

RURAL ELECTRIFICATION IN SOUTH ASIAN REGION

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Project Report

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Disclaimer:

The analysis, recommendations and comments presented in this report are solely of the author unless specifically quoted. They do not necessarily represent the opinions of the project implementing organizations.

List of Acronyms

AEPC:	Alternative Energy Promotion Center
AFC:	Agricultural Finance Corporation
ARDC:	Agricultural Refinance Development Corporation
BOM:	Bank of Maldives
BPDP:	Bangladesh Power Development Board
BREB:	Bangladesh Rural Electrification Board
BSES:	Bombay Suburban Electricity Supply, Ltd.
DESA:	Dhaka Electricity Supply Authority
GOI:	Government of India
GS:	Grameen Shakti
HMGN:	His Majesty's Government of Nepal
KW:	1,000 Watts
Micro-hydro:	Hydropower plant with an installed capacity below 100 kW
Mini-hydro:	Hydropower plant with an installed capacity between 100 - 1,000 kW
MNES:	Ministry of Non-Conventional Energy Sources
MW:	1 Million Watts
NGO:	Non-Governmental Organization
NPCL:	Noida Power Company Limited
PBS:	Palli Bidyut Samiti
PGCB:	Power Grid Company of Bangladesh
RE:	Rural Energy
REC:	Rural Electrification Corporation, Ltd.
SARI/Energy:	South Asia Regional Initiative/Energy
SEB:	State Electricity Board
SHS:	Solar Home System
Small Hydro:	Hydropower plant with installed capacity between 1 and 10 MW
SPV:	Solar Photovoltaic
VBS:	Village Vidyut Sangh
VCP:	Village Contact Person
XIM:	Xavier Institute of Management

Preface

Given the abysmal situation of rural electrification in various South Asian countries and mostly weak and deficient efforts that are made today to electrify rural communities, Confederation of Indian Industry (CII) and Independent Power Producers' Association, Nepal (IPPAN) decided to analyse various aspects of rural electrification (with a regional perspective) and set some broad guidelines that can help various concerned stakeholders in devising more calibrated measures, while enhancing the pace of rural electrification.

The above said activity was taken under a project titled (Rural Electrification in South Asian Region), the findings, of which, are presented in this report. The Rural Electrification in South Asian Region (RESAR) project was funded under USAID sponsored SARI/E Small Grant Scheme, jointly managed by Winrock International and Institute of International Education.

The South Asia Regional Initiative for Energy Cooperation and Development (SARI/Energy) promotes sustainable economic prosperity by fostering mutually beneficial energy linkages among the nations of South Asia. SARI/Energy has built a network of stakeholders and potential investors that appreciate the economic, policy, financial, contractual and investment advantages and requirements for increased energy cooperation in South Asia. Based on feedback from these regional stakeholders, the SARI/Energy program is supporting the design and implementation of specific cooperation opportunities and disseminates lessons learned from other successful energy initiatives, such as the Southern African Power Pool and the Rural Electrification Board in Bangladesh.

The Report is a single volume divided into two main parts, namely “ Analytical Discussions ” and “ Case Studies ”, with specific reference to South Asian RE programs. It is hoped that the Study findings will be useful to all stakeholders in making decisions on future policies and strategies regarding rural electrification. Lastly it is also desired that this Report will be of benefit to those involved with future impact assessment(s) of the RE program and also to interested socio-economic development researchers.

Executive Summary

The energy problems of South Asia are both serious and widespread. Despite major public investments over the past half-century, over 50% of the people residing in the rural areas of South Asian countries do not have access to electricity. Grid connected villages also suffer from perennial electricity shortages. Despite substantial investments in the modern rural energy systems, not enough electricity has reached rural areas. The non-accessibility and non-availability of electricity in the villages have been some of the major reasons of low level of income and poor quality of life for rural dwellers in the region. In addition, with technical progress, the gap between the electrified and the non-electrified areas continues to widen and has serious socio-political ramifications. Most of the governments in the region have been very proactive in implementing measures to achieve faster rate of rural electