

4

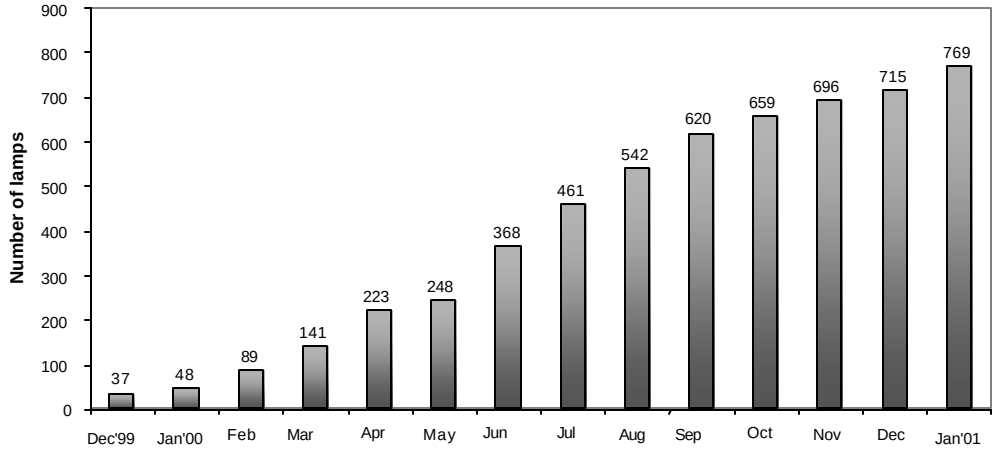
Performance of the CEWDM

4.1 The major contribution of the CEWDM is making low-cost, off-grid electrification available to the community. The provision of services includes training of women, construction and sale of DC lamps and batteries, and a diesel-powered microgrid. Income from all the activities—sales of DC lamps, sales and rentals of batteries, sales of BCS and microgrid services, and sales of other household electrical accessories (switches, lamps, wires and cables, and so forth)—make the enterprise viable. This chapter will focus on the performance of the CEWDM after 14 months in business.

Sales of DC Lamps

4.2 The CEWDM has increased its sale of DC lamps by 20-fold within its first year of operation. In this regard, the members have achieved remarkable sales performance. Lamp sales by the CEWDM over the year of its operation are shown in figure 4.1.

Figure 4.1 Cumulative Number of Lamps Sold



4.3 The lack of convenient transportation and communication services presents challenges for the lamp marketers. For example, collection of funds from retailers on the different islands creates a time lag; hence, actual sales per month may not be accurately reflected in the sales revenues shown in figure 4.2.

4.4 The women's microenterprise makes a profit of Tk30 for each DC lamp sold from the BCS outlet. Funds from the sale of the lamps are allocated into separate accounts to cover production cost components. Table 4.1 shows the amount per lamp allocated to each category, based on sales from the BCS.

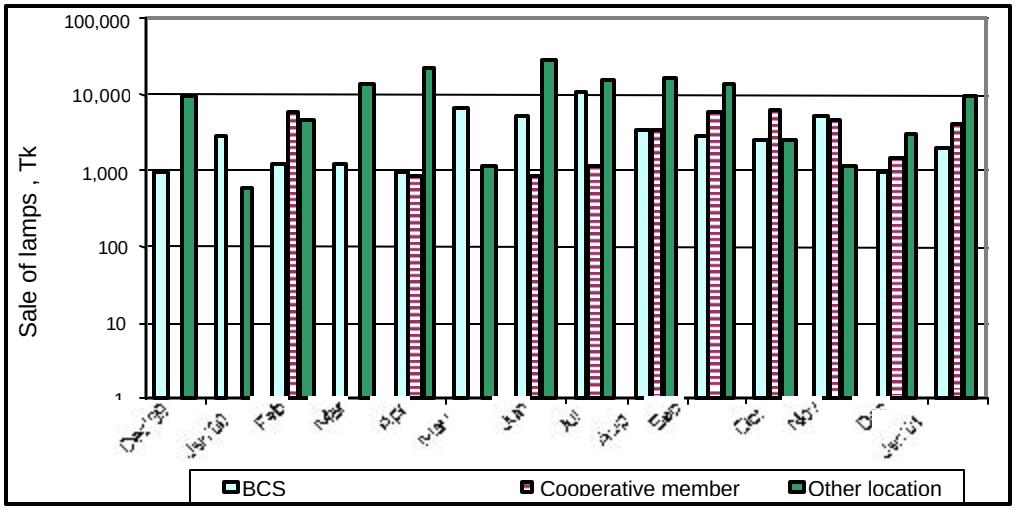
Table 4.1: Allocations of Funds from Sale of DC Lamps

	Product cost breakdown for DC lamps (Tk)						
Description (e.g., watts, voltage)	*Sale price of lamp*	*Materials cost*	*Labor cost*	*Overhead and transport cost*	*Savings*	*Ex-factory price*	*Profit from selling at BCS outlet*
6W, 8W, 10W lamps (8 & 12V)	325	225	50	15	5	295	30
Funds to be deposited into →		Lamp material revolving fund		Labor cost fund	Overhead cost fund (transport and overhead)		Coop growth fund
Sale price of lamp 325		225		50	15		=35 depending on point of sale

Performance of the DC Lamp Sales Network

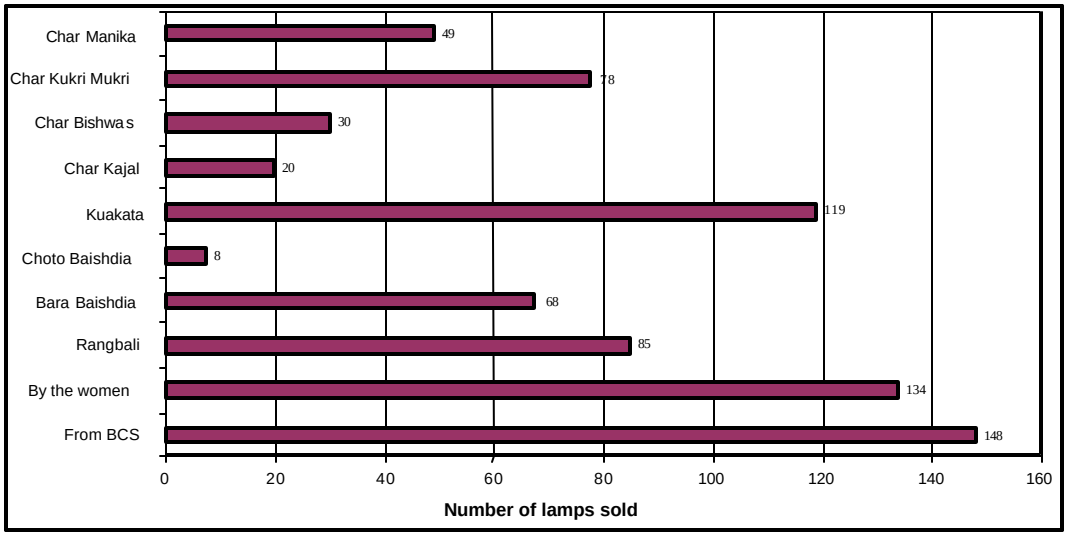
4.5 As discussed in chapter 3, in Char Montaz, sales of DC lamps are accomplished through sales in the BCSs, direct sales by members of the women's microenterprise, and sales by 17 retailers at various locations on different islands. Cumulative lamp sales from retailers located on the different islands have exceeded the sale volume in Char Montaz, as shown in figure 4.3.

Figure 4.3: Monthly Sales Distributions of DC Lamps in Various Locations



4.6 Sales at different retail centers vary considerably, as shown in figure 4.4. This is an indicator of the market distribution and marketing success at the various locations. However, the manufacturing capacity of the microenterprise remains much larger than the volume of sales. Therefore, there is still a significant opportunity for business growth by extending lamp sales to other locations beyond Golachipa Thana. Efforts must be made to create more sales outlets in Patuakhali district and the adjacent Barisal division, which consists of many unelectrified islands and coastal region.

Figure 4.4: Sales of DC Lamps from Various Sales Outlets

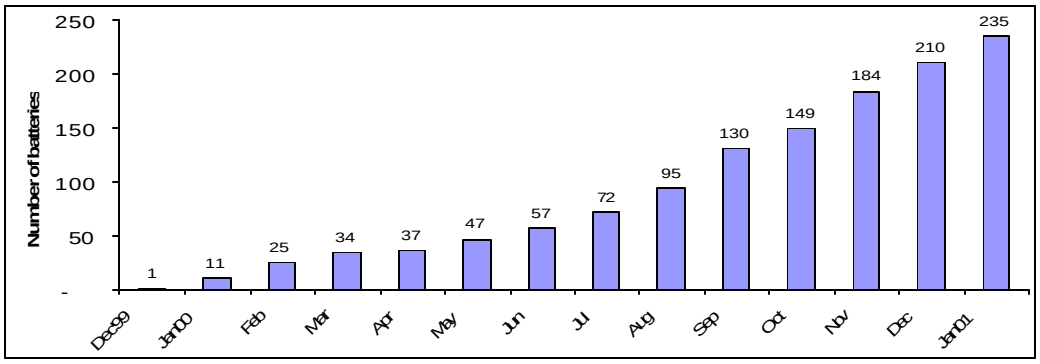


Battery Sales

4.7 Members of the CEWDM are selling batteries of different sizes and voltages, both independently and at the BCS. A few batteries are also sold from other sales centers on behalf of the microenterprise. Figure 4.5 shows cumulative sales of batteries by all sources. Different sizes of batteries are bought from retailers and sold at 15 percent profit. To make maintenance services available locally, CEWDM members were trained in battery assembly. At present, the CEWDM procures parts and assembles batteries in Char Montaz. The microenterprise also provides battery maintenance services to all the islands in their region.

4.8 Over 14 months, the CEWDM's sale of batteries has increased rapidly, and its performance in this regard is remarkable. Two factors may have contributed to this large battery sale: the provision of microcredit for battery sales (Of the 235 batteries sold, 120 were sold through microcredit. The microenterprise provided the credit at their own risk and achieved a 98 percent recovery of funds—a noteworthy success.) and the availability of a nearby BCS.

Figure 4.5: Cumulative Number of Batteries Sold

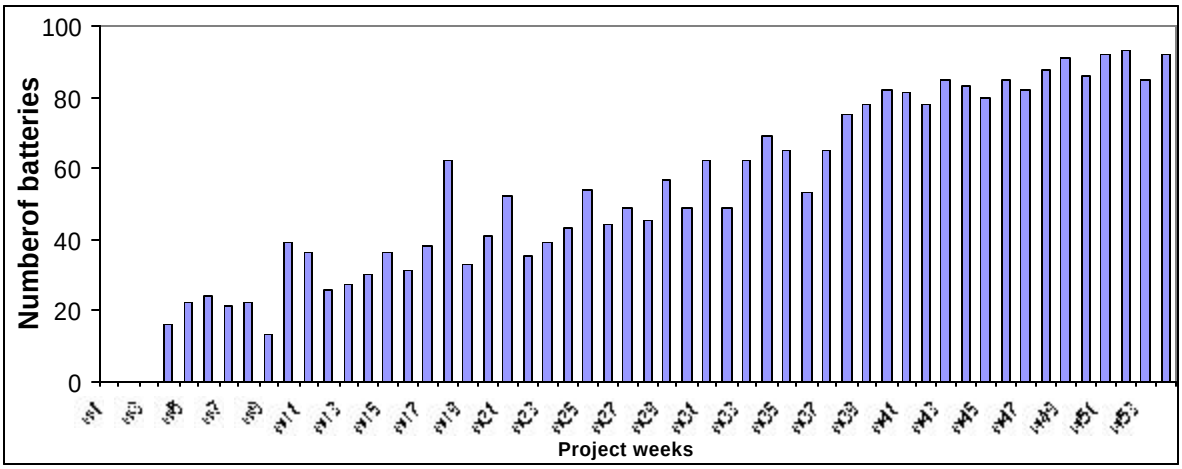


Battery Charging Service

4.9 The cycle time for returning discharged batteries to the BCS varies, depending on end use and battery capacity. For example, households using a 20 ampere hour (AH) , 8V battery for a single DC lamp usually return after 20 hours of lighting service (every five or six days, on average). The BCS fee is Tk20[21] (US$0.40) per charge. Households using larger, 50AH, 12V batteries tend also to use multiple lamps and television and hence spend approximately Tk200 (US$4.00) per month on charging.

[21] With the recent rise in diesel prices, the battery-charging fee has been increased.

Figure 4.6: Number of Batteries Charged per Week by the BCS

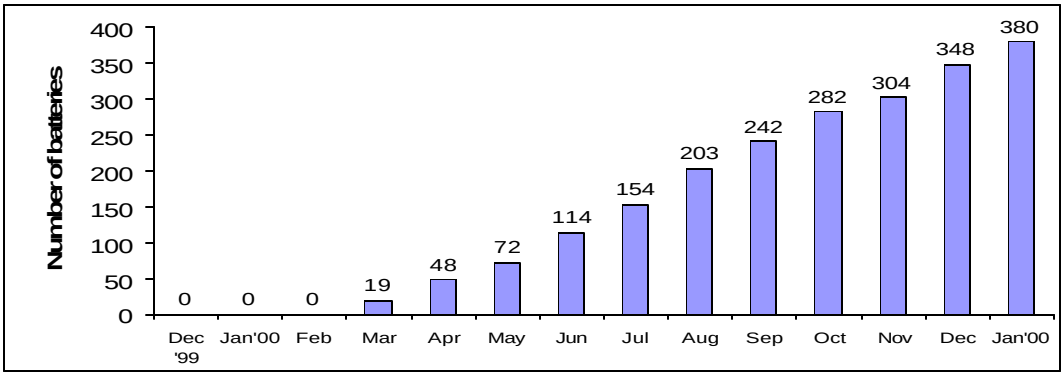


4.10 Figure 4.6 shows the number of batteries charged by the BCS per week, which has slowly increased over time. Clients for the BCS include owners of batteries purchased from the microenterprise, battery users from nearby islands, and boat owners who power their radios with batteries.

Battery Leasing Service

4.11 Leasing batteries on an hourly, daily, and weekly basis is a demand-driven operation that has evolved during the course of this project's implementation. It has become a strong supplement to the battery-charging business on Char Montaz. Figure 4.7 shows the cumulative number of batteries leased by the CEWDM since leasing began in March 2000, only two months after the BCS began operation. Battery leasing has become a valuable service to residents in the lowest income sectors.

Figure 4.7: Cumulative Number of Batteries Leased from the BCS



BCS User Survey

4.12 The batteries charged at the charging station are used to power DC lamps, radio-cassette players, and televisions. A survey was conducted at the BCS to find out the customers' purposes for using BCS services. The sample size of the survey was 120. Figure 4.8 shows that the breakdown, according to the survey, is 37 percent for lamps, 54 percent for radio-cassette players, and 9 percent for televisions. The majority of radio and DC lamp users recharge 8V batteries. Most television users recharge 12V batteries, which are also used for lighting.

Figure 4.8: DC Appliances Used with Batteries Recharged at the BCS

(Sample Size: 120)

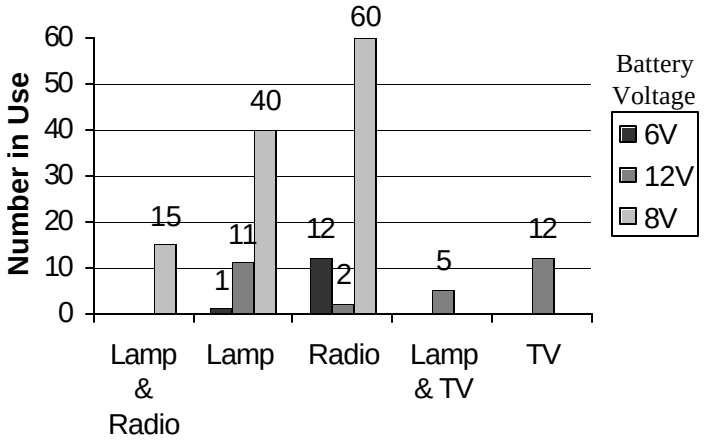
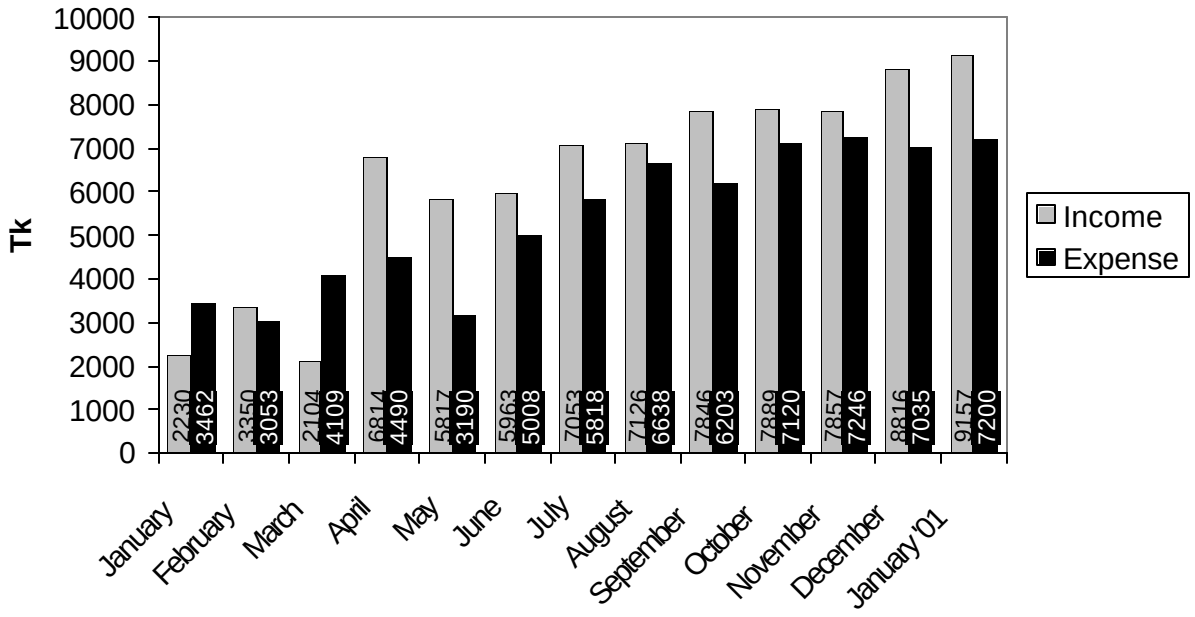


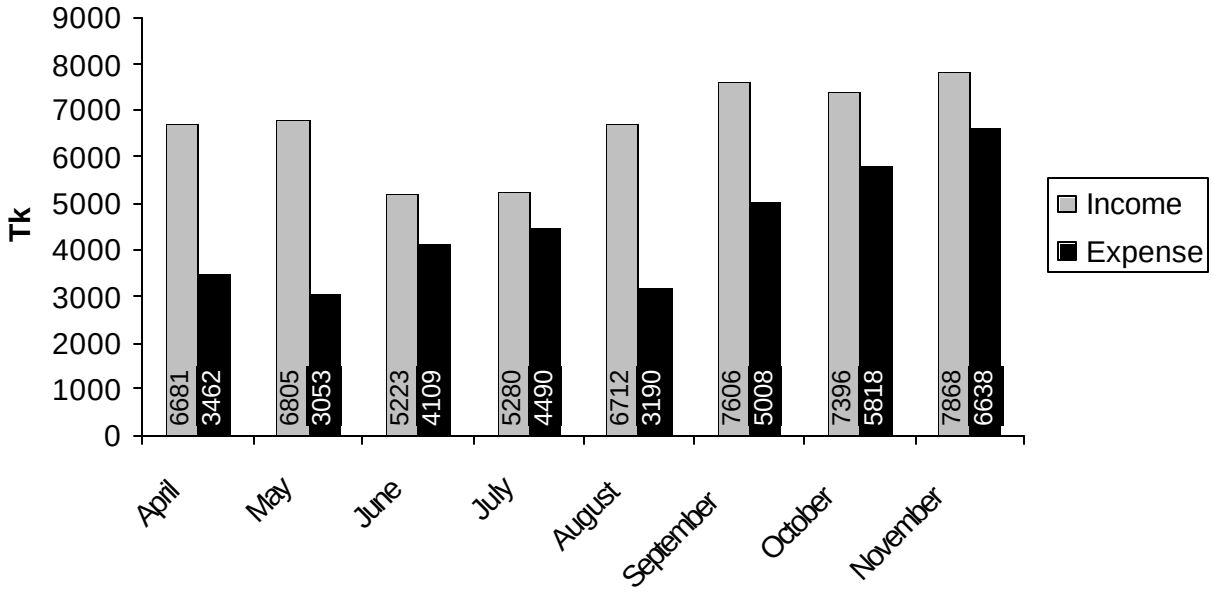
Figure 4.9 Financial Performance of the BCS at Char Montaz



BCS Financial Performance

4.13 Financial performance of the BCS is related to the cumulative performance of all its activities, including business development and training. Within its first three months of operation, the Char Montaz BCS had reached its break-even level. It is expected to begin capital recovery soon. However, there has been a large variation in monthly receipts for the business.

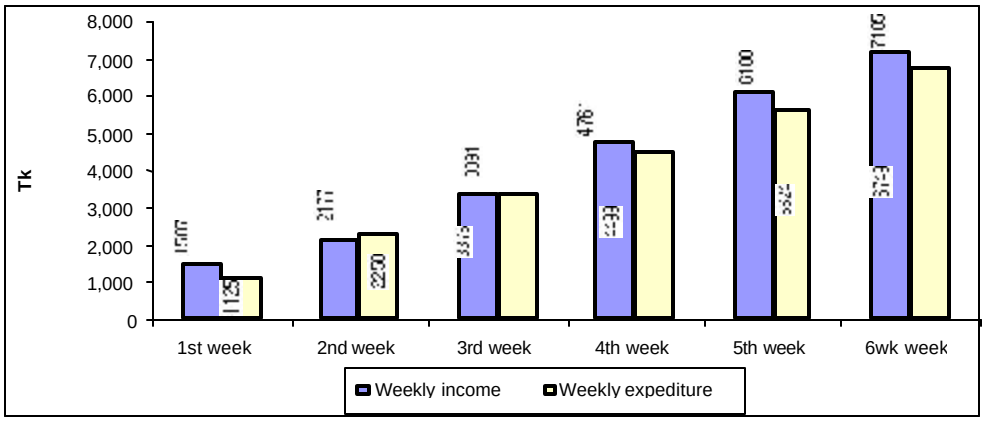
Figure 4.10: Financial Performance of the BCS in Char Rangabali



Performance of the Microgrid in Char Bestin

4.14 The operation of a diesel-powered microgrid service is a new activity for the CEWDM. Figure 4.11 shows its weekly income and expenditures. This service has made a significant impact on the commercial activities of the weekly markets. However, further impact on the households in the vicinity will require attention to safety standards for distribution lines through the public area, additional funds to create the necessary infrastructure, and sufficient demand from surrounding households willing and able to pay higher rates to cover the associated costs. There is also the possibility, given sufficient capital, that the power generation system can be converted into either a diesel-wind hybrid or solar photovoltaic (PV).

Figure 4.11: Financial Performance of the Microgrid Service in Char Bestin



Overall Financial Performance of the CEWDM

4.15 An income and expenditure analysis and a balance sheet of the microenterprise are shown in table 4.2 and table 4.3, respectively. Over the last 14 months, the CEWDM has had a direct operational loss of Tk81,536 (US$1630). If fixed cost and technical support from PSL are added, the total deficit becomes Tk688,385 (US$13,770). Without increasing assets further, the enterprise expects to achieve an operational break-even point in the second year. (This is discussed further in chapter 5.) Although income from lamp sales alone cannot keep the enterprise viable, other energy source activities have generated additional income, including sales and rentals of batteries, sales of BCS and microgrid services, and sales of other household electrical accessories (switches, lamps, wires and cables, and so forth).

Table 4.2: Income Statement, December 1999–February 2001

Revenue	*Tk*
Sales of solar homes	68,000
Cash receivable from sale of solar homes	19,000
Sales of lamps	107,742
Sales of batteries	229,915
Cash receivable from sale of batteries	114,910
Sales of electrical goods	30,692
AC line rental	21,151
Income from Montaz BCS	68,054
Income from Rangabali BCS	34,825

Battery and lamp rental	14,450
Total revenue	**708,739**
Direct operating expenses	
Lamp components	70,163
Batteries	301,112
Electrical goods	17,999
Purchase of SHSs	85,726
Direct workshop expenses (labor for lamp making, rent, and other related expenses)	131,163
Transport and labor	26,191
Expenses at Montaz BCS	127,228
Expenses at Rangabali BCS	30,713
Total direct operating expenses	**790,295**
Direct operating deficit	**81,556**
Fixed costs and technical assistance	
General office expenses (printing, publicity, and other miscellaneous office expenses)	12,314
Expenses at the site	117,533
Marketing expenses	121,633
Staff salary	116,000
Local travel expenses	55,587
Training expenses	80,000
Depreciation on assets	53,944
Other expenses	49,818
Total, fixed costs and technical assistance	**606,829**
Total surplus/deficit	**(688,385)**

Table 4.3. Women's DC Lamp Enterprise Balance Sheet as of February 2001

Assets (Tk)		*Liabilities and funds (Tk)*	
Current assets		*Total current liabilities*	-
Cash and bank balance	599,106		
Stock of lamp and lamp components	384,817		
Batteries in stock	62,750		
Accounts receivable	133,910		
SHSs	41,000		
Total current assets	1,221,583		
Fixed assets		*Total long-term debt*	-
Assets for workshop premises	108,329		
Assets for Montaz BCS	151,597	Members' equity	5,600
Assets for Rangabali BCS	43,773	Grant from World Bank	2,300,000
Microgrid (generator, space, grid line)	80,744	Less deficit	688,385
Vehicles (4 bicycles)	11,189		
Total fixed assets	395,632		
Total assets	1,617,215	*Total equity*	1,617,215

5

Impact of the CEWDM

5.1 Although conducted on a limited scale, this project has had a significant impact on the CEWDM members and residents of coastal islands. Today, about 1,000 households (or 6,000 beneficiaries) are using the DC lamps produced and sold by the women, and the market is increasing. The women members of the CEWDM have learned technical skills, and they have been able to generate income. They are playing a role in decentralized energy service delivery, which is helping to transform the local economy and promote social transformation. The CEWDM has created forward and backward linkages. For example, before this project began, there was no mechanized transportation except boats. However, the CEWDM created demand for battery charging and, as a result, entrepreneurs introduced rickshaw vans to transport batteries for charging; which generated both employment and income for the community. Local government is rehabilitating local roads, thus transportation has improved. The CEWDM has also helped to improve household environments with better lighting and cleaner indoor air. Finally, the women members have enhanced their own socioeconomic status and become role models for other women in their community. To obtain qualitative and quantitative information on the impact of the CEWDM operation, a small survey was recently conducted. The findings are discussed in this chapter.

Skill Development

Technical Skill Level 1

5.2 Successful operation of the CEWDM required that its women members learn technical skills—something quite unusual for the rural women of Bangladesh. However, such skills have been achieved, most of them involving tasks necessary to manufacture DC lamps, such as PCB production, final lamp assembly, and quality control. Other skills acquired by the women include identifying components, using electronic tools, chemical etching, soldering, wiring, and using power drills.

Technical Skill Level 2

5.3 The women have also attained skills necessary to demonstrate the operation of the products they manufacture, such as using batteries to power the DC

lamps. This helps them to market lamps and batteries to potential customers. They are familiar with the sizes and applications of the batteries, and they can instruct customers on appliance use and safety.

Technical Skill Level 3

5.4 CEWDM members are now familiar with the hardware associated with the three diesel generators they own and operate. The generators are used for the BCS, drilling operations in the DC lamp factory, and powering the microgrid. Microenterprise members are responsible for the operation and maintenance requirements, performance limitations, and financial requirements of the engines.

Operational Skill

5.5 The women conduct all the day-to-day operations of the microenterprise, and PSL provides technical assistance if there are unforeseen problems. Mechanisms for supplemental procurement, transport, repair, and maintenance services are being developed to anticipate this contingency.

Accounting Skill

5.6 The women in charge of accounts maintain detailed daily ledgers. They perform this function for all three operations—DC lamp manufacture and sales, BCS operations, and microgrid service. Financial performance and status of the microenterprise are discussed in weekly and monthly meetings attended by all members.

Management Skill

5.7 Five elected members of the microenterprise are the management team. Two of the women participated in the national seminar held in Dhaka on November 18, 2000. The women demonstrated their confidence by answering the questions posed to them by a large group of planners and practitioners from the public and private sectors. Because the concept of off-grid electrification for business development and market expansion is still relatively new, PSL is continuing support for overall activities and management decisionmaking for phase II.

Social Impact

5.8 Use of DC lamps has increased security at night, improved indoor air quality, and enhanced human development, especially in the areas of better health and expanded hours for reading by adults and students. The owners of DC lamps also feel that their social importance has increased, and they spend longer periods in educational, social, and cultural activities. Women and children are now exposed to informational and educational programs on television and radio. A brief survey was conducted recently (for the preparation of a broader survey in phase II) to obtain qualitative and quantitative data on the impact of DC lamp usage. The survey includes 10 households, 10 businesses, and 28 CEWDM members as respondents. The findings of the survey are presented in tables 5.1 and 5.2.

Impact on Women

5.9 Removing Gender Disparity, a Social Barrier to Growth. This project initiated a gender mainstreaming approach for removing some of the social and cultural division of labor so that women are able to play nontraditional roles. This goal is being achieved through helping rural women to attain technical skills through the microenterprise operation. As time passes, gender division of labor in Char Montaz and neighboring areas is being reduced, and the respective roles of men and women are becoming more equal and cohesive in nature.

5.10 To facilitate paradigm shift in gender roles and relations, there is an emphasis on involving members' husbands in the activities undertaken by the microenterprise, especially marketing and sales. Individually and collectively, the women are encouraged to bring their husbands to the monthly meetings with the marketing manager to discuss the potential of the business. Moreover, the small survey reveals that 45 percent of the surveyed members talk to the local male leaders in meetings and 77 percent of the surveyed members' husbands encourage women's membership in the microenterprise. These interactions have been found to instill confidence and cohesion among the women and men. As a result, the women have begun to enjoy more self-esteem, as well as a sense of importance in the well-being of their families and their community.

5.11 Regular participation by the women in the activities of the microenterprise demands time away from their homes. This could have been a social barrier experienced by rural women in Bangladesh because it requires the support of other family members—mostly male—who have to assume some of the women's traditional household responsibilities so that the women have time to attend training and production activities.

5.12 Such a shift in gender roles of rural households signifies that a social transformation leading to gender equality is being achieved by the project. The women's participation in income-generating activity outside the households is now valued.

5.13 By facilitating a shift from traditional farm labor to off-farm skilled labor, such as employment in rural energy services, the Char Montaz project has elevated the knowledge base of the microenterprise's participants and has expanded their scope of work in the CEWDM.

Table 5.1. Impact of CEWDM on Members

Type of benefit	*Beneficiaries (%)*
1. Raised self-confidence	100
2. Capacity to read has improved from training	78
3. Members talk to the local (male) leaders in the meeting	45
4. Husbands encourage women's membership in the CEWDM	77
5. Women use their earnings for personal saving	15
6. DC lamps have increased working hours of businesses owned by individual members	18
7. Members who have never used DC lamp before the CEWDM	100
8. Members who have seen a DC lamp before the CEWDM	3
9. Children benefit from DC lamp at home	50
10. Children's study time has been enhanced by more than one hour, and their performance in the school has improved	93
11. Cleaner environment at home	100
12. Social importance has been raised from using DC lamps	93
13. More security at night	93

5.14 The rural women are now meeting the challenge of operating a factory, manufacturing a product (the DC lamps), and providing services (battery charging and microgrid electricity), which have a high value to local consumers and are therefore generating both interest and moral support in the region. The process has demonstrated that women are capable of running a business enterprise and providing quality services with competence. The effort has produced a high level of self-confidence among the women that is evident among both the group leaders and their associates. The small survey revealed that 100 percent of the surveyed members feel that the microenterprise has raised their self-confidence and that they make all the decisions for the microenterprise.

5.15 The impacts of the project on the microenterprise's members include

- creating employment opportunities for the women, thereby raising their family incomes and helping them to learn technical as well as managerial skills within a microenterprise;
- giving the women practical knowledge in manufacturing, business, marketing, and microcredit operations;
- helping the women to attain a stronger negotiating voice in their community by providing important electrical services;

- providing DC lighting for households, replacing kerosene lamps and kupis, and thereby creating healthier environments for the women and their families (Good-quality lighting is also helping the children to show more interest in studying after dark.); and
- providing information on better technologies for other household activities, such as cooking and appliance operations.

Table 5.2: Impact of DC Lamp Usage on Households

Type of benefit	*Beneficiaries (%)*
1. Positive impact on children's health	80
2. Positive impact on children's performance in school	80
3. An increase in income by 30%	10
4. Listen to radio (news) more than before	70
5. Improved indoor environment	100
6. Social importance enhanced by having DC lamp	90
7. The lamp brings security during the night	90

Other Impacts

5.16 *Public awareness.* The project has developed significant awareness among the general public of the importance of having modern household lighting and the potential of off-grid electrification service. Throughout Galachipa Thana, the CEWDM has become well known and demand for their services is increasing.

5.17 *Impact on family income.* The women in the CEWDM were given the option of using microcredit to purchase batteries to power the DC lamps. Those who have accepted the offer have been using lighting to extend the hours of their family businesses. For example, those who perform tailoring at home have extended their work hours, increasing their revenues, especially during the festival periods. Some of the husbands have used the lighting in their retail shops in the market, getting extra hours of sales beyond the local diesel-powered lighting service. All household businesses using the DC lamps and the microgrid electrification have augmented their income. For example, among the surveyed households, 10 percent had an increase in income of 30 percent. A similar scenario has been noticed for fishing families. They have been using the lamps extensively on their boats to extend work hours into the evenings and increase security.

5.18 *Impact on education.* Families with school-age children have shown significant interest in purchasing the lamps. These families want better light for their children to study in the evening. Children have even encouraged their parents to save money to purchase the lights. The increased hours available for study by children (and by elders who have decided to learn to read) can enhance a family's long-term quality of life. The small survey shows that children's study time increased by more than an hour

and was due to the purchase of DC lamp. Eighty percent of the surveyed households and 93 percent of the surveyed members stated that their children's performance in school has improved as a result of their owning a DC lamp.

5.19 *Impact on private enterprise.* This project has revealed the potential of private initiatives in rural energy service delivery. Manufacturing of the lamps and marketing and sales of energy services are taking place in the private sector. Private entrepreneurs interested in battery-charging operations are considering investment in such businesses. Individual retailers are involved in cash sales of the lamps in the rural markets and villages. NGOs in the region are considering offering microcredit to their members for purchasing lamps and batteries.

5.20 *Impact on labor.* Nonfarm labor among women was not significant in the Char Montaz area before the CEWDM's operation. Now, the prospect of rural women entering the formal labor force has become a reality. Many have become skilled labor thanks to their involvement in the microenterprise. In addition, households are taking advantage of the modern lighting to extend their working hours and recruit staff. Also, the businesses that already existed are able to extend their hours because they have access to lighting powered by the microgrid.

Environmental Impact

5.21 To date, the CEWDM members have manufactured and sold more than 760 lamps. The lamps have replaced the kerosene-fired hurricanes and kupis. As a result, at the household level, there has been a significant reduction of indoor air pollution. Replacing kerosene with electricity also has caused a significant reduction in greenhouse gas (GHG) emissions. Analysis shows that overall emissions of carbon dioxide are reduced by 58 percent when households replace kerosene lighting with battery power. Quantitative data on reduction of carbon dioxide emissions into the atmosphere for 75 lamps are shown in table 5.3. Total savings are estimated to be correspondingly higher, considering that each of the 760 lamps in use in early 2001 has displaced at least one kerosene lamp. When solar household battery charging begins in the future, it will result in total elimination of GHG emissions.

Table 5.3. GHG Emissions Savings (BCS Replacing Kerosene)

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Table 5.3: GHG Emissions Savings (BCS Replacing Kerosene)

	Baseline	*Alternatives*		*Savings*	*%*
	Kerosene	*Diesel*	*Solar*		
CO_2	20.37	8.63	N/A	11.74 ton/yr	58
Carbon	5.56	2.35	N/A	3.20 ton/yr	

N/A Not applicable.

6

Growth Potential, Sustainability, and Lessons of the CEWDM

6.1 Potential for further growth in current activities of the CEWDM will depend on the customer base, the acceptability of DC lamps in place of traditional kerosene lanterns, and the provision of innovative financing schemes, such as energy credits for rural consumers, by either the CEWDM or other organizations. However, the overall sustainability of the CEWDM operation will mainly depend on its financial viability and ability to attract capital.

6.2 Those interested in replication and expansion of this Char Montaz project elsewhere in Bangladesh and throughout the developing world need to consider the lessons that were learned during this project. A business plan for the project's operation in the coming five to seven years is attached in annex D.

Growth Potential of CEWDM Activities

Growth Potential for DC Lamp Marketing

6.3 There are several additional venues for selling the lamps, some of which can help the CEWDM's marketing efforts. It is estimated that the full potential market for the Char Montaz microenterprise encompasses some 20,000 households, consisting of about 100,000 beneficiaries. For example, several thousand fishing boats are at work in the region. Boat owners who purchase DC lamps will be displaying them as they sail, demonstrating their practicality and reliability. In addition, local shop owners and other entrepreneurs interested in expanding their businesses can act as sales agents for the women's microenterprise on neighboring islands. Several have already been trained as part of CEWDM's market development efforts. Also, NGOs are beginning to show interest in this activity. Moreover, the microenterprise can extend its DC lamp market into the Barisal division, which comprises five districts with 778,000 unelectrified households.

6.4 The CEWDM has a production capacity of 600 lamps per month. Because of low demand, in the last 14 months, it produced only 9.15 percent of the number it could produce in full capacity. The CEWDM can meet the growing demand with its

production capacity; however, to extend the use of DC lamps in other offshore islands in the Patuakhali, Baraguna, Barisal, and Bhola districts, there will be a great need for reliable BCSs to be made regularly available to nearby households. To ensure this, the CEWDM needs to demonstrate the cost effectiveness of a BCS to the private investors on other islands, similar to its initiative undertaken in Poolghat on Rangabali.

Microgrid Growth Potential

6.5 A recent study[22] by PSL reveals that there are about 5,000 rural unelectrified markets in southern Bangladesh where small shops carry out their commercial evening activities with decentralized, diesel-powered microgrids. The grids are owned and operated by private providers, who usually recover their initial investments within 8 to 14 months. Hence, based on the findings of the study, there would seem to be opportunities for the Char Montaz CEWDM to expand its microgrid business to communities not yet receiving such services.

SHS Growth Potential for Dispersed Households

6.6 An essential part of the overall growth potential of the market for DC lamps depends on the availability of a nearby battery-charging facility. Regularly transporting batteries for recharging is difficult, thus the BCSs are of marginal use to many of the dispersed rural households. For these households, access to solar modules, including an appropriate financing mechanism, is of great potential interest, as discussed in chapter 1. Otherwise, households that are too distant from BCS or microgrid services will continue to lack modern lighting, and they will remain unelectrified unless they can obtain SHSs at affordable prices.

6.7 Phase II of this project aims to help rural households move up the ladder of energy technology, from DC lamps and battery use to SHSs. One of the creative financing approaches that will be used to initiate this process involves shared risk between the service provider—the CEWDM—and its customers. This could allow more households to acquire improved lighting and electrification sooner. Under this innovative scheme, households may first procure DC lamps with cash and batteries with microcredit from the microenterprise. Then, when SHSs become available, consumers can lease or purchase solar modules from the microenterprise.

Sustainability

Financial Sustainability

6.8 Financial sustainability of the women's microenterprise will depend on several factors embedded in the off-grid infrastructure that has been established.

6.9 *Financial viability.* Although currently the CEWDM has an operational deficit, it is believed that without increasing assets further, the operational break-even

[22] *Feasibility Study for a Solar Home System Project within the Context of Alternative Options for Rural Electrification*, by PSL for the World Bank, March 1, 2000.

point can be reached in the second year. However, this is based on the assumption that battery sales can be increased by 27 percent per month for the entire year, with corresponding growth in sales of lamps and other services. If such growth cannot be achieved, there is a risk of operational losses for the DC lamp production facility.

6.10 Meanwhile, financial performance of the microenterprise is expected to improve further with the introduction of SHSs. The CEWDM expects to sell more lamps as SHSs become widely available. If so, the break-even point will be reached sooner, subject to the mode of accounting.

6.11 *Operation and maintenance.* The normal cost of operation and maintenance of diesel generators is high. The most important factors in providing reliable service and keeping life-cycle costs low are proper maintenance of the diesel generator, availability of good-quality fuel for regular use, and timely availability of technical support.

6.12 *Tariff structure.* Sustainability of the microgrid operation will depend on a tariff that allows a minimum of full-cost recovery, with a potential for return on investment.

6.13 *Ability to attract capital funds.* An effort by the microenterprise is under way to attract investment in a solar modules leasing service, at a cost level that suits the rural households. However, attracting such funds has proved difficult for small- and medium-size enterprises (SMEs)[23] such as the CEWDM. A majority of the established funds are directed to serve capital investors, microfinance institutions (MFIs), or local governments. Furthermore, each category of funds tends to have its own definition of business mission. To some extent, donor grant funds are available for only social development. Dedicated soft funds for the MFIs are also unavailable to for-profit SMEs of the rural sector. Commercial bank funds are not available for small-scale rural electrification, and dedicated funds such as the Solar Development Group offer funds at higher than bank rates.

6.14 There is potential risk that failure to obtain development funds will retard the growth of the microenterprise and confine its scope. For any realistic progress in providing off-grid electrification, SMEs and the CEWDM alike will require dedicated funds. Fortunately, the upcoming World Bank credit and Global Environment Facility (GEF) assistance for Bangladesh rural electrification are expected to provide such funds and help to remove some of the barriers. There is also an interest at the international level[24] in directing large-scale funds to the developing countries for global acceleration of RETs.

The Role of Microcredit in Off-Grid Market Growth

6.15 Microcredit can play a significant role in the off-grid rural electrification infrastructure of Bangladesh. Several operators can fulfill this role, including local

[23] Here we define the women's microenterprise as a rural SME in energy service delivery.
[24] G8 Task Force on financial recommendations for accelerating energy access.

NGOs, rural banks, cooperatives, or the PBSs. Rapid growth of the off-grid electrification market will depend on availability of consumer credit from any of the above sources for procurement of lamps and batteries by unelectrified rural households.

6.16 The CEWDM aims to attract seed funds to establish an institutional mechanism so that its customers can obtain microcredit to purchase or lease DC lamps and batteries. For example, the mechanism could consist of disbursing "energy credits" to potential consumers. Sustainable expansion of the DC lamp market will depend on the availability of such funds and on their efficient disbursement.

The Role of NGOs in Sustainable Market Growth for DC Lamps

6.17 The rural poor women of Bangladesh have received worldwide attention to their successful use of microcredit for sustainable poverty reduction, increased human development, and empowerment. In many cases, women entrepreneurs have demonstrated their ability to play significant economic roles in their communities. But because there is no obvious correlation between household lighting and income generation, the NGOs have been hesitant to offer microcredit to their members for microenterprises involving off-grid electrification. The recent experience in Char Montaz validates this observation. There has been a decided lack of interest by the local NGOs in risking their funds to provide energy credits.

6.18 When the Char Montaz project was initially designed, it was assumed that an appropriate arrangement could be reached with the local NGOs to furnish microcredit to the sizable rural population. However, that did not materialize. Dialogues took place, but the organizations displayed no significant interest in extending energy credits. The situation would change as soon as the NGOs are willing to collaborate in financing activities. The Char Montaz experience shows that the participants in the CEWDM achieved a 98 percent recovery of the microcredit provided for the sales of more than 120 batteries. The project therefore establishes that the credit risk for household energy perceived by the NGOs has been exaggerated.

Barriers to Operating an Off-Grid Electrification Service

6.19 This project has aimed to demonstrate the feasibility of off-grid electrification using innovative methods involving RETs. In the absence of necessary infrastructure, the project has created a framework for operation that is still under development. Potential barriers to successful operation include

- mismatches of tariffs with household income,
- unavailability of good-quality batteries and BCSs,
- unavailability of credit to purchase batteries and lamps, and
- inconvenience of transporting batteries to the charging stations.

6.20 To grow into a sustainable operation, the CEWDM is working to eliminate these barriers. Success of these efforts will depend on how well the new technologies can establish themselves among the rural people within a reasonable period. RET demand has

only been initiated within the project period. Positive market growth and smooth business operations will be crucial to a sustainable performance.

Lessons Learned

6.21 Major technical and logistical issues that have developed during this project, and resulting lessons learned, are as follows (details in annex B):

- The CEWDM incurred some problems related to engines and parts availability. For example, the fuel injector was replaced three times in six months, costing Tk70–80 for parts.
- The rise in fuel prices due to increased global oil prices necessitated an adjustment in the tariff structure for battery charging.
- There were some incidences of lamp failures and blackening of tubes, which were mainly caused by improper use of lamps by the consumers. For example, the users ignored instructions to connect the lamps to only to an AC line and connected them to a DC line instead.
- Some of the lamp failures were due to improper assembly, most of which were corrected immediately.
- In two locations of Kuakata, users of Grameen Shakti's SHS replaced their lamps and added additional lamps from the CEWDM because of cost advantage and better quality.

7

Capacity Building for Professional Women

7.1 An important activity of this project is to enable professional women to take leading roles in RET implementation. In Bangladesh, few women are encouraged to attain the qualifications to lead a technical project's development. This situation can be changed through professional training, networking, and sharing experiences and expertise. Women will be able to assume important roles in RET use and designing projects that minimize gender bias or preference. With this in view, under phase I of the program, 35 professional women (in science and engineering) from the public sector and private organizations were provided with technical training on RET use of solar, biomass, and wind energy; and 10 selected participants also attended a study tour in India to visit existing projects on RET use.

7.2 This project's training program has been intended to improve women's skills in RET use, their awareness of gender issues, and their understanding of the role of rural women in developing countries as the most numerous and frequent daily consumers of renewable energy. It was expected that field experience, demonstration visits, and study tours would enhance the scope of the contribution of professional women. This chapter summarizes the training and study arranged for them to meet the goals stated here.

Training Course on Renewable Energy Technology for Professional Women

7.3 The first training program for professional women on RET use in Bangladesh was funded by this project. It was held in Dhaka during from May 6 to 10, 2000. The objective of the five-day training course, conducted by Prokaushali Sangsad Limited (PSL), was to provide information on the technical, economic, and developmental aspects of RET to professional women and enhance their potential for leadership roles in future projects. The program covered the major aspects of technology transfer, its dissemination, and policy requirements.

7.4 To attract participants from a wide range of fields, invitations were sent to government organizations, national research centers, NGOs and private organizations, academic institutions involved in technical education and vocational training, and others

involved in renewable energy projects. All were asked to submit nominations for women participants with experience in RET, general science, engineering, or economic development.

7.5 In all, 33 women from 18 different government organizations and NGOs participated in the course. The participants included practicing engineers, technologists, teachers, researchers, and other professionals. However, many interested organizations replied that they did not have suitable female candidates, but wished to send men instead. This indicates an acute shortage of professional women available for training in renewable energy use.

7.6 The course covered the technical details of alternative technologies related to planning, design, implementation, and monitoring of renewable energy. Alternative technologies discussed in detail included

- bioenergy use;
- solar thermal application in water heating and distillation;
- solar PV systems for household electrification, water pumping, and refrigeration;
- microhydro power for small-scale generation and its community applications; and
- wind-diesel hybrids for microgrids.

7.7 Participants learned how to assess solar, wind, and renewable energy resources, as well as renewable technologies for water pumping, village power, water purification, lighting systems, hybrid systems, and other rural applications. They also were made aware of gender issues, such as the fact that rural women are the most numerous and frequent biomass users in developing countries.

Study Tour for the Professional Women

7.8 After the training course in Dhaka, a selected group of the professional women visited renewable energy sites in neighboring India on October 15 to 24, 2000. The tour reinforced their knowledge of RET applications and hardware manufacturing. The women were selected based on their performance in the training course and the relevance of their present professional activities to the potential of RETs in Bangladesh. A detailed description of the training program is presented in annex C.

Professional Women's Network

7.9 It was apparent to all those present at the training course that this type of gathering for technology transfer and dissemination, arranged only for women, was an unusual event in Bangladesh. As a result, the women created a network among themselves to create opportunities for further interaction. They call the network Energy, Women, and the Environment. The network decided to disseminate the knowledge gained in the course to a wider audience, especially in the professional area of each

member. It also serves as a focus for further recommendations in the areas of economic development, women's empowerment, and renewable energy use.

Recommendations of the Discussion Sessions

7.10 Participants in the training course discussed various issues on the information accumulated during the five days. They identified possibilities for expanding the use of RETs and proposed how they could improve their participation and contribution. They also proposed several ideas to enhance their collective knowledge base, outlined below.

Information Dissemination

7.11 It was suggested that more news articles be published on the scope and utility of RETs, and that advertising be used to communicate the potential economic and social impact of the technologies. It was also suggested that regular demonstrations be conducted in schools and colleges. [25] In particular, rural schools should be the sites of the demonstrations. The Ministry of Science and Technology could be approached regarding funding.

Education

7.12 The curriculum of the Bangladesh School Textbook Board should include emphasis on RET use. The participants agreed to work toward adding information about RET and energy efficiency to textbooks for children in grades 6 to 10.

Pilot Project

7.13 It was proposed that a pilot project for a village be funded to create a widespread impact. About 100 households would be given access to the smallest-size solar systems for one year, to see how well the residents would be motivated to use the systems and gradually accept the technology. Women of the village would be taught the benefits of using improved stoves for cooking (less fuel, less time) and would be trained to use them.

Policy Guidelines

7.14 Participants will assess the role of women and the scope of RET use within their own organizations, using the same guidelines being prepared by PSL for the sector ministries (see volume II of this report).

Seminars

7.15 To share their knowledge with colleagues, individual participants will arrange to hold seminars on RETs and energy efficiency within their organizations.

[25] PSL, along with Energy Systems, has been demonstrating renewable energy activities in the secondary schools of Dhaka and adjacent areas since 1997.

Communications

7.16 Network participants will use e-mail, Websites, or other means to share information gathered on gender issues and RET use.

Linkage with International Forums

7.17 The participants will search for similar networks and forums in other countries to gather and share more information on RET projects and activities elsewhere.

Leadership Roles for Women In Energy

7.18 The group of professional women who participated in the training course and study tour is expected to have learned from the experience and be able to share their knowledge with others. Nearly all of the women are working in professional capacities where they are engaged in decisionmaking or are in contact with other decisionmakers. Therefore, they should have an impact on technology choices in energy matters. Those who are in the teaching profession perhaps will find even more opportunities to influence people's opinions about the importance of use RETs and promoting the role of women in the energy sector.

7.19 Some of the participants of the training course were invited to attend the national seminar on November 18, 2000, when the draft guideline (see volume II) was presented. There, they discussed the benefits of incorporating RETs into public projects with high-level government officials, representatives from donor agencies, and other guests. This helped the participants to understand national issues and examine the energy problems of the rural sector from a broader perspective.

7.20 It was not possible for the team of professional women to visit the project area of Char Montaz during the time frame of phase I of the project. This will be arranged by PSL during phase II, however, and the women will participate in special activities and be assigned specific responsibilities.

8

Conclusions and Recommendations

8.1 There is indication that a social transformation is taking place in Char Montaz as women are becoming empowered through technology transfer and working as energy service providers. Perception of women as passive beneficiaries has changed as women were able to break traditional, gender-based division of labor.

8.2 The conclusions strongly suggest that the project objectives detailed in chapter 1 have been achieved. The CEWDM is becoming an economically viable off-grid service provider of energy. Although the microenterprise has not yet established its role as a renewable energy distributor, it has created the essential infrastructure. Perhaps most important, the microenterprise has enhanced the lives of its women participants, their families, and the surrounding community.

8.3 The primary indicator of success for this off-grid electrification project is the creation of new business potential in the light of changing demand.

A Successful Women's Microenterprise

8.4 The several commercial energy service activities adopted by the women's microenterprise - CEWDM in the offshore islands have demonstrated successful delivery of off-grid electrification, including assembly of DC lamps and their sale, operation of a BCS on Char Montaz, and operation of a diesel-powered microgrid for commercial and household electrification. Each of these activities has required the women to develop different operational skills. Some of the activities have generated more revenue for the CEWDM and its members.

8.5 This project has focused on developing off-grid electrification activities at the lowest possible costs, reducing capital expenditure for a household to a minimum of Tk1325 (US$26.50) and monthly costs for battery charging to as low as Tk75 (US$1.50)[26] . These amounts are by far the lowest investment for a user of decentralized or off-grid lighting using batteries as a power source. Yet these services can enhance the quality of life in rural households and reduce unemployment in the community—

[26] Charging cost for a battery of 20AH is Tk20 (US$0.40). The frequency of charging depends on the energy usage rate. Because there are 6W, 8W, and 10W lamps, a user's monthly cost will vary accordingly.

especially among women. The resulting increases in household income will enable the purchase of additional electrification services, like the SHS.

A Positive Impact on the Members of the CEWDM

8.6 The significant contributions of this project are its enabling the members of the CEWDM to shift from traditional farm labor to skilled off-farm labor, providing them with employment in rural energy services, elevating their knowledge base, and expanding their activities in the mainstream commercial energy sector.

8.7 Perhaps more significant, this microenterprise has reduced some of the social and cultural barriers limiting women's participation in life and work outside household, giving them an opportunity to build self-confidence and alleviate their poverty.

8.8 This improved economic and social environment for women has a far-reaching potential, extending to every new household that adopts modern lighting.[27] Therefore, the CEWDM should be enlarged, allowing it to extend solar electrification service to the households in Char Montaz and elsewhere in Galachipa Thana. In addition, other cooperatives of rural women should be encouraged throughout the country.

A Growing Market for Off-Grid Electrification

8.9 The primary determinant in the energy demand equation is household income. It was determined that households in a cluster or within 0.25 kilometer of a market can be economically served by an AC microgrid service. Households located within 2 kilometers of a BCS are likely to use batteries for household lighting and other appliances. Middle-income households located farther than 0.25 kilometer from a microgrid, or 2 kilometers from a BCS, probably will not adopt modern lighting unless affordable solar electrification is available. Higher-income households at any location will be willing to pay for sufficient electrification.

A Role for the Private Sector in Fostering Off-Grid Market Growth

8.10 The private sector has an important role to play in expanding off-grid markets. Small entrepreneurs can become leading investors in off-grid electrification services, so long as the public sector provides a congenial environment for such activities. [28] Then, entrepreneurs can establish BCSs, provide microgrid services, and market SHSs.

A Role for Microcredit in Off-Grid Market Growth

[27] About 700 DC lamps are currently in use on the six islands of Golachipa Thana.
[28] Including financial, legal, and technical (standards) institutional policies.

8.11 Microcredit would play a significant role in the off-grid rural electrification infrastructure of Bangladesh. It can be provided by nearly all institutional participants, including the local NGOs, rural banks, cooperative microenterprises, and even the PBSs. Rapid growth of the off-grid electrification market will depend heavily on the availability of consumer credit, which will permit low- and moderate-income households to procure DC lamps, batteries, and SHSs.

8.12 As discussed in chapter 3, the NGOs thus far have been hesitant to offer microcredit for the purpose of obtaining off-grid lighting and electricity. Allocated new funds for energy credits should encourage the local NGOs to cooperate in loan activities. However, even without such assistance, the organizations should be able to participate with little fear of risk. The CEWDM has extended microcredit for battery sales at their own risk, and they have achieved a 98 percent recovery of costs in sales of 122 batteries.

Renewable Energy Use Can Be an Off-Grid Electrification Option

8.13 This project has only been able to create the groundwork necessary to provide solar electrification service to the rural households. This unique approach being proposed is a combination of risk and cost sharing between the service provider and consumers. Potential consumers of SHSs in Char Montaz are being encouraged to purchase DC lamps with cash and batteries with microcredit from the CEWDM. The solar modules with controllers will be leased or sold. This approach allows rural users to invest in a significant 40 percent of the cost of the system and its installation through a series of small and affordable expenditures, without having to pay up front. As in many rural electrification programs, this service will not be sustainable in the initial stages unless capital funds are partially subsidized.

A Need for Capital Funds for RET

8.14 No accessible funds are yet available to encourage private investors to get involved with RETs, especially at this early stage of development. The potential risk is that failure to obtain development funds will continue to inhibit the potential of this commercial business. For any realistic progress to be made in providing access to off-grid electrification via the private sector, SMEs and cooperatives will require dedicated funds. Recently negotiated World Bank and GEF assistance for the Bangladesh Rural Electrification Board provides a window for such funds, which will be made available for SMEs and NGOs—as a result, some investment barriers will be removed. It is noteworthy that there is an interest at the international level in directing large-scale funding for the developing countries to accelerate global access to RETs.[29]

A Need for Fiscal Policies for Renewable Energy

[29] G8 Task Force was established in 1995 for making financial recommendations for accelerating energy access.

8.15 Infrastructure for capital investment is one of the most important building blocks in the growth of a developing economy. Domestic and local investment in renewable energy can be initiated through implementing effective policies, tax incentives, reduction of duties and tariffs, ease in foreign exchange regulation, and so forth. Without capital inflow to the energy sector, many of the potential benefits can never be achieved, especially considering the high capital cost for RETs.

A Need for Institutional Oversight

8.16 There is an urgent need to establish an institutional framework for overseeing the renewable energy activities in Bangladesh. Any integrated energy development program requires an effective and committed administrative body. This kind of dedicated government body can facilitate collaboration among NGOs and private organizations and educational, research, and financial institutions. Such a programmatic approach is an essential component of this project's future development. In volume II of this report, recommendations are detailed regarding the need and scope of an institutional framework for RET use by the public and private sectors.

Summary of Recommendations

- Efforts should continue toward the removal of the social and cultural discrimination associated with the role of women in energy management activities.
- The women's microenterprise of Char Montaz should be encouraged to extend its renewable energy–based activities.
- There is a significant role for microcredit in the off-grid rural electrification infrastructure of Bangladesh. It should be offered through several outlets, including local NGOs, rural banks, cooperatives, or even the PBSs.
- The NGOs committed to social and economic development should take a leading role in assisting poor women to participate in mainstream energy-based activities and take risks in extending energy credits to poor households.
- Access to dedicated funds must be made available for any realistic progress to be made in providing off-grid electrification services to the rural sector through the private sector, SMEs, and cooperatives.
- The Planning Commission, which is the central planning unit of the government of Bangladesh, in combination with the Ministry of Energy and Mineral Resources, should assume the leading role in creating a primary organization for planning and supervising the integrated advancement of RETs within the country.

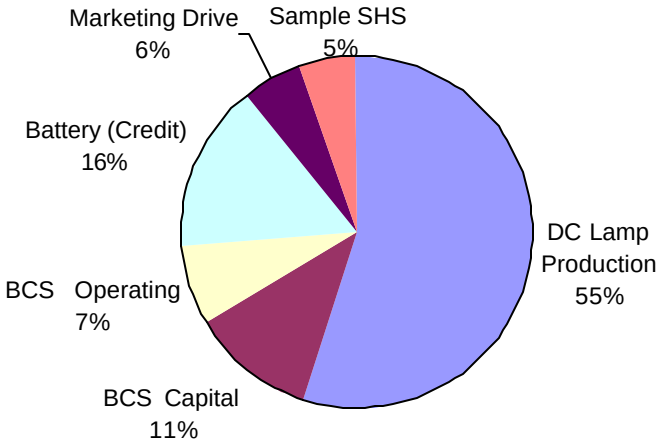
- Suitable fiscal policies should be developed by the Ministry of Finance for a basis of capital investment in renewable energy.
- The mass media and government institutions should be used to disseminate information on the availability and benefits of using RETs.
- More women should be encouraged to become involved in the planning and management of energy services, including both the selection of energy sources and their efficient use. Elected women members of local governments should be urged to recruit more women participants in energy services, especially in the rural areas.
- More action research should be undertaken to develop alternative and innovative ways to meet the energy needs of the country.

Annex A

Current Cost Distribution of the Coastal Electrification and Women's Development Microenterprise (CEWDM)

A.1 The costs associated with different components of the Char Montaz microenterprise are distributed as shown in figure A.1. The CEWDM currently offers microcredit to its customers for purchases of batteries. This activity is expected to expand to offer credit for other renewable energy purchases. Other current expenses include costs of credit for purchasing electronic components and stocking batteries and lamps at retail sales centers. A major portion of the costs associated with DC lamp production will also be revolved as capital required for materials purchase.

Figure A.1: Relative Cost Distribution of Microenterprise Development



A.2 To maintain the break-even point, battery sales must reach 27 units per month. In the case of additional investment in solar home systems, the profit margin is significantly

higher. It is worth noting that theCEWDM operates just like any other business where multiple activities are pursued to diversify the risk. Income from sales of lamps is not enough to keep the enterprise viable. However, activities such as lamp assembly and cash and credit sales, battery charging and rentals, microgrid operation, and sales of household electrical accessories (e.g., switches, lamps, wires and cables, etc.) have all contributed to making the business viable as a whole.

Comparison of Prices of DC Lamps and Sources

A.3 A comparison of DC lamp pricing among various sources shows that the lamps manufactured by the women's microenterprise are sold at highly competitive prices. Lamps manufactured elsewhere in Bangladesh (or imported) are sold at prices that are considerably higher. Table A.1 gives a comparison of available DC lamps.

Table A.1: Comparison of Prices of DC Lamps and Their Sources

Specifications	*Price, Tk*	*Manufacturer*	*Remarks*
CFL-7 Watt	750	Bangladesh	Available in the Dhaka market
CFL-11Watt	850	Bangladesh	Available in the Dhaka market
FTL-6 Watt	325	CEWDM	Available in southern parts of the country
FTL-6 Watt		Bangladesh	Not sold separately[a]
FTL-8 Watt	500–800	Bangladesh	Limited production
FTL-8 Watt	325	CEWDM	Available in southern parts of the country
FTL-10 Watt	650	Bangladesh	Available in the market
FTL-10 Watt	450	Bangladesh	Not available for sale
FTL-10 Watt	650	Imported	Available in the Dhaka market
FTL-12 Watt	950	Imported	Available in the Dhaka market
FTL-20 Watt	800	Imported	Available in the Dhaka market

a. Lamps are sold for automotive use.

A.4 It is evident that the lamps assembled and sold by the CEWDM, without any subsidy, are highly competitive with the other locally available brands. Moreover, none of the other brands is available in the Char Montaz area. Small retailers are not interested in investing in the imported lamps without warranty, and competition from the microenterprise precludes a justifiable margin of profit.

Table A.2: Sales Media for the DC Lamps of the CEWDM

Sales media for DC lamps	*Potential customers*	*Barriers*
1. Direct sales by women participants	Neighbors and relatives	Batteries not available Credit needed for batteries
	Local businessmen	Lack of awareness
	Village market	Weekly—battery needed for cash sale of lamps
	Regular market customers	Short-term market (may become saturated)
2. BCS at the market of Char Montaz	Businesses in the market	Large but seasonal market
	Fishing boat owners	
	Other	Done by marketing drive
	Retail sales to customers	Sustainable but slow growth of customers
3. Private retailers and sales centers on other islands	Cash sales to households	Lack of awareness—needs more demonstration
	Sales to NGO members	Large market dependent on NGO credit funds
4. NGO sales to members from four regional centers	Sales to SHS users	High initial cost of SHSs, therefore ESCO is preferred
5. Electrification cooperative	Using the centers of Ministry of Women and Children Affairs	Limited access and awareness
6. Union Parishad (local government administrative unit office)		

Demonstration of DC Lamps for Market Development

A.5 It was necessary to demonstrate the DC lamps to build initial market interest. A list of the markets that were visited is given in table A.3, including the names of possible future dealers. Demonstration of DC lamps was done through these dealers over the period of the project. It should be noted that both 6 watt (W) and 8W lamps with 8 volt (V) batteries were most popular because 80 percent of residents use 8V batteries for radios.

Table A.3: Demonstration of DC Lamps for Market Development

No.	*Name of market*	*Name of dealer*	*Occupation*	*Demonstration lamp*
1	Moudubi	Md. Shalehuddin Bishwash.	Grocery	8V, 8W
2	Taktabunia	Md. Nasir Paloan	Pharmacy	8V, 8W
3	Mollar Hat	Bimol Krishna Das	Medicine & BCS	8V, 8W
4	Koralia Bazar	Bimol Krishna Shaha	Stationery	8V, 6W
5	Baher Char bazar	Md. Fazar Ali	Radio repair & BCS	8V, 8W
6	Kachiabunia(Khalgora) Bazar	Md. Shahjahan Hawlader	Gen-set service & BCS	8V, 8W
7	Kachiabunia (Poolghat) Bazar	Md. Mizanur Rahman	Gen-set service & BCS	8V, 8W
8	Neta Bazar	Md. Mahbub Hossain Talukder	Gen-set service & BCS	6V, 6W
9	Char Bishwash (Budhbar) Bazar	Md. Hemeyat Hossain	Watchmaker	8V, 8W
10	Bottola Bazar	Md. Helal Uddin	Tailor	8V, 8W
11	Char Bishwash (Launch ghat)	Tofazzal Hossain	Matsha Arat	12V, 8W
12	Sonibar Bazar	Md. Rafiq Sikder	Stationery	8V, 8W
13	Nutan Bazar	Md. Jashim Uddin	BCS	8V, 8W
14	Char Kajal (Robibarer Bazar)	Mr. Gokul Chandra Halder	Ornament shop	8V, 8W
15		Md. Hanif Miah	Hawker (medicine)	8V, 8W
16	Char Bishteen			
17	Char Luxmi			
18	Char Margaret			
19	Kuakata	Md. Tofael Hossain Tapu	Battery making & charging.	12V, 8W

Annex B

Lessons Learned from the CEWDM

Engine Maintenance and Parts Availability

B.1 In general, the quality of locally available fuel and lubricating oil is very poor, causing frequent failure of the diesel generator and increasing its maintenance requirements. These malfunctions were detected from the sound of the engine knocking and from its overheating. Availability of good quality parts is also critical in keeping the engine in good condition. Some of the problems incurred related to the engine and its parts are:

- The fuel injector was replaced three times in six months, costing Tk70–80 for parts.
- Piston rings were replaced two times in a year, with the new parts costing Tk200 each. The oil pump was also replaced two times as a result of damage from friction caused by debris.
- The crankshaft bearings had to be replaced two times.
- Bearings made in Bangladesh cost about Tk70 and have a life of only two weeks to three months. Better-quality bearings, imported from Japan, cost about Tk90 and are expected to last for one year.

B.2 The CEWDM is currently purchasing better diesel fuel in 200-liter barrels. Each barrel can power about 25 days of engine operation. Since the generator started using the better fuel, its service has become more dependable, with smooth engine performance 12 hours a day.

The Price of Diesel Fuel

B.3 In response to the global change in oil prices, the retail price of fuel has changed in Bangladesh. Since January 2001, the price of diesel fuel is Tk16.5 per liter, and the price of lubricating oil is Tk70 per liter. These prices are higher than the December 1999 levels. The rise in fuel prices necessitated an adjustment in the tariff structure for battery charging—from Tk15 per charge to Tk20 per charge for 20 AH for 8V or 12V batteries.

DC Lamp Failures Due to Misuse by Users

B.4 There were some incidences of lamp failures and blackening of tubes. These lamps are repaired and returned to the customers under a one-year service warranty. In most cases, these failures were caused by improper uses of lamps by users, such as:

- Fishing boat crews applied higher voltage (e.g., an 8V lamp connected to a 12V battery).
- Batteries charged by the dynamo of a boat engine are usually at much higher voltage than recommended for the lamps. This higher charge damages the batteries as well as the lamps.
- Lamps were connected to an AC line by users who ignored instructions to use the lamps with DC sources only.
- Low battery voltage would damage DC lamps.
- Low-quality cable caused high line resistance. (Using a cable longer than the 10-foot cable provided with the lamp is not recommended. Should the user need a longer cable, 40–76 gauge wire should be substituted, with a length limit of 20 feet.)

4. Manufacturing Problems

B.5 Some of the lamp failures were due to improper assembly. Most of them were corrected immediately after detection in the factory. Some of the failures were in the form of

- loose tube connections or tubes disconnected because of loose screws,
- improper winding (over- or underturns in the inductors), or
- transistor mismatch.

B.6 These problems have now become rare with continued emphasis on quality checking. Meanwhile, transformer problems have been identified and corrected in the early stages of operation. The most common causes of irregularity are air gap in transformer winding or loose connection at output.

Quality Comparisons with Other Sources

B.7 In two locations on Kuakata (Mohipur and Chapli Bazar), both users of Grameen Shakti's SHS replaced their three lamps and added additional lamps from the CEWDM. This demonstrates the users' confidence in the quality of the DC lamps made by the CEWDM.

Annex C

Training the Professional Women

C.1 At the professional women's course, the participants learned about various renewable energy technologies and their potential applications in developing countries. Technical details of the technologies related to planning, design, implementation, and monitoring were discussed. The technologies discussed in detail included:

- bioenergy use;
- solar thermal application in water heating and distillation;
- solar PVs in household electrification, water pumping, and refrigeration;
- microhydro power in community-scale power generation; and
- wind-diesel hybrid generation for microgrids.

C.2 The potential for a significant role of women in the context of bioenergy use in Bangladesh was discussed during the training. The social aspects of energy technologies and implications for the health of poor women were also highlighted. The content of the course included the important role of government policies in establishing new energy technologies.

C.3 Additional topics included alternative solutions for electrification of the rural households of Bangladesh, the importance of improving energy efficiency, and economics and conservation. All the issues were examined as they pertained to RET use, both in Bangladesh and in other countries with different geographic and social backgrounds.

C.4 The training was based on recognized international standards. All participants received supporting documents. The women received practical demonstrations of solar PV lighting, water pumping, and thermal water heating, as well as energy-efficient stoves. They were given the opportunity to perform hands-on measurements of solar radiation and PV voltages and current, and they were encouraged to connect various components of PV systems to make working circuits.

C.5 Participants in the course viewed video presentations on RET as it is used in different countries and on other energy projects involving women in Bangladesh. The videos included microhydro in Nepal, solar and wind energy systems in North and South America, and the microenterprise in Bangladesh. It was proposed that the videos should be used in future training and demonstration programs by PSL.

Instructors

C.6 Knowledgeable individuals were invited to lecture on different topics of interest. Speakers included

- Mr. Robert Foster, Southwest Technology Development Institute (STDI), New Mexico State University;
- Prof. Nurul Islam, Institute for Appropriate Technology, Bangladesh University of Engineering and Technology (BUET);
- Mr. Bikash Pandey, Winrock International, Kathmandu, Nepal;
- Ms. Nilufar Ahmad, World Bank, and
- Dr. Hasna J. Khan, PSL, Dhaka.

C.7 Mr. Foster was the primary instructor, giving technical details on solar and wind energy. He provided extensive overview and details on the best practices for sizing solar PV systems. He taught design parameters for solar energy use in detail and discussed applications of solar thermal technology in water heating and water distillation. He also outlined methods of design and system sizing for solar PVs in household electrification, water pumping, and vaccine refrigeration.

C.8 Prof. Islam lectured on bioenergy issues, emphasizing the implications of energy policy in project development. He also informed the audience of the national energy policy implications of RETs. Prof. Islam also discussed issues involving rural women and energy, highlighting the position of poor women and their energy use in the context of Bangladesh.

C.9 Mr. Pandey spoke on the applications of microhydro technology and its suitability and limitations in the context of design and implementation. He illustrated the utility of microhydro for community-based power generation and discussed design issues.

C.10 Dr. Khan talked about energy economics for alternative technologies. She focused on the potential of alternative modes of rural electrification and their socioeconomic implications. She also highlighted the economic importance of energy efficiency in both rural and urban Bangladesh.

C.11 There also were two presentations from invited speakers. Ms. Patricia Flanagan of the United States Agency for International Development (USAID) gave a presentation on gender awareness in the context of projects undertaken by her agency. Ms. Nilufar Ahmad of the World Bank presented a paper emphasizing gender aspects of

developmental indicators in Bangladesh. She also talked about the importance of technology in the empowerment of women.

C.12 Ms. Hafiza Khatun, chief planner of the Ministry of Women and Children Affairs, and Mr. Bruce McMullen, chief technical advisor to the USAID, attended the closing session. Dr. M.A. Mannan, chief coordinator of the training program, and Ms. Asma Huque, director of PSL, distributed certificates to the participants at the end of the training program.

Evaluation

C.13 After the course, the participants were invited to evaluate the instruction and identify its strengths and weaknesses. The participants recommended that such training events should be made available continuously, so that the women can keep pace with new and innovative solutions to the country's relevant energy issues and maintain contact with a body of professionals and others. They also suggested that the program's length was inadequate to cover all the points of technical theory and demonstrations, because most of the lectures were conducted in English.

Educational Tour to India

C.14 Eight of the women participants were selected for an educational tour of RET sites in India (although one of them could not attend because of official engagements). Two male technical members of PSL also accompanied the team. The tour participants are listed in table C.1.

C.15 The Ministry of Nonconventional Energy Sources (MNES) in India was contacted for support in planning the tour to some of the project areas. The Indian Institute of Science in Bangalore also assisted by providing information and helping in organizing the tour. The locations visited by the group were

- ASTRA, the Application of Science and Technology to Rural Areas center, part of the Indian Institute of Science, Bangalore;
- Hosahalli village, Tumkur district, Karnataka (100 kilometers from Bangalore);
- Auroville village, Pondichery;
- Information Technology Power, Pondichery; and
- Webel-Solar Energy Systems Ltd. solar PV cell manufacturing plant in Calcutta.

C.16 Among the various installations visited at ASTRA was a fully computerized, 250 kilowatt (kW), wood-fueled gasifier installed at the Department of Aerospace Engineering. Two biogas plants using cow dung, leaves, and straw were visited. The technology of producing stabilized mud blocks for construction of rural and

urban buildings was observed in the Department of Civil Engineering. Only 30 percent of the energy required for burnt bricks is necessary for making this kind of block, which uses a mixture of sandy red soil (60–70 percent), clay (10–15 percent), and cement. This technology has been in use in south India for the last 22 years.

C.17 Hosahalli is a small village in south India where participants observed examples of decentralized power generation for rural areas. The village is electrified by using a small, wood-fueled gasifier-generator system developed by the Indian Institute of Science. The electricity produced is used for lighting flour mills, pumping water for drinking and irrigation, and other productive uses on a fee-for-service basis. The farmers produce biomass feedstock from their dedicated energy plantations. The project demonstrates the viability of bioenergy-based, decentralized electrification.

C.18 The village of Auroville is an international township of people from more than 40 countries, and it is an excellent place for the demonstration of renewable energy. A solar kitchen with capacity for 1,000 meals, a 36 kW PV power plant, more than 100 solar water pumps and lighting systems, and a large program for making and using ferro-cement and low-energy building materials have been installed here. Tour participants visited an installation for manufacturing portable solar chargers where most of the components are locally manufactured or assembled. The PV electrification plant uses three arrays of 600W peak-capacity (eight 75W modules) and a manual tracking system for the Center for Scientific Research. Two wind-power plants were also visited. The solar kitchen in Auroville uses a 15-meter-diameter, solar bowl concentrator to heat a central coil that creates steam for cooking for the 1,000 inhabitants.

C.19 Webel-Solar Energy Systems Ltd. manufacturing plant in Calcutta specializes in production of PV cells, modules, and systems in collaboration with Helios Technology, Italy. Their range of products includes silicon wafers, solar cells, and modules.

C.20 Several other facilities where visits were planned could not be covered because of extreme congestion in the public transport system caused by several religious festivals in India at the time of the tour. However, videos of some of these facilities were shown at the Indian Institute of science.

Table C.1. Participants at the Training Course for Professional Women

Sl. no.	*Name*	*Designation*	*Organization*
1	Ms. Afroja Perveen	Assistant director	Geological Survey of Bangladesh
2	Ms. Bithi Islam	Assistant engineer	Bangladesh Power Development Board
3	Ms. Nurun-Nahar Begum	Subdivisional engineer	Bangladesh Power Development Board

4	Ms. Jakia Najnin Panna	Assistant engineer	Bangladesh Power Development Board
5	Ms. Dipti Rani Fouzder	Assistant engineer	Bangladesh Power Development Board
6	Dr. Lulu Bilquis Banu	Senior scientific officer	Bangladesh Council for Scientific and Industrial Research
7	Ms. Sharmin Farhat Ubaid	Program organizer	Center for Mass Education in Science
8	Ms. Mariam Akhter	Program organizer	Center for Mass Education in Science
9	Ms. Kulsum Akhter Banu	Lecturer	Dr. Malika College
10	Ms. Nazma Begum	Assistant professor	Dr. Malika College
11	Ms. Begum Jobaida	Senior sales engineer	Rahimafrooz Batteries Ltd.
12	Ms. Kausar Shahab	Program associate	Anando, an NGO
13	Ms. Latifa Quadir	Senior scientific officer	Bangladesh Atomic Energy Commission
14	Ms. Khondaker Selima Begum	Senior scientific officer	Bangladesh Atomic Energy Commission
15	Ms. Rownak Jahan	Program officer	Anando, an NGO
16	Ms. Latifa Begum	Senior trainer	Bangladesh Rural Advancement Committee, an NGO
17	Ms. Sharmin Jahan Khondoker	Assistant engineer	Local government engineering department
18	Ms. Haque Sultana	Assistant engineer	Local government engineering department
19	Ms. Shaila Joarder	Lecturer	University of Asia Pacific
20	Ms. Dona Halder	Project officer	Development Wheel, an NGO
21	Ms. Tanzila Rahat	Lecturer	Dania College
22	Ms. Nargis Akhter	Demonstrator	Dania College
23	Ms. Nazma Nahia Nabi	Science graduate	
24	Ms. Anwara Hasina	Instructor	Dhaka Polytechnic Institute
25	Ms. Nasima Khanam	Junior instructor	Dhaka Polytechnic Institute
26	Ms. Kabita Hussain	Junior instructor	Mohila Polytechnic Institute
27	Ms. Feroza Begum	Junior instructor	Mohila Polytechnic Institute
28	Ms. Mahfuza Khatun	Senior instructor	Agricultural Training Institute
29	Ms. Parveen Akhter	Instructor	Agricultural Training Institute
30	Kaniz Fatema	Science graduate	
31	Ms. Latifa Akhter Jahan	Assistant director	Power Cell, government of

		(tariff)	Bangladesh
32	Ms. Fahmida Begum	Program coordinator	PSL
33	Ms. Salma Khatun	Scientific officer	PSL

Annex D

Business Plan for Opportunity for Women in Renewable Energy Technology Use in Bangladesh—Phase II the Professional Women

Business Description

The Goal

D.1 A major objective of the project is empowerment of rural women through (a) a business of selling DC lamps and controllers, and (b) off-grid energy service delivery by providing electric lighting to households and markets on a remote island off the southern coast of Bangladesh.

Business Location

D.2 The main office of the business is in rented premises on the island of Char Montaz, Patuakhali district, Bangladesh. At the moment, it has service operations in three other locations. At the end of phase II, the business will operate on five other nearby islands within Barisal division.

Proposed Business

1. The market for off-grid DC lamp and battery service will be expanded to a larger area so that more people can experience the benefit of modern lighting.
2. Financial viability of solar electrification service for the dispersed households that are too distant to be able to use grid and microgrid alternatives will be demonstrated.

3. In addition to DC lamp construction, the manufacturing facilities will be enhanced to assemble charge controllers for solar home systems.

4. The business will participate in the national SHS project.

Owner(s)

D.3 The business is wholly owned by the 35 existing members of the CEWDM, Char Montaz, Galachipa Thana, Patuakhali district, Bangladesh.

Operators

D.4 The members of the executive committee of the CEWDM will operate the business with assistance from the other members, the operations manager and other employees, and technical assistance from PSL.

Financing

D.5 The project has been in operation since September 1999. As of February 28, 2001, it owns total assets worth Tk16,17,215 (US$29,403). This will be available for business continuation. Funds for technical assistance and partial coverage of microenterprise development have been requested from ESMAP under phase II of the project. Capital funds for starting phase II have also been requested from the Whitley Foundation and FONDEM.

D.6 For continuity of successful activities and scaling up in the future, the microenterprise has received provisional approval for access to loans from a local development bank called Bank of Small Industries and Commerce (BASIC) in Bangladesh. There is also an opportunity to participate in the upcoming national SHS project, for which loan funds may be available for SMEs.

D.7 The business will succeed because

- There is a growing demand for use of DC lamps among the unelectrified households (who are already using car batteries to power television).
- There is a demand for battery use if a reliable BCS is available.
- Microgrid service is in demand in the unelectrified markets.
- There is a demand for SHSs among the middle-income households in dispersed rural areas.

- The women's microenterprise has gained technical and operational experience with off-grid electrification requirements.

Market Analysis and Electricity Demand

Target Market

D.8 There are seven unions in the surrounding project area targeted for marketing the DC lamps. The total number of households in the area is nearly 23,000, according to 1991 statistics,[30] including the islands and part of the mainland of Galachipa, Dashamina, and Kalapara. In the long term, the project is expected to have an impact on a population exceeding 100,000 within this area. Overall household density of the area is approximately 65 per square kilometer, which is well within the definition of priority areas for SHS installation.[31] Beyond the immediate project area and within the extended target area, there are about 42,000 unelectrified households in Mehendigonj Thana of Barisal district, which are also beyond any grid electrification plan of the next 20 years. Initial surveys indicate that about 17 percent of the households would be able to afford an SHS, and 43 percent can afford BCS service. The proposed business of off-grid electrification should be viable even if only 1 percent of the targeted market can be reached successfully in the near term. Awareness of the benefits from modern lighting will also enhance market growth.

Customers

D.9 Unelectrified rural households are the major customers for the product and services of the CEWDM. Households currently using two or more kerosene hurricane or kupi lamps and a radio spend about Tk150 (US$3.11) per month on this service (after considering the cost of fuel and replacement of lighting appliances). Through microfinance services, poor and marginal households earning between Tk2000 and Tk4000 (US$50 and US$80) and spending nearly Tk100 (US$2) will be able to afford a 20W SHS. Households with incomes above US$100 will be able to afford a 35W SHS with cash or credit payment.

D.10 Small shops in commercial centers and rural markets are customers for diesel-powered microgrid electricity for extending their business hours.

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[30] Bangladesh Bureau of Statistics Report 1991.

[31] Feasibility Study for a SHS Project within the Context of Alternative Options for Rural Electrification, by Prokaushali Sangsad Ltd. Funded by the World Bank, March 2000.

D.11 Fishing boats are large users of batteries, and they are potential customers for DC lamps and battery charging stations.

Competition

D.12 A major part of the target area is outside long-term plans for grid service, thus minimal competition is expected with off-grid service. Conventional kerosene lamps will remain in use, although DC lamps will replace them partially. Reliable BCSs from private entrepreneurs are not available in rural areas because of the lack of technical knowledge and business motivation. With the involvement of reliable BCSs, the market for DC lamps and batteries will grow.

Electricity Demand

D.13 Electricity demand for each of the different business ventures is varied:

- Households using 1 DC lamp use 0.12 kWh per five days or 0.72 kWh per month.
- Households using 1 20W SHS use approximately 1.5 kWh per month.
- Rural shops using diesel-powered microgrid service use maximum 100W AC lamps—that is, 0.50 kWh per night.

Marketing Plan

Marketing Goals

D.14 The marketing goals[32] are to

- Sell DC lamps to cover 2 percent of the entire market of DC lamps to be used with batteries by the unelectrified rural households[33] in Barisal division. Market development for use of DC lamps will be extended further, into 2,000 households within five districts of Barisal division with an estimated 778,000 unelectrified households.

[32] A revolving fund is being requested for 2000 lamps, 1000 batteries, 500 controllers and 200 solar panels. The strategy includes cash sale of DC lamps, six months microcredit for battery purchase and three years hire purchase of solar panel with controllers.

[33] According to the feasibility study for SHS reference Table C.1, in the unelectrified areas of Mehendiganj in Baeisal District and Galachipa of Patuakhali district, the target household numbers 65,000. An additional market in the electrified areas Dashmina and Kalapara of Patuakhali district are 13,000 and 27,000 respectively. As a conservative estimate, we assume that 20% will use DC lamps with battery or solar power, and 10% of the will be supplied by CEWDM. The scenario changes with access to national SHS project.

- Promote diesel-powered battery charging among households within 2 kilometers of a reliable charging station. A total of 400 households will be served through all the BCSs of the microenterprise per month, and a total of 900 rural shops will receive four to five hours of lighting service from the diesel-powered microgrids.
- Establish three new, diesel-powered BCSs.
- Through microcredit, sell 1,000 batteries for household lighting.
- Offer solar electrification service to 200 households in Char Montaz.
- Extend the production facility to initially assemble 500 controllers for SHSs.
- Participate in the national solar electrification project with efficient DC lamps and high-quality controllers.
- Implement a suitable financing mode for hire purchase or leasing of SHSs to households in Char Montaz.

Marketing Strategy for DC Lamps

D.15 The basic strategy for selling DC lamps for electrification is to partially replace the existing sources of lighting and energy of the rural households. Rural consumers' financial ability to pay for the lamps is seasonal, which has been taken into consideration in designing the marketing strategy. The specific marketing strategies of DC lamps are:

- Advertise DC lamps using the media, community meetings, local leaders, and rural organizations.
- In the areas where three new BCSs will be established, local investors will be provided with technical training and assistance on battery charging operation to begin business serving the households in their areas and communities.

D.16 There are several different avenues for selling the DC lamps built by the women's microenterprise. Table D.1 summarizes the market analysis of the sales outlets of DC lamps in the rural area. Using the available market analysis, scheduled marketing drives will be designed for generating demand for DC lamps.

Table D.1. Market Analysis of Sales Outlets for DC Lamps in Unelectrified Rural Areas

	Potential Customers	*Barriers*
1. Sales by CEWDM participants	Neighbors and relatives	Batteries are not available—credit needed for batteries
	Familiar businesses	Lack of awareness
	Village market	Weekly basis—battery needed for cash sale of lamps
2. From BCS at the Char Montaz market	Regular market customers	
	Businesses in the market	Short-term market (may get saturated)
	Fishing boat owners	Large but seasonal market
	Other	
3. Private retailers and sales centers in other islands	Retail sale to customers	Sustainable but slow growth of customers
	Cash sale to households	Lack of awareness—needs more demonstration
4. NGO sales to members from four regional centers	**Sale to NGO members**	Large market dependent on NGO credit funds
5. SHS electrification program	Sale to SHS users	SHSs have high up-front cost—affordable financing is needed
6. Union Parishad (local government administrative unit office)	Using the centers of Ministry of Women and Children Affairs	Limited access and awareness

D.17 Background information to be collected before and during marketing drive includes

- number of households and the potential market for DC lamps,
- household density in the unelectrified villages,

- number of commercial centers and rural markets for sales centers and BCSs,
- entrepreneurs interested in becoming agents for selling DC lamps,
- number of NGOs involved in other development activities in the area,
- discussion with the local elite and elders about attitude toward the project, and
- support of the local administrative bodies for the project.

D.18 Technical and nontechnical staff of PSL will provide the necessary support to the marketing agents for penetrating new market areas and product marketing.

Marketing Strategy for SHSs

D.19 The marketing strategy for SHSs is that rural households will be offered 36 months' microcredit for procuring solar panels with controllers. For systems with 2 DC lamps and a radio-cassette player (i.e.< 20Wp capacity), a household will spend about Tk150 (US$3.15) per month. Similarly, for the larger 40Wp panels used for 3 DC lamps and a television, a household will spend about Tk325 (US$6.62) per month.[34] It is estimated that a subsidy of US$50 per household will be needed for this purpose. Cheaper solar panels of 14Wp (thin-film technology), suitable for 2 DC lamps, will be introduced for this group of consumers. The project will begin with 200 of the smallest-size solar panels and gradually move toward larger ones, depending on demand and the beneficiaries' ability to afford them.

Marketing Budget

D.20 The marketing budget is expected to encompass total costs of travel, lodging, demonstration equipment, advertising, and other related expenses. It is anticipated that each marketing drive will require 5 to 10 days for one marketing agent and one technical staff member to cover one isolated location or two adjacent locations. The cost per marketing drive has been estimated to be Tk5,000 (US%100), and a monthly budget of Tk10,000 is to be allocated. Engaging in sales of lamps and controllers to the national SHS project will also require critical upstream marketing with the PBSs and NGOs and additional budget.

Technical Design, Equipment Procurement, and Construction Plan

[34] Business plan for "Opportunity for Women in Renewable Energy Technology Use in Bangladesh—Phase II," by Hasna J. Khan, September 2001.

D.21 Technical support will be provided to the microenterprise for proper selection of hardware and cost efficiency:

- The DC lamps are already in production by the microenterprise. To satisfy the target market and part of the upcoming national SHS project market, starting capital of Tk550,000 (US$11,000) for standard parts and components of 2,000 lamps is requested.
- At present the women's microenterprise rents a facility for assembly of DC lamps. A permanent facility will be necessary. The total cost of construction of this facility is estimated to be Tk60,000 (US$12,000). Discussions are continuing with the local government bodies for allocation of land in Char Montaz at no cost to the microenterprise.
- The budget for the microcredit revolving fund for 1,000 batteries is Tk Tk1,400,000(US$28,000).
- To provide a reliable service to the potential battery users in the vicinity, microcredit funds will be offered to assist private entrepreneurs in refurbishing existing facilities. Three BCSs will be refurbished at a cost of Tk 50,000 (US$1,000) each (a total cost of Tk150,000 (US$3,000) with loans to the owners).
- New BCSs will be built with 5kW generators, which will remain the property of the microenterprise unless co-investment is favorable for business operations. Three new BCSs will be established (one every six months) with microgrid service facilities at Tk200,000 (US$4,000) each (a total budget of Tk600,000 (US$12,000).
- Two hundred SHSs will be sold on hire purchase to the households in Char Montaz: 150 units of 20Wp and 50 units of 40Wp solar PV modules with frames will be procured at Tk1,400,000 (US$28,000).
- Controller assembly will require procurement of component parts, tools, and testing hardware, with an approximate cost of Tk650,000 (US$13,000) (including 500 controller kits for SHSs).

Table D.2. Breakdown of Costs

	Capital (US$)	*Labor (US$)*
Building and site for DC lamps assembly	10,000	2,000
BCS refurbishing	2,400	600

New BCS construction	10,500	1,500
Total	22,900	4,100

Operating Plan

Operating Procedures

D.22 The women's microenterprise will collectively make decisions for the benefit of the cooperative through the elected executive body, as shown in figure D.1. They will employ a full-time manager for guiding the overall management of the cooperative's activities. Women members of the cooperative are the labor force of the factory.

D.23 Marketing and electrification service operations will require additional full-time personnel, including

- two marketing agents responsible for marketing drives and hardware procurement,
- one technician and operator for the BCS in Char Montaz, and
- one diesel generator and microgrid operator for each established BCS.

D.24 In addition, the cooperative will meet with the 10-member advisory body once each quarter to discuss business prospects and planning. The consultants of PSL will offer their technical expertise to the microenterprise and monitor management and operations until the end of the project period. It is expected that the enterprise will be able to take responsibility for all aspects of operation by that time.

Operating Facilities

D.25 The women's microenterprise will operate the DC lamp construction and controller assembly facility, as well as the solar electrification business, the BCS, and microgrid service. Space procured in the commercial market will remain the outlet center for meeting consumers and potential clients. A new and permanent facility will be constructed for assembly of DC lamps and controllers. Cash sale of lamps and batteries will be accomplished through the outlet centers and selected retailers in the area. The pricing structure to be followed by all outlet centers and retailers will be provided by the cooperative.

Product Purchasing

D.26 Technical support for hardware and product purchasing will be provided by PSL. Local staff employed by the women's microenterprise are being trained in hardware procurement.

Service Delivery

D.27 The women's microenterprise will take total responsibility for delivery of services to its clients. The ongoing operational policies of the BCS will be maintained by all BCSs. All daily, weekly, and monthly fees collected are deposited in the bank account of the microenterprise.

Quality Control System

D.28 The DC lamp manufacturing facility has its own procedures for quality control of production. The new establishment for controller assembly will have its independent quality-control testing procedures. Diesel BCSs and microgrid services are regularly monitored for reliability of charging performance and fuel quality control. BCS user feedback is taken seriously as a system performance indicator. Solar electrification service will be managed with established criteria on PV system performance and quality control. Results of a survey of users will be used as criteria for service quality control and monitoring.

Organizational Plan

Organizational Structure

D.29 *Women's Cooperative.* The cooperative registered with the Ministry of Women and Children Affairs is named Coastal Electrification and Women's Development Microenterprise (CEWDM). According to its constitution, this body will be made up of 35 women members who will elect and guide an executive committee to be responsible for all its operations. (Figure D.1 shows the organizational structure and the functions of its different components.)

D.30 *Advisory Body.* The microenterprise will maintain an advisory body, which will be made up of the local elite and representatives from the CEWDM.

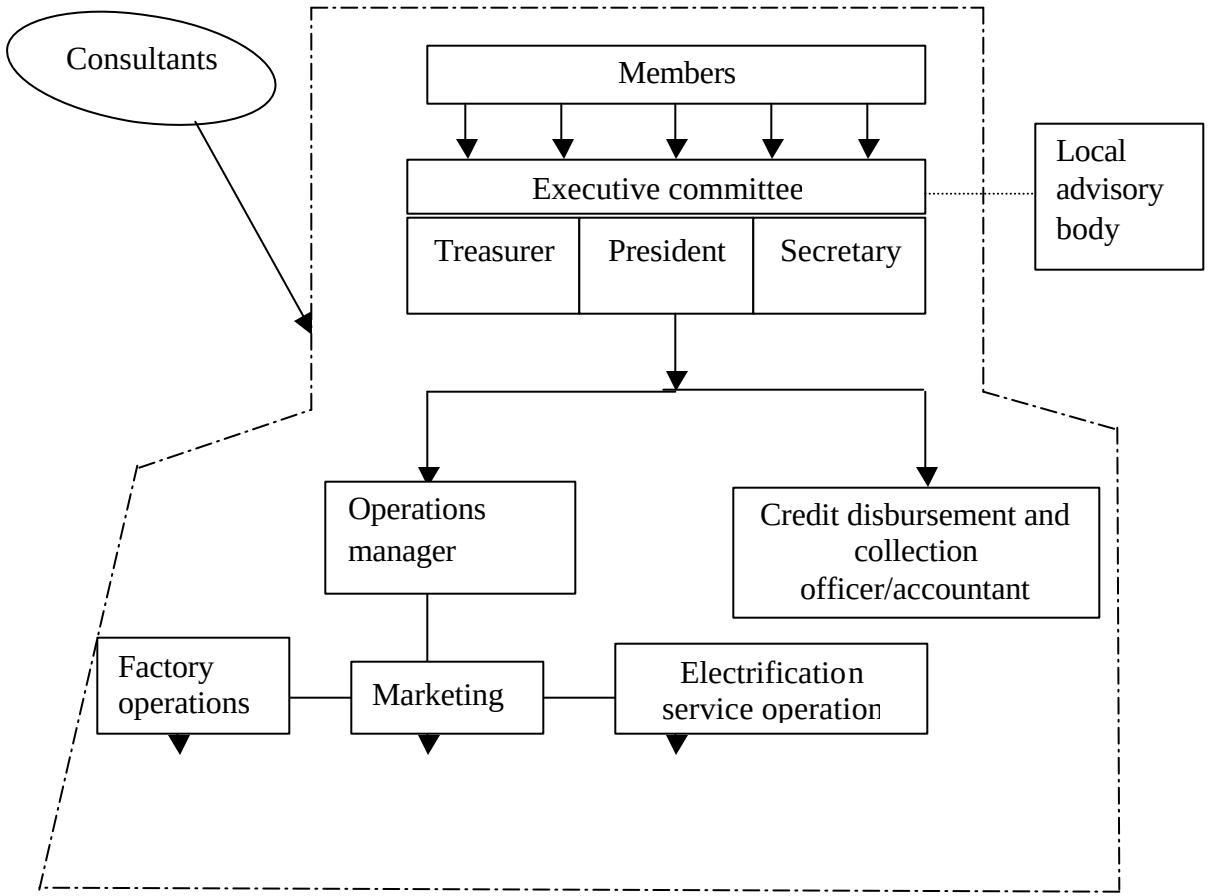
D.31 Technical *Support Team.* Standard operation and maintenance of the BCSs and solar electrification systems will be performed by the technical support team engaged by the cooperative.

Other Links

D.32 *PBSs.* Periodic liaison will be maintained with all the PBSs within Barisal division. The DC lamps and controllers manufactured by the microenterprise will be made available to future SHS programs to be undertaken by all the participating PBSs.

D.33 *Local Government Services.* The women's cooperative is interested in providing off-grid lighting service (diesel- and solar-powered, as appropriate) to the Asrayan and Adarsha Gram housing projects developed by the government of Bangladesh for landless people, and it has been in contact with the relevant officials in this regard. Liaison will also be maintained with the office of the district commissioner of Patuakhali for obtaining national-level government support available for community organizations.

Figure D.1: Functional Chart of the CEWDM



Financial Analysis and Plan

Business Cash Flow

D.34 There are two business plan options for the microenterprise, and they are significantly different in the potential business opportunities and management considerations.

D.35 *Option 1 with Basic Market.* With the business-as-usual option, the microenterprise is expected to scale up its ongoing business of DC lamps assembly and sales, battery sales through microcredit, BCS operation with microgrid service with diesel generator, and sales of a small number of SHSs on hire purchase or lease basis.

D.36 *Option 2 with Extended* Market. In addition to all of the business options described above, the microenterprise may participate in the upcoming national SHS project of the Rural Electrification Board (REB) as a supplier of DC lamps and controllers assembled by the microenterprise. Under this project, they will supply SHSs to 2,000 households.

D.37 Both the options are being considered by the microenterprise. Option 1 is less demanding of external financing after the project has begun, and option 2 will require access to commercial or concession funds for its execution. However, the aim of the microenterprise is to prepare for option 2 and establish its market demand from the initial stage.

D.38 A comprehensive seven-year financial analysis for the microenterprise has been prepared. A revolving fund has been budgeted for 2,000 lamps, 1,000 batteries, 500 controllers, and 200 solar panels. The strategy includes cash sale of DC lamps, six months' microcredit for battery purchase and three years' hire purchase of a solar panel with controller. A summary of the various assumptions used in arriving at the financial analysis is given in tables D.3 to D.7. Distribution of capital costs is described below.

Capital Cost Distribution

D.39 Distribution of capital costs among the different business ventures includes the costs of a permanent factory facility (US$15,000), three diesel generators and BCSs (US$11,000), and a revolving fund for DC lamp and battery, solar home system purchase, and controller assembly startup (totaling US$83,000 in two years). Revenue generated from the continuing and future business activities will be reinvested into business expansion to serve the unelectrified areas.

D.40 It is anticipated that a financial loan will be necessary for the CEWDM to engage in option 2 with the extended market, as shown in the cash flows of the business plan. It is assumed that the CEWDM will participate for a minimum of three years in the REB's SHS project. It is also assumed that at the end of the three-year term for hire purchase, the CEWDM will reinvest in further dissemination of SHSs. The business plans are prepared for seven years to include two turnovers of the SHS capital cost. Similarly, the revolving fund from lamp, battery, and controller sales will also be reinvested to continue

business. In the fifth year, US$31,638 will be being spent on solar panels with accessories, and the funds will be reinvested as cost of goods. This will be recovered within three years (years 5, 6, and 7). However, the subsidy portion of the cost—US$10,000 (US$50 per module)—will not be recovered in the existing model. The microenterprise will have to adjust this cost with higher tariffs in the second cycle unless external subsidy funds are available.

Financial Controls

D.41 The CEWDM will recruit a full-time manager to oversee operations. Today, the elected treasurer and secretary of the CEWDM manage the accounts. They are the official account operators and are responsible for maintenance of records, bank deposits, and withdrawals. However, in case of option 2, an accountant will also be recruited to assist them with the relatively larger financial operations and management of bank loans.

Table D.3: Income Statement for Women's Microenterprise Option I (with basic market)

	Year						
	1	*2*	*3*	*4*	*5*	*6*	*7*
Sales	15,404	47,424	42,563	42,563	42,563	42,563	42,563
Cost of Good	70,850	18,667	18,667	18,667	53,820	22,182	22,182
Gross Margin from Sales	(55,446)	28,757	23,896	23,896	(11,257)	20,381	20,381
Other Income (BCS line income)	11,073	17,400	18,982	18,982	18,982	18,982	18,982
Operating Expense	18,161	21,736	18,949	18,949	19,382	19,382	19,382
Depreciation	2,000	2,000	3,000	3,000	3,000	3,000	3,000
Net Income before Tax	(64,534)	22,421	20,929	20,929	(14,658	16,980	16,980
Income Tax							
Net Income	(64,534)	22,421	20,929	20,929	(14,658	16,980	16,980
Profit Margin=Net Income/Sales	-4.19	0.47	0.49	0.49	0.34	0.40	0.40

Table D.4: Income Statement for Women's Microenterprise Option II (with extended market)

	Year						
	1	*2*	*3*	*4*	*5*	*6*	*7*
Sales	15,404	164,424	159,563	159,563	42,563	42,563	42,563
Cost of Good	70,850	110,303	110,303	110,303	53,820	22,182	22,182
Gross Margin from Sales	**-55,446**	**54,121**	**49,260**	**49,260**	**-11,257**	**20,381**	**20,381**
Other Income (BCS Line income)	11,073	17,400	18,982	18,982	18,982	18,982	18,982
Operating Expense	20,561	28,636	30,349	30,349	19,382	19,382	19,382
Depreciation	2,000	2,000	3,000	3,000	3,000	3,000	3,000
Net Income before tax	-66,934	40,885	34,892	34,892	-14,658	16,980	16,980
Income tax							
Net Income	-66,934	40,885	34,892	34,892	-14,658	16,980	16,980
Profit Margin = Net Income/Sales	-4.35	0.25	0.22	0.22	-0.34	0.4	0.4

Table D.5: Cash Flow Statement for Women's Microenterprise—Option I (with basic market)

	Year 1		*Year 2*		*Year 3*		*Year 4*		*Year 5*		*Year 6*		*Year 7*	
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Revenue	Phase 2 Implementation													
Microenterprise Dev fund	60,496	40,330												
Equity									15,819	15,819	15,819			
Loan														
Income per 6 months														
Sales		15,404	15,404	23,204	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404
Microcredit for SHS			2,939	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878
Service	4,745	6,327	7,909	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491
Total Cash	**65,241**	**62,061**	**26,252**	**38,573**	**30,773**	**30,773**	**30,773**	**30,773**	**46,592**	**46,592**	**46,592**	**30,773**	**30,773**	**30,773**
COSTS														
Capital Costs														
Generator	3,704	3,704	3,704											
Building	10,000	2,000												
Installation Cost	3,500	1,045	1,045	1,000	1,000	1,000								
Solar Equipment		31,638							15,819	15,819				
Electronic Components	20,545								3,515		3,515		3,515	
Battery	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333
Micro-grid Cable etc.	1,500													
Operating Cost														
Marketing	1,451	1,451	1,451	1,451	120	120	120	120	120	120	120	120	120	120
Fuel Cost	1,800	2,400	3,000	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Maintenance Cost	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Co-op Staff Salary	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
MC Fee Collection Cost		600	600	600	600	600	600	600	600	600	600	600	600	600
Factory Labor Cost		433	433	433			–-	–	433		433		433	
Rental Space	513	513	513	655	655	655	655	655	655	655	655	655	655	655
Miscellaneous Cost	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Total Cost	**56,846**	**57,617**	**24,579**	**21,572**	**19,808**	**19,808**	**18,808**	**18,808**	**38,575**	**34,627**	**22,756**	**18,808**	**22,756**	**18,808**
Cash Flow (Revenue-Cost)	8,395	4,444	1,673	17,001	10,965	10,965	11,965	11,965	8,017	11,965	23,836	11,965	8,017	11,965
Loan repayment (Less)														
Net Cash Flow	8,395	4,444	1,673	17,001	10,965	10,965	11,965	11,965	8,017	11,965	23,836	11,965	8,017	11,965
Net Cash Flow / year		12,839		18,674		21,930		23,930		19,982		35,801		19,982
Cash Balance in $		**12,839**		**31,513**		**53,441**		**77,371**		**97,353**		**133,154**		**153,136**

Table D.6: Cash Flow Statement For Women's Microenterprise—Option II (with basic market)

	Year 1		*Year 2*		*Year 3*		*Year 4*		*Year 5*		*Year 6*		*Year 7*	
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Revenue	Phase 2 Implementation													
Microenterprise Dev fund	60,496	40,330												
Equity									15,819	15,819				
Loan														
Income per 6 months														
Sales		15,404	15,404	23,204	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404	15,404
Microcredit for SHS			2,939	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878	5,878
Service	4,745	6,327	7,909	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491	9,491
Total Cash	65,241	62,061	26,252	38,572	30,772	30,772	30,772	30,772	46,591	46,591	46,591	30,772	30,772	30,772
COSTS														
Capital Costs														
Generator	3,704	3,704	3,704											
Building	10,000	2,000												
Installation Cost	3,500	1,045	1,045	1,000	1,000	1,000								
Solar Equipment		31,638							15,819	15,819				
Electronic Components	20,545								3,515		3,515		3,515	
Battery	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333	9,333
Micro-grid Cable etc.	1,500													
Operating Cost														
Marketing	1,451	1,451	1,451	1,451	120	120	120	120	120	120	120	120	120	120
Fuel Cost	1,800	2,400	3,000	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Maintenance Cost	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Co-op Staff Salary	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
MC Fee Collection Cost		600	600	600	600	600	600	600	600	600	600	600	600	600
Factory Labor Cost		433	433	433			–	–-	433		433		433	
Rental Space	513	513	513	655	655	655	655	655	655	655	655	655	655	655
Miscellaneous Cost	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Total Cost	56,846	57,617	24,579	21,572	19,808	19,808	18,808	18,808	38,575	34,627	22,756	18,808	22,756	18,808
Cash Flow (Revenue-Cost)	8,395	4,444	1,672	17,000	10,964	10,964	11,964	11,964	8,016	11,964	8,016	11,964	8,016	11,964
Loan repayment (Less)														
Net Cash Flow	8,395	4,444	1,672	17,000	10,964	10,964	11,964	11,964	8,016	11,964	8,016	11,964	8,016	11,964
Net Cash Flow / year		12,839		18,672		21,929		23,929		19,980		19,980		19,980
Cash Balance in $		12,839		31,513		53,440		77,369		65,711		85,691		105,672

ANNEX: COST BREAKUP FOR WOMEN'S MICRO-ENTERPRISE PROJECT

Installation		$		
SHS	300 Taka each	1091	For 200 SHS	
BCS installation		500	each	
BCS refurbish		1000	each	Loan to private sector provider
Micro-grid cable etc.		500	each BCS	
Operating Cost				
Marketing drive		182	$/mo	2 drives per month
Fuel Cost (per additional BCS)		100	$/mo	
Space rental for Factory		1700	Taka/mo	For 18 months (untill the factory space)
Space rental for BCS		1000	Taka/mo	For each BCS

Lamp				
Factory Labor cost		55	Taka/unit	$1 for all sold units of lamps and controllers
Lamp selling price		6.5	$/unit	
Number sold per month		56		1000 sold in 18 months
Additional sale for SHS project		500		500 sold per month for 36 months

Battery	20 AH	70 AH	
Size			
Original price of battery	20	52	$/unit
Markup for sale/micro-credit in%	20	20	
Selling price of battery	24	62	$/unit
Number sold per month	42	14	1000 sold in 18 months
Monthly fee (6 month credit)	3.8	10	$/unit

Solar panel			
	20 Wp	40 Wp	
Price of Solar panel	112	214	$/unit
Markup for micro-credit	15%	15%	
Selling price of solar panel	138	262	$/unit
Subsidy for solar panel	50	50	Subsidy for SHS
Subsidized price of solar panel	88	212	
Number sold per month	13	4	200 sold in 12 months
Monthly install. (36 month credit)	2.43	5.90	$/mo
Installment for 6months	15	35	$/ 6 mo.

Controller			
Original price of controller components	20	$/unit	
Selling price after assembly	26	$/unit	Also wholesale ex factory price
Subsidy for controller	0		
Number sold per month	17		200 sold in 12 months
Monthly install(36 month credit)	0.72	$/unit	
Installment for 6 months	4.33	$/ 6 mo	
Balance of first batch of controllers	300		For retail sale with SHS
Additional sale for SHS project	250		250 per month for 36 months

Service Income	Number	Taka	$ per mo	
BCS Charges per month	400			
Average fee per Charge		25	0.45	
Existing BCS Service	3	10000	182	
New BCS	3	10000	182	Installing 1 new BCS per six months
No. of Micro-grid customer fees/mo	900			
Average fee per light per night		5	0.09	
Existing Micro-grid service	3	4500	82	
New Micro-grid	3	4500	82	Installing 1 new micro-grid per six months
Cash sale to SHS user			$ 20	Mount + wiring etc.

Annex E

Guidelines for Equitable Use of Renewable Energy Technologies (RETs) by the Public Sector in Bangladesh

E.1 The goal for any developing country is to reduce its poverty by promoting economic growth. Economic growth depends on the availability and use of modern energy and technology by a majority of the population. Today, the developing countries use less than 20 percent of the world's energy resources, but account for 80 percent of the world population; and as a result they not able to achieve economic growth. In Bangladesh, only 22 percent use modern electrification. Its rural households use mostly biomass as fuel, lack significant access to commercial energy, and rely on primitive energy consumption devices. Modern energy supplies remain unaffordable for most of the rural population. As a result, economic growth in the country continues to lag, and limited resources are not being used efficiently.

E.2 Evolving energy technologies can change these unequal consumption patterns. However, before any change can occur, the potential of available resources, which include both renewable and nonrenewable energy sources, must be optimized. Policymakers should emphasize renewable energy and energy efficiency along with commercial primary energy as an integral part of Bangladesh's total energy delivery system. Bangladesh's national plan for using energy resources must recognize these realities to meet the growing energy demand from both urban and rural areas.

E.3 Bangladesh's National Energy Policy (NEP)35 has been in place since 1996. The NEP stresses the importance of planning conventional energy use, but it lacks sufficient consideration of renewable energy technologies (RETs). Moreover, in the absence of an apex organization for administering renewable energy activities, no identifiable progress has been made in renewable energy activities in compliance with the national plan.

E.4 Similar to the NEP, the Fifth Five-Year Plan of the Planning Commission has placed a low priority on renewable energy. Appropriated funds for RETs have been

[35] "National Energy Policy," *Bangladesh Gazette,* Ministry of Energy and Mineral Resources, Government of the People's Republic of Bangladesh, January 6, 1996.

negligible. As a consequence, Bangladesh in recent years has had difficulty attracting global funds for its energy sector. This deficiency of funding can be overcome by emphasizing renewable resources and strategically applying modern technologies.

E.5 The Guideline was prepared to promote and incorporate energy efficiency, gender and renewable energy technology in the planning activities of the sector ministries of Bangladesh. The guideline was prepared as a component of the Opportunity for Women in Use of Renewable Energy Technology (RET) in Bangladesh project, sponsored by the Energy Sector Management Assistance Program (ESMAP), a joint program of the World Bank and the United Nations Development Programme (UNDP).

E.6 The use of biomass for cooking, which accounts for more than 60 percent of Bangladesh's total energy consumption, continues to have significant and negative economic, health, and environmental impacts on the rural population. This trend is expected to continue for many years, until more efficient fuels and new technologies are made available. Women are the majority users of biomass for supplying energy. They gather the fuel and burn it in inefficient cooking devices. Both activities make significant demands on their time and pose a threat to their health and that of their families. Improved design for energy-efficient cooking stoves can have a significant positive impact on the health of women and their families, the rate of biomass fuel consumption, and depletion of natural resources. Efforts are needed to develop such cooking stoves, which would be affordable to the poorest and disseminate information about such devices so that the entire rural population can benefit.

B.8 In this efficiency and gender context, diversification of energy alternatives should play an integral part in the public sector's planning process, especially in the case of rural development. This document will identify such energy alternatives as components of public programs, with special emphasis on RETs. Addressing these alternatives should improve Bangladesh's energy use environment in the long term. For example, in the power sector, scarce conventional energy resources can be conserved if dispersed rural households begin using solar electrification.

E.7 Existing policy instruments and institutional mechanism are inadequate for promoting commercial use of RETs and energy-efficient devices. Moreover, RET devices have high initial costs and require a special financial infrastructure to ensure their acceptability and use. Likewise, efficient devices should be made available at prices that are competitive with conventional energy devices. Until operational and institutional structures, accompanied by favorable policy guidelines for RETs, are in place, the role of the private sector as service provider or end user will remain very limited. In the absence of an effective framework, private initiatives face considerable investment risk and often make choices without sufficient attention to efficiency. To reach significant private interest in RETs and energy efficiency, the public sector must create the enabling environment.

Rationale of the Guideline

E.8 This Guideline provides recommendations for the policy framework necessary for incorporation of energy efficiency and gender issues, and accelerated use of RETs, in the planning and programs undertaken by the sector ministries. The guideline focuses these three issues:

1. *efficiency:* the approach to incorporate energy efficiency in public programs, with special emphasis on industrial and rural areas;
2. *RET:* incorporation of RET in the policy framework and in various government sector programs, and steps to ensure its implementation; and
3. *gender:* priority gender issues in government energy programs and steps to ensure their incorporation.

Expected Impact of the Guideline

E.9 With suitable advocacy for using the guideline and increased awareness among the decisionmakers of its issues, it is anticipated that it will have the following impacts at various levels:

- The Planning Commission, in coordination with the planning cells of the sector ministries, will focus on the policy framework for RETs by taking these actions:
  - ? Enacting a policy paper on renewable energy,[36]
  - ? Selecting priority national programs and activities using RETs,
  - ? Identifying projects to be included the Sixth Five-Year Plan, and
  - ? Forming an apex organization to regulate renewable energy activities.
- The guideline will also provide supply and demand indicators for developing integrated planning tools for use of RETs and energy efficiency in future projects of the public sector. If such a congenial policy environment can be developed, it should increase the private sector's interest in RETs and energy efficiency. Specifically, RETs can strategically contribute to the national rural electrification program.
- Further, it is expected that the existing information databases on women in development (WID) and gender and development (GAD) will be used in the preparation of RET policies and

[36] "Revised Draft of Renewable Energy Policy of Bangladesh," Ministry of Energy and Mineral Resources, Government of the People's Republic of Bangladesh, 1999, prepared by the Power Cell.

planning. This will enhance mainstreaming of gender and RET issues in policy formulation. Likewise, the WID and GAD focal points within the government offices may also promote incorporation of RET and energy efficiency issues and achieve a long-term impact on social development.

- It is envisaged that current energy systems would address the basic needs of the rural economy through focused project preparation benefiting health, education, energy, and economic development of women and the poor. Continuation of existing practices and policies should be sustainable without limiting the economic, social, and environmental prospects of future generations.

Methodology Adopted for Preparation of the Guideline

E.10 The guideline has been prepared by Prokaushali Sangsad Limited (PSL) through three major activities:

1. The Annual Development Plan of 1999–2000 was reviewed for selecting several representative projects. It was analyzed to investigate the scope of incorporating RETs in typical project documents and develop generalized guidelines that could be adopted by the planners. The various steps taken during the process were:

a. Collecting Project Pro-forma (PP) of selected projects for study,

b. Meeting with selected representatives of the sector ministries, and

c. Analyzing PP to identify the scope of RETs and the draft guideline.

2. The draft guideline was distributed with a request for comments from the planning cells of the sector ministries and relevant government departments active in RET promotion.
3. A one-day seminar was conducted for ESMAP.[37] The Seminar on Incorporation of Renewable Energy Technology (RET) in Development Projects was convened on November 18, 2000. Attendees included the Minister of Agriculture, members of the Energy Planning Commission, national officials, representatives of the private sector and industries involved in RETs, bilateral donors, the World Bank, and representatives of the nongovernmental organizations (NGOs). The seminar was

[37] Seminar on Incorporation of Renewable Energy Technology (RET) in Development Projects, November 18, 2000, organized by PSL and sponsored by ESMAP.

organized to identify key issues for incorporation of RETs in development projects. The final draft of the guideline, incorporating comments from the sector ministries and the various presenters at the seminar, has been prepared. The major issues and highlights of the speeches are presented in annex A to this volume.

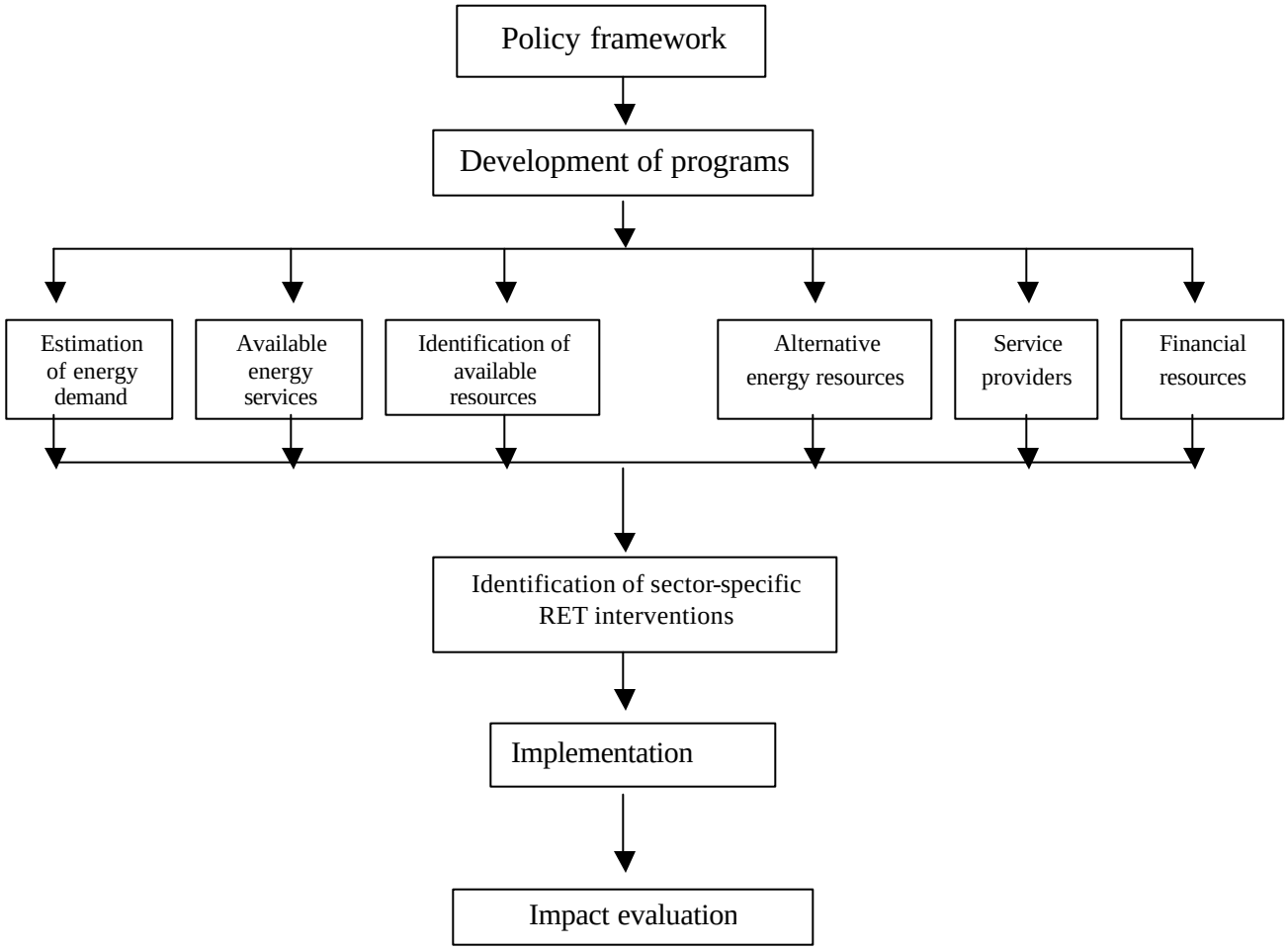
Delivery of RET Services

E.11 Energy services are described as the benefits made available to the end user in all sectors. There are several parameters of significant importance that must be fulfilled before such services reach the end user in the domestic, commercial, or industrial sector. In the case of RETs, these parameters would include

- policy framework:
  - ? development and enactment of a policy paper on renewable energy, and
  - ? strategy formation for translating policy into programs and actions.
- program development:
  - ? selecting priority national programs and activities using RETs,
  - ? identifying programs and projects to be included the Sixth Five-Year Plan,
  - ? feasibility of the programs and projects,
  - ? financial viability of the technologies,
  - ? supply of materials and hardware, and
  - ? safeguarding the environment and the population.
- implementation:
  - ? institutional arrangements for services,
  - ? technical education and information dissemination, and
  - ? – human resources development.

E.12 A schematic flow diagram for planning and implementation of RET projects is given in figure 1.

Figure E.1: Flow Diagram for Planning and Implementation of RET Projects



A Policy Framework

E.13 The objectives of expanding power supply in the rural areas are to boost regional economies, alleviate poverty, and ensure women's participation. Conventional power alone cannot achieve these objectives. RETs have the advantage of being decentralized sources of power that can satisfy the basic needs of dispersed rural households. RET use can achieve a significant impact on Bangladesh's energy growth and environmental health, but only if a sound policy framework is in place to promote private and public investment.

E.14 At the policy level, two actions are required:

1. enacting a final policy paper on renewable energy, and
2. developing a strategy.

E.15 To ensure effective use of available resources, an integral approach to energy planning as recommended in the National Energy Policy is needed, which would include both nonrenewable [38] and renewable energy. With input from public, private, and NGO sectors, the Power Cell has prepared a draft document on renewable energy policy. This document has been available for the past several years. However, because of lack of initiative for implementation, it has not yet had a direct impact on RET use. To gain sustainable economic benefit from natural resources, it is time to expand the Power Cell's draft document and develop the strategies and policies for effective use of renewable energy and promotion of energy efficiency in the national interest.

Development of Programs

E.16 Consistent with the revised policy paper and policy strategy, the Sixth Five-Year Plan and, consecutively, programs and projects of various ministries need to incorporate RET and energy efficiency. These three actions are required:

1. identifying projects to be included the Sixth Five-Year Plan,
2. selecting priority programs and activities using RET, and
3. RET interventions in sector- and ministry-specific programs and projects.

E.17 However, the above actions need to consider certain aspects—such as feasibility, financial viability of the technology, and availability of materials—to develop various RET programs.

[38] "Reflections on Energy Development Issues of Bangladesh," by M. N. Islam, paper presented at the 43rd Convention of the Institution of Engineers, Bangladesh, March 20, 1999.

Availability of Renewable Energy Resources

E.18 Renewable energy resources are distributed over the Earth and include solar, wind, micro- and minihydro, geothermal, tidal, and bioenergy resources. Apart from the traditional use of bioenergy for cooking, all forms of renewable energy can be converted into efficient sources of electricity through modern technology. Focusing on modern technologies ensures that renewable energy sources will begin to contribute to grid-based electricity generation as well as off-grid electrification. The latter is known to contribute to the benefit of rural economies in the developing countries, where the grid infrastructure has not yet reached dispersed locations.

E.19 *Solar Energy.* Solar energy is available more uniformly over the country than other forms of renewable energy. On average, during the period of low solar insulation in winter, approximately 5 kilowatt hours (kWh) per square mile are available in Bangladesh. This amount increases during the summer to approximately 8kWh/square mile, due to longer duration of daylight. Efficient use of solar energy can be integrated in the planning stage of a particular program design. However, overcast and cloudy days reduce potential of solar energy use, and this should be taken into consideration in designs.

E.20 Wi*nd Energy.* Wind energy resources in Bangladesh are location- and season-specific. Usable wind energy is available approximately during the months of May to August. June is the peak month for wind energy. Limited assessments of wind resources in the coastal areas show average annual wind speed variations from 3.5 to 4.2 meter per second (m/sec). Although this is below the requirement of cost-effective application, the utility of wind energy can be enhanced through wind-diesel hybrid systems.

E.21 *Bioenergy.* Bioenergy is the most widely used renewable energy in Bangladesh. Approximately 70 percent of the total energy consumption of the country is bioenergy-based, consumed by 12 million rural households. Energy efficiency and conservation in bioenergy use would have a widespread impact on the environment, and on the health of rural women and children in particular. It also would reduce the cost of energy and prevent biodegradation.

E.22 Microhydro *energy.* To harness its potential energy, microhydropower requires a steady water supply from sufficient altitude. The hilly terrain and irrigation reservoirs of the hill tract region of Bangladesh show potential for application of this technology. High flow rates in rivers are also potential sources of energy. However, the necessary technology is currently limited.

Feasibility

E.23 Potential benefits of renewable energy should be evaluated on a case-by-case basis. There is no universal method of evaluation of benefits, because performance of these technologies is closely tied to local conditions and availability of natural resources. RET use is very specific to the spatial and temporal variations of natural

renewable resources. Spatial and geographic distribution of natural energy resources within a country are major criteria for effective planning for RET applications. It is also important to consider temporal or seasonal dependence of renewable energy resources. This parameter is critical to the cost effectiveness of each renewable resource because it imposes a natural constraint on use.

Financial Viability of the Technologies

E.24 The financial viability of RETs and energy efficiency options is case-specific and a function of the robustness of financial planning. There are several financial instruments that need to be in place for widespread distribution and commercialization of RET. On a level playing field, renewable energy is found to be the least-cost solution to many applications. Amortization of RET costs over their useful life increases the viability of application, especially when they are integrated into a basic service plan competing with the subsidized alternatives. Considerable subsidies are offered to conventional power generation. Its productive end uses have been instrumental in the establishment of its infrastructure. However, the cost of developing a viable infrastructure for renewable energy adds to the cost of the technology itself. Therefore, it is necessary that favorable national policies and appropriate local capacity be developed to create a supportive environment for testing the commercial viability of RETs.

E.25 The infrastructure for capital investment is one of the most important building blocks in a developing economy. Domestic and local investment in renewable energy can be initiated through effective policy adoption, tax incentives, duty and tariff reduction, ease of foreign exchange regulations, and so forth. Without the inflow of capital funds to the energy sector, many potential benefits can never be achieved, especially considering the high capital cost of RETs.

E.26 The existing draft proposal for renewable energy policy drafted by the Power Cell has identified the essential issues concerning the fiscal benefits of promoting RET use. Further action for its enactment will assist progress of RET use in Bangladesh.

Supply of Materials and Hardware

E.27 A steady supply of materials and hardware is a basic need of any successful business environment. But it is not ensured in the commercial market of Bangladesh, because much renewable energy hardware is imported. There is limited demand for the necessary material, and it is not common to find an adequate supply or variety in the local markets. Sufficient planning of time and other resources is therefore needed to improve the supply of raw materials. Most electrical and electronics materials are imported, as are raw materials for plastic, metal, glass, and other supplies. Therefore, domestic users are limited by the availability of supply either in quantity or quality. An essential aspect of equipment procurement is its selection from the retailers with warranty. For the rural area, many of the national manufacturers do not provide a warranty, discriminating against rural consumers and project developers. Locally manufactured or assembled products are necessary to instill confidence, as was found in

the direct current (DC) lamps manufactured by the Coastal Electrification and Women's Development Microenterprise (CEWDM) on the island of Char Montaz.[39]

RET Interventions in Sector Programs

E.28 After considering the factors described in section 5, the interventions in various sectors need to be identified so that the public sector ensures a greater return on the limited financial resources. Potential areas of RETs use and energy efficiency in the public sector include:

- energy
- industry
- health,
- communications,
- agriculture, and
- rural development

The Energy Sector

E.29 In recognition of the benefit of solar electrification to rural communities, the Rural Electrification Board (REB) [40] recently began a project using solar photovoltaic (PV) for lighting. The project was approved in April 2000 by the Executive Committee of the National Economic Council (ECNEC). Solar PV is a proven technology that can be used for "pre-electrification" of rural households until grid services can be made available. Solar PV may also be adopted by the health and education sector of Bangladesh, so that modern lighting can bring more benefit to the rural population. Using solar PV for lighting rural schools and clinics can extend their evening hours.

E.30 Intervention by the energy sector should:

- Use RETs for decentralized power generation;
- Use RETs as cost-effective supplements to grid electrification and for pre-electrification of rural households;
- Introduce solar PV for household and building electrification in remote areas by the public sector, private sector, and NGOs;
- Make energy conservation assessments mandatory for new physical plant designs and commercial architecture;

[39] "Opportunity for Women in RET Use in Bangladesh, Volume I.
[40] "Diffusion of Renewable Energy Technologies—2nd Phase," Directorate of Program Planning, REB, June 2000.

- Use biogas plants for household cooking gas production, thereby improving health and sanitation; and
- Use PV systems for cathodic protection of underground gas pipelines.

The Industrial Sector

E.31 The industrial sector is the country's foundation for growth and economic development. Although the developmental indicators of Bangladesh reveal a slow rate of growth in this sector, possible technological interventions should be investigated. RETs, energy conservation, and energy efficiency have the potential for aiding the development of small and cottage industries. Projects undertaken by the Bangladesh Small and Cottage Industries Corporation (BSCIC) include basic infrastructure development such as land acquisition, electricity, water, and other service facilities for industrial estates. Because most of the applications of alternative technologies are modular in nature, they can be integrated into the planning stage of any project.

E.32 Energy conservation through thermal heat exchangers reduces power consumption, which improves energy efficiency and overall performance. Such devices should be promoted in locations where industries are using process heat. This reduces total energy consumption, typically from oil, gas, and wood. All primary process industries—such as plastic, metal, glass, and others, including dying (cottage textile industries)—use significant amounts of thermal energy, which may be optimized for energy conservation. In addition, solar drying mechanisms in agro-food processing can be used with the introduction of appropriate technical measures. In distant and isolated locations, solar PV–based drinking water pumping and thermal distillation can also be considered if they are cost effective. Possible interventions in the industrial sector include

- Energy conservation measures in all industries using process heat;
- Solar thermal energy for preheating water for industrial use;
- Decentralized power generation from RETs in rural industries;
- Energy auditing programs in existing public sector industries and other facilities;
- Incentives for domestic manufacture of RET products;
- Projects for technical improvement of existing RET products—for example, solar drying mechanisms, thermal heating and distillation processes;
- Use of solar PV for lighting in dispersed unelectrified areas;
- Solar PV for communications systems in remote areas; and
- Solar-powered pumps for drinking water supply in isolated locations.

The Health Sector

E.33 Widespread use of renewable energy in the health sector of developing countries is evident today. Appropriate planning of resources can lead to efficient and economic use of RETs. Although rural health clinics provide the only health services to the poor, these centers are not adequately equipped with services. Solar PV used in vaccine refrigeration is known to meet World Health Organization (WHO) standards, removing a major constraint od maintaining cold chain for vaccine preservation in rural areas. Availability of safe drinking water through solar thermal distillation has proven successful, requiring minimum maintenance from individuals with low levels of formal education. Dispersed sources of water for the villages can be accessed through solar PV water pumping. In addition, women have a special role in health and sanitation at the village level. Direct participation of women in awareness building within their communities has been found to have a long-lasting impact on the success of the projects. Possible interventions in this sector are

- Solar PV for lighting rural health clinics;
- Solar PV for vaccine refrigeration;
- Solar PV for water purification;
- Solar thermal power for water distillation, preheating water for disinfecting utensils, and laundry in rural health clinics; and
- Solar and wind power (if feasible) for pumping for rural drinking water supplies.

The Communications Sector

E.34 The communications sector in Bangladesh has been using solar modules for many years. In addition to wireless communications for public telephone service and transportation, the Disaster Management Bureau uses this technology to send information to remote areas. The remote islands and isolated locations of Bangladesh can be linked with other areas of the country through the decentralized power of RETs. However, public access to remote communications has not yet been explored commercially. With a suitable business environment, there is significant potential of private sector involvement in using RETs for distant communications:

- Solar PV for remote communications for disaster prevention;
- Solar PV for distance education through radio, television, and the Internet;
- Solar PV for community-based television and radio;
- RETs for general telecommunication and transportation signals;
- Solar PV in lighting and communications for navigation; and

- Solar PV lighting at ferry ghats (inland river ports) and unelectrified bus depots.

The Agricultural Sector

E.35 Agriculture provides the most widespread livelihood for the rural population of Bangladesh, and 70 percent of all working women are involved in this sector. The scope of using RETs in this sector deserves a critical review. Any growth of the rural economy will demand substantial energy resources. RET can only complement grid power in modifying energy usage patterns from the traditional to more efficient techniques. In an agriculture-based economy like Bangladesh, an integrated rural energy program could be developed through the Ministry of Agriculture in collaboration with the energy, science and technology, rural development, industry, and education sectors. A significant plan for RET use would require such integration:

- Solar thermal energy used in efficient drying of crops and fish,
- Energy efficiency for process heating,
- Biomass and bioresiduals conserved for auxiliary power generation,
- Effluents from biogas plants used as enriched sources of fertilizer,
- Solar PV water pumping for highly valued vegetable production, and
- Biogas effluents used as feed for the fishing industry.

The Local Government and Rural Development

E.36 The scope of RETs in rural development is recognized through several activities undertaken in recent years. The ongoing UNDP Sustainable Rural Energy project has been designed to demonstrate use of RETs. Lighting rural markets, remote hilly regions, isolated households, and clustered houses of landless poor people are some of the exemplary applications of RETs under this project. Using solar PV to electrify the cyclone shelter buildings in the remote coastal regions has also been demonstrated. However, the participatory role of women should be emphasized in the ongoing renewable energy activities.

E.37 Rural infrastructure development may also use the benefit of energy efficiency and RETs, as discussed in the previous sections of this document. Specific application of renewable energy and energy efficiency in the rural health centers, schools, union parishad (UP – lowest tier of local government offices, and other service buildings in the remote locations needs to be investigated in an integrated manner with the respective ministries:

- Solar PV lighting in rural markets and for streetlights,
- Solar PV for electrification of cyclone shelters in remote areas,
- Solar PV lighting in UP offices in unelectrified areas,
- Solar thermal energy for energy conservation,
- Introduction and dissemination of biogas technology, and
- Expansion of off-farm activities and income using RET.

Implementation

E.38 The implementation stage requires establishing an apex body, making institutional arrangements for services, and making people and businesses aware of available RETs and the government's RET-related programs.

Institutional Arrangements for Services

E.39 There is an urgent need to establish an institutional framework for regulating renewable energy activities in Bangladesh, which is part of the policy decisions highlighted in section 2 of this guideline. Any integrated energy development program requires an effective and committed administrative body. Such a body can set up the framework for collaboration between NGOs and private organizations, as well as with educational, research, and financial institutions. In the absence of such an organization, there will be a total lack of coordination between different project developers, and therefore the long-term implications of such efforts remain questionable. In Bangladesh, demonstration of RETs through pilot projects has been under way since 1985, mainly by different public agencies, with various levels of success and failure and without much coordination. To achieve significant benefits in the future, a suitable national program should be developed.

E.40 A viable option for participation of the private sector and the NGOs is to set up programmatic approaches with intermediary bodies for direct channeling and lending of funds. A possible organization for financing solar and other renewable energy projects could be the Infrastructure Development Company Ltd. (IDCOL).

E.41 Recommendations for institutional structure:

- The Planning Commission, the central planning unit of the government of Bangladesh, in combination with the Ministry of Energy and Mineral Resources, should assume the leading role in this process and administer the responsibilities of an apex organization for RETs.
- An apex body, such as a renewable energy development agency, should be established to develop policies and regulate an integrated RET program. It should coordinate between funding and

implementing agencies, with an overall goal of improving both the rural economy and national energy efficiency.

- Organizations like IDCOL should be authorized to finance RET projects for the private sector, with NGOs as the implementing agencies.
- The Ministry of Finance needs to acknowledge the long-term economic potential of RETs and energy efficiency and provide the necessary fiscal support.
- The Ministry of Science and Technology should initiate research, in coordination with the Ministry of Education and technical institutions, involving technology transfer and field implementation. The Ministry of Local Government and Rural Development, the Ministry of Health and Family Welfare, and others should also be involved.

E.42 Priority activities for institutional structure. In coordination with the existing framework of conventional energy planning, priority activities for renewable energy should include

- Policy: Enact renewable energy policy through legislation.
- Planning: Take steps toward introducing RETs to meet rural energy demands.
- Organization: Create an apex organization to regulate the national renewable energy program.
- Coordination: Coordinate private agencies and organizations in an integrated plan.
- Finances: Provide tax incentives, good interest rates, and targeted loans and subsidies. Mobilize funds from different sources for RETs and energy efficiency.
- Promotion: Establish a technology transfer mechanism between the research organizations and the industrial sector. Provide incentives for participation.
- Training: Provide and maintain information on project feasibility, energy conservation, fuel efficiency, and transition to modern fuels and devices.
- Technology: Improve energy efficiency through increased use of improved fuels, stoves, and energy devices as a means toward a better environment and better economy.

Technical Education and Information Dissemination

E.43 Application of RETs in various sectors will require an adequate technical foundation among users, planners, designers, and implementers. Above all, the education system should recognize the utility of RETs and benefit from their application by increasing the knowledge base. Curriculums of the technical and nontechnical institutions should include RET use. Incorporating appropriate courses in the existing engineering academic programs will ensure that sufficient technically qualified personnel are available within Bangladesh. In addition, dissemination of basic information on energy and the environment, energy efficiency, and conservation will ensure long-term sustainability of the technology within the frameworks of rural and urban applications. Suggested intervention by the education sector can be summarized as follows:

- Introduce RETs and energy efficiency in the education policy of Bangladesh.
- Introduce energy efficiency and renewable energy concepts into primary and secondary school curriculums.
- Create facilities to demonstrate RETs in rural and urban secondary schools.
- Initiate training programs for skilled people in maintenance services for RET installations.
- Introduce rural and urban applications of RETs and energy efficiency in the academic programs of higher education and technical institutions.
- Create technology transfer among research laboratories, academics, and field applications of the private and public sectors.
- Introduce the necessary courses on biomass conservation and forest preservation into the academic and technical extension programs of the Ministry of Agriculture.
- Introduce energy efficiency, RET project installation, manufacture of RET products, safety issues, and so on into the curriculums of the polytechnic institutions.
- Human Resource Development

E.44 Trained human resources will be needed to embark on any program for promoting RETs. Awareness of RETs and their potential benefits can be integrated with job opportunities at the rural level. Training programs sponsored by the government, the private sector. The NGOs can be designed to develop skilled people capable of setting up private enterprises dealing in RET services. These trained men and women can serve in manufacturing, installation, operation, and maintenance, as well as generate employment

for others. Networks of skilled professionals, facilitated by NGOs or academic institutions, will accelerate modern energy use and economic growth.

The Role of Energy Efficiency

E.45 The idea of energy efficiency is to use a lesser amount of primary energy to get the same energy service. Energy service is composed of its supply and demand, leading to its benefits. The total amount of energy required to gain the same energy service is directly related to the efficiency in generation, delivery, and use. Although the energy supply side has received the most attention, there is much to be gained from improving the technology of the demand side.

E.46 Energy efficiency measures can be classified as:

- Efficient end use in existing installations through improved operation and maintenance, as well as technology intervention by device modification; and
- Efficient end use in new installations, which means using energy-efficient technologies.

E.47 The intervention of energy efficiency and RETs in the industrial sector is important because energy efficiency is equally as important as energy production. Often, the cost of energy efficiency is less than increasing the energy supply, because it reduces the life-cycle cost of service. In addition, in the absence of commercial energy, renewable energy can establish a niche market that accelerates development. Also, because energy efficiency devices are modular in nature, they can be integrated at any stage from planning to operation. For consumers, it is a means of reducing service costs. For energy suppliers, it means reducing capacity shortfall and unserved demand.

E.48 An important area for achieving direct benefits from energy efficiency is in existing power generation using fossil fuels. To maximize the benefit of the fossil fuel reserve, energy efficiency should be applied for generation, transmission, distribution, and end use. Very pragmatic steps should therefore be taken by the energy sector to ensure such action. For example, Bangladesh should focus more on efficient use of its gas resources. Out of the 2,600 megawatt (MW) capacity in the country, 600MW are used for electric lighting. Using efficient fluorescent lamps could effectively save 64 percent of this energy and thereby contribute to peak power management. Another area of conservation is the use of energy-efficient equipment, which can be specified by design codes, for industries, buildings, and construction.

E.49 For the industrial sector, energy conservation is a means of improving energy efficiency and overall economic performance. Suitable devices should be promoted in locations where industries are using process heat. This reduces total energy consumption, typically of oil, gas, and wood. Industries such as plastic, metal, glass, dying, and chemical operations use significant amounts of thermal energy, which may be optimized for energy conservation. For example, solar water heaters and heat exchangers

can be used for preheating. From the environmental viewpoint, discharging heated and chemically polluted water into the water reservoirs is known to affect the ambient aquatic life. Recovery of waste heat, therefore, improves cost efficiency and prevents environmental damage.

E.50 In the rural sector, the introduction of energy efficiency through improved fuel, efficient stoves, and better energy usage patterns can lead to monetary benefit for the poor. In addition, using efficient fuels and stoves ensures less time spent by rural women in collecting fuel for cooking, which has a direct impact on their health and well-being. Information on improved stoves, access to modern fuels, and construction of biogas plants should be made available through all media and outreach programs. In addition to the benefit to women's health from a better environment, improved efficiency can contribute to the overall conservation and balance of the biofuel reserve. However, middle- and low-income households are not users of biogas plants because of a shortage of necessary fuel and the high cost of installation. Alternative applications of RETs, energy efficiency in biomass use, and dissemination of improved stoves for rural households should be part of new and widespread educational programs, administered through community-based organizations and NGOs.

E.51 In addition to contributing to energy efficiency, renewable energy is a means of achieving energy conservation in an environmentally sustainable way. Some of the facets of an approach promoting energy efficiency and renewable energy use, which should be applied without delay, are

- Improving decentralized power generation for small rural industries,
- Shifting to less energy-intensive transport systems,
- Improving solar drying and similar mechanisms for agriculture-based industries,
- Technical improvement of existing end-use products, and
- In unelectrified and isolated locations, using PV-based lighting for community buildings, schools, health centers, and rural homes.

Gender and Energy

Background

E.52 In recent years, there have been advancements of women in social, economic, and political areas; most notably in health and education. The most successful and significant economic role played by rural women of Bangladesh is in use of microfinance services from the government and NGOs. Although WID and GAD) have

received much attention[41] in terms of the policy framework and technology, very little attention has been focused on women and their energy usage pattern. Sporadic projects, but without any pragmatic approach or integrated planning, have been attempted in the past by different government organizations and NGOs to improve the cooking environment and reduce the time spent by women and children in collecting wood for cooking fuel.

E.53 Women constitute about half the population of Bangladesh, but it is clear that they are almost never taken into consideration when energy planning decisions are made. It is assumed that decisions made at the national level by policymakers have no differential impacts on men and women. For example, during the assessment of availability of various kinds of fuels in the country, more thought is usually given to the supply of fuels for the transport and power sectors, which are mostly used directly by men. However, a supply of kerosene at reasonable prices, which could be used as a cleaner, more efficient cooking fuel by millions of women (compared with the biomass fuels used in conventional stoves), does not receive similar attention. In the same manner, efficient cooking stoves and easily affordable portable gas stoves are not developed or promoted through proper incentives.

E.54 The gender aspect of RETs should be regarded as a means of empowering women. How far it can enhance their well-being and improve their status in society, with respect to both economic conditions and their personal environments, will determine its usefulness and relevance for women. RETs are merely one component on a list of energy sources for meeting the energy needs of an economy. What is required is addressing women's energy needs by making sustainable energy systems available to them.

Gender and Energy in Development

E.55 To promote gender and energy issues in the development programs of the country, the attitude and understanding of the decisionmakers must be changed. Energy issues must be viewed against the background of poverty and the way decisions about choice of energy are made at the household level. Issues such as perpetual dependence on free fuels or ability of the households to pay for energy in case of intermittent and unpredictable supply have to be taken into consideration. In addition, it has to be made clear that "engendering" does not mean only how many women are engaged, either in energy projects or in an organization, but what kind of inputs they are permitted to make at times of critical decisionmaking. The different roles of women and men in decisionmaking, and the benefits to them that result from those decisions, must be understood by the planners.

E.56 To change the prevailing indifference to women's energy needs, the government must undertake pragmatic steps by making its planning machinery engender its energy policy. In the past, the government included women's issues as an important

[41] *Institutional Review of WID Capability of the Government of Bangladesh, GOB Planning Processes and Women's Development*, Ministry of Women and Children Affairs, 1996.

consideration in all projects. It is now necessary to translate phase considerations into actions in the energy sector, especially the rural energy sector.

E.57 Integrating household energy programs into rural development plans can achieve the desired outcome of women's economic empowerment and community development. A policy of integrated, cross-sector cooperation in the government is needed. For example, social or community forestry projects, along with improved stove projects, will ensure a supply of biomass fuels and their efficient use. Also, ensuring availability of modern cooking fuels in biomass-deficient areas through decentralized fuel processing and better transportation can reduce time used by women on fuel collection, and the time saved can be used for more productive activities. This will also reduce pressure on the biomass, which is all that the very poor can afford.

E.58 An active role for women in the economy. Empowering women by the use of RETs will be possible only if the efforts made are able to change the position of women in society. Experience in the garment sector has shown that increased income enhances women's status in the household and the community. In the rural energy sector, women are usually the users—but with proper support, they can become suppliers of energy as well. This does not necessarily mean that they will be in competition with men; rather, men and women can work together for the development of the community.

E.59 Opportunity for women participating as energy service providers with individual and collective economic benefit is a new concept in Bangladesh. One special example is this project Opportunity for Women in RET Use in Bangladesh

E.60 The most successful and significant economic role played so far by the rural women of Bangladesh is their use of microfinance sources from government and NGOs. Women have proved their capacity as entrepreneurs in such fields as handicrafts, food processing, and agriculture-based businesses. The role of women can be expanded by technology transfers and access to finance and markets. The NGOs and academic institutions that are committed to the benefit of the poor should take a leading role in this endeavor.

E.61 Developing income-generating opportunities for women in the energy supply sector needs innovative approaches. Pilot efforts provided lessons and mechanisms, but the government must take responsibility for sustained support by providing congenial environments and encouragement through proper policies. It has been observed that rural electrification has reached 15 percent of the population, but that has not changed or even had minimal impact on the majority of rural women. In general, they have not been able to use opportunities that tend to emerge from electrification, yet the majority of rural women seek the social and economic opportunities for improved quality of life for their families that modern technology and electrification can provide.

E.62 *Gender and energy efficiency.* Until modern energy is made available to rural women of Bangladesh, biomass will remain the primary fuel source for cooking. Women are the main consumers and managers of rural energy because they are responsible for all cooking and grain processing activities. The largest share of energy

usage in the country is for cooking for the 12 million rural households, amounting to more than 65 percent of total usage in terms of heating value. The major source of energy for that purpose is biomass, available as firewood, agricultural residues, and animal waste. The current availability of modern energy sources such as electricity or gas is much smaller than what is required for rural cooking and lighting. Thus increasing energy efficiency and improving energy supply for cooking needs, whether by increased use of RETs or otherwise, will provide some relief to the current women's "energy crisis."

Priority Issues on Gender to be Mainstreamed in Public Programs

E.63 The following is an initial list of issues that can be given priority by the government:

- Create more gender awareness in technology-related development initiatives.
- Involve men in gender and technology discussions, so that they can share responsibility for women's education, health, and well-being, and expose women to household and community issues.
- Improve women's living conditions—especially in the kitchen, where inefficient cooking appliances are causing health problems.
- Increase opportunities for income generation for women by using available energy resources, such as rural electrification, off-grid electrification, RET technologies, and so on.
- Effectively use the capacity of television, radio, and other media for information dissemination to increase awareness of how RET use can lead to the economic and social advantage of women.
- Provide assistance in shifting women's careers toward skilled labor in a technology-oriented environment. Among the major barriers in this regard are limited finance, lack of access to information and training, and lack of scope and opportunity in general.

Priority Activities Involving Gender for the Energy Sector

- *Quantify benefits to women:* Measure the direct and indirect benefits to women from rural electrification (RE).
- *Selection of parameters to measure:* Investigate the parameters used to measure and account for the benefits of RE. These parameters could be, for example, education, security, health, income, business, entertainment, and free time.
- *Gender sensitivity:* Establish parameters to measure sensitivity to women's issues. If it appears that the parameters are not gender-sensitive, then find a means to make them so.

- *Surveys:* Determine the actual profile of the energy demand of rural women, including preferences and access.
- *Economic impact:* Electric power is essential to economic growth. Determine how many women are denied access to this resource for income generation.
- *Income generation:* Determine if income generation for women increases with rural electrification. If not, take steps to ensure that it happens. Conventional economic analysis undervalues women's time—therefore, this is not addressed adequately.
- *Sensitizing:* The social scientists of the funding agencies should learn to think about energy as a necessary (although not exclusive) tool for development. Women, energy, and poverty should be discussed together. The social scientists should make greater efforts to listen to the voices of the women in poverty. Women do not go to the markets to participate in discussions. Many cannot read or play the radio to listen to the world, which means they are largely isolated from current events in general.
- *Awareness:* Rural and urban men need to receive education on gender as well, so that they can share responsibility for women's health, education, and well-being. Women need more exposure to household and community issues.
- *Technological barriers:* Determine if women have benefited from the advancement of technologies, especially in the rural sector. Women's access to public services also should be investigated. It is perceived that a lack of digital communications retards economic and social growth among the poor, especially the women. The local NGOs, who are close to many rural women, could help bridge this gap.

Annex F

Seminar on Incorporation of RET in Development Projects

A seminar on incorporation of renewable energy technology (RET) in development projects was organized by Prokaushali Sangsad Limited (PSL) and sponsored by World Bank and ESMAP on November 18, 2000. The country director of the World Bank; the Minister of Agriculture; the manager of ESMAP; representatives from the government of Bangladesh, civil society, NGOs, members of the Coastal Electrification and Women's Development Microenterprise (CEWDM); and donors participated in the seminar. During the presentations and the discussions afterward, several issues regarding RET and gender arose and are presented below.

Incorporation of RET in Development Projects seminar in Dhaka, Bangladesh, November 18, 2000. From left, Mr. Fred Temple, the country director, World Bank, Dhaka; Begum Matia Chowdhury, the Minister of Agriculture, government of Bangladesh; and Ms. Dominique M. Lallement, the manager ESMAP. (Photo: Sameera, Drik)

Welcome Address by Mr. Frederick Temple, Country Director, World Bank, Dhaka

Mr. Temple first welcomed Begum Matia Chowdhury, the Minister of Agriculture, the invited guests, and participants. He stressed the current energy delivery crisis in Bangladesh, noting that only 15 percent of rural households are receiving electricity from the Palli Bidyut Samities (PBSs) under the regulatory guidelines of the Rural Electrification Board (REB).

The country director mentioned the recent World Bank report that identified half a million rural households willing to pay for solar home systems (SHS). The study suggested a suitable blend of private-public joint venture service delivery opportunities to achieve the desired goals.

Mr. Temple explained that the project titled Opportunity for Women in Renewable Energy Technology Use in Bangladesh is a community-driven development activity, focusing on poverty reduction and gender equity by empowering women and the

poor. He described the importance of ongoing project activities in providing access to modern lighting at affordable prices by decentralized electrification in rural households, which can be a model for the REB.

He also specified the components of the project, which include Coastal Electrification and Women's Development Microenterprise (CEWDM), institutional capacity building within government by efficient use of RETs, women's participation in future projects aimed at poverty reduction, and capacity building among women to provide technical training on RET for future project development and implementation. Last, he added that the World Bank encourages such programs involving a bottom-up approach and strengthening village-level capacity.

Introduction to the Project by PSL: Dr. Hasna Khan

Dr. Khan, director of PSL, stated the objectives of the seminar and made a presentation on the recent developments of the Opportunity for Women in Renewable Energy Technology Use in Bangladesh project. She mentioned that the revised guideline on RETs will be handed over to the Planning Commission of the government of Bangladesh for initiation of future actions.

Regarding the ongoing microenterprise activity, she noted that the capacity of lamp production by the Coastal Electrification and Women's Development Microenterprise (CEWDM) far exceeds its sales, and therefore there remains a need for market penetration. She also noted that the project should not yet be considered a renewable energy project, because it has not thus far begun marketing solar photovoltaic (PVs). It is estimated that with appropriate funding sources, it will take two to three years to reach 2,000 households.

Dr. Khan emphasized that the PBSs are an ideal vehicle for expansion of decentralized rural electrification to distant households within their areas of jurisdiction. Finally, she mentioned that effective planning with commercial funds is needed to develop private programs in rural electrification.

Address by the Special Guest: Mr. Omar Farooq, Member, Planning Commission

Mr. Farooq presented some data on greenhouse gas (GHG) emissions by the developed countries, especially the United States, quoting from the 1997 Kyoto conference. Data indicated that emissions from the developing countries are much less than that of the developed countries. Actions should be taken now to control future global damage. He emphasized that recognition of GHG effects is no longer an academic exercise, and global weather change is an indicator of the cumulative effects of GHG emissions.

Mr. Farooq discussed both the environmental benefits of renewable energy and energy efficiency. He emphasized that to prevent waste, energy efficiency should be

the focus of existing power generation from fossil fuels. He requested cooperation between the Organisation for Economic Co-operation and Development (OECD) countries and the developing countries for assistance in production, transmission, and distribution of energy-efficient power in Bangladesh. He noted that Bangladesh should focus on efficient use of its gas resources. Out of 2,600 megawatt (MW) of capacity in the country, 600 MW are being used for electric lighting. Use of efficient fluorescent lamps could save 64 percent of this energy and thereby conserve a valuable resource and contribute to peak power management.

In the case of renewable energy, he mentioned that compared with wind or microhydro power, solar power is widely available throughout the country. He also suggested that hydrogen fuel cells can bring a more promising future and should be included in the energy guideline. Mr. Farooq noted that the government of Bangladesh has some experience in solar PV electrification in Narshingdi, using Tk8 crore from a French grant. He added that the government has approved 6,000 households for solar home systems, for which funds are not yet available.

He acknowledged that the Prime Minister's call for complete electrification by 2020 was ambitious, but also noted that the country would need an ambitious plan to reach a higher result. Mr. Farooq commented that Bangladesh looks forward to funding from the World Bank and other financial institutions to fulfill its plans. Last, he cited that Global Environment Facility (GEF) funds received by other countries, including China, Croatia, and Romania, are US$7.5, 4.5, and 10 million, respectively, and requested that the World Bank and ESMAP make arrangements for Bangladesh to receive funding of a similar scale.

Address by the Manager of ESMAP: Ms. Dominique Lallement

Ms. Lallement introduced ESMAP's program directives to the audience. As an organization of technical assistance for the energy sector programs of the developing countries, ESMAP receives 80 percent of its funds from public donors and 20 percent from the World Bank. All technical data and information acquired by ESMAP are shared among the developing countries.

She mentioned that a study by ESMAP has revealed that the poor want energy as much as they want education. She also emphasized that energy is essential for reducing poverty and child mortality and improving women's health, adding data to demonstrate the strong correlation between human development and energy, and the correlation between gross domestic product (GDP) growth rates and energy consumption.

Ms. Lallement explained that the poor receive an inferior quality of energy services and in general pay more for such services compared with better-quality services. As an example, she mentioned that the rural poor pay as much as US$0.30 per kilowatt hour (kwh) for electricity, which is 100 percent higher than the urban rates. The poor also pay nearly 20 percent of their income for energy. Further, as an example of the impact of

lighting, she described her observation of a man who began teaching children in his shop after he obtained lighting.

Considering that 2 billion people in the world are without any access to modern energy, she quoted the World Energy Council in noting that 100 million connections per year are needed, requiring capacity expansion of 500 kWh per year per capita. Therefore, she expressed the need for new business with new models to meet such demand. Ms. Lallement spoke of new solutions that match local requirements, including policy issues, market liberalization. and regulatory setup. These solutions need to consider financial, technical, and institutional aspects to meet growing demand. Where there are risks associated with early investments, different market approaches are required to promote renewable energy. She mentioned that finance is necessary but not sufficient: Affordability is a primary issue in promoting RET. Access to credit for small- and medium-size enterprises (SME) should be established because guarantees are critical for financing.

Instead of the earlier models of centrally controlled generation, new strategies should involve local cooperatives, NGOs, and the private sector. Technical standards should be established for off-grid power generation. The misconception that grid power is cheaper than decentralized power should be removed.

Ms. Lallement continued that energy issues can be a major driver in poverty alleviation, if they are given sufficient focus in manufacturing, training, and building local capacity. She mentioned that the World Bank's focus on energy projects has the highest impact on poverty alleviation and promoting environmentally sustainable energy use. The ESMAP project in Bangladesh has revealed that women have significant potential to provide energy services. Ms. Lallement completed her speech by disclosing that a search for more financing for expanding the Char Montaz project has been under way for five months, without success.

Address by Special Guest: Mr. Mesbah Uddin Ahmed, Chairman, REB

Mr. Ahmed stated that rural electrification service in Bangladesh is available to 3 million households, or 23 percent of the total, and the remaining 77 percent is without any electrification service. To provide electrification to unserved households, rapid deployment of renewable energy is needed. The chairman mentioned that perhaps ESMAP, with the REB, could establish such a solution to gain access to the large number of unelectrified households.

Renewable energy sources should not be measured from a financial perspective alone. Social, economic, and environmental factors should also be considered. Mr. Ahmed called for an action plan, including long-term wind data for introducing windmill and other renewable energy.

He also mentioned the need for a central agency in Bangladesh to promote renewable energy and monitor activities. The Narshingdi experience with 1,000

households has given the REB an initial breakthrough in solar energy, but more experience is needed.

Finally, Mr. Ahmed mentioned that women make up 30 percent of the staff of the PBSs, and there are three women on the board of directors. He said the REB should also encourage women to become entrepreneurs and establish more microenterprises and cottage industries.

Address by the Chief Guest: Begum Matia Chowdhury, Minister of Agriculture, Government of Bangladesh

As the chief guest at the seminar, Minister Chowdhury emphasized the need for women's access to sustainable energy. The minister stressed that it is essential for rural women to obtain access to energy-efficient fuel, stoves, and other devices to reduce their burden of collecting wood for fuel and improve their environment for cooking. Women must have access to credit to seek energy solutions.

Minister Chowdhury further mentioned that rapid growth of the economy requires energy. An integrated energy plan for RETs will be necessary to achieve any significant impact. The minister also stated that electricity has social implications besides economic impact. She mentioned that rural lighting lessens crime rates and brings a capacity for entertainment that is scarce in most rural communities today. Without such entertainment, many of the nation's youth are left with few diversions or opportunities for enrichment. She also mentioned that the lack of electrification seems to have a strong negative impact on family planning efforts.

Attending guests of seminar: Mr. Mesbah Uddin Ahmed, chairman, REB; Mr. Sief Ijermann, ambassador of the Royal Netherlands Embassy; Dr. Makhduma Nargis, joint secretary of the Ministry of Health, government of Bangladesh, (Photo: Sameera, Drik)

The minister continued that the national demand for electrification should not be solely dependent on the PDB, REB, or any one agency. Diversity is essential for sustainability. There is a need to seek integrated and innovative solutions for energy demand.

The minister praised the women of Char Montaz, who established the Coastal Electrification and Women's Development Microenterprise (CEWDM), for proving their capability as energy service providers. She recalled that rural women, spending up to five hours collecting firewood, followed by cooking and feeding their households, have no time left for themselves or their children. Moreover, rural women also conduct postharvest labor, which further reduces their leisure time. Rural women desperately need relief from this drudgery.

Minister Chowdhury mentioned that the scope of biogas use in Bangladesh is limited by the scarcity of cows in the average household. She also noted that households with dairy farms are adopting biogas plants; however, unless alternative

fuel sources are considered, most rural homes will not be using biogas. Wood is becoming scarce in the northwestern part of the country. Managed sources of wood fuel will be needed to keep a sustainable supply of biomass. She also noted that solar PV is an expensive alternative, well beyond the affordable limits of the rural poor. Although there is high potential demand for it, only the rich can currently afford such systems.

The minister emphasized the need for research and development to reduce the costs of renewable energy and other alternatives. Close monitoring of innovative technologies is needed before they can be mainstreamed for mass consumption. It is essential that the organizations coordinate their efforts and devise affordable solutions.

Minister Chowdhury concluded her speech by stressing that Bangladesh has a scarcity of capital funds and cannot proceed without assistance. She urged the World Bank to provide support and financial assistance in combination with policy intervention to meet the energy demand.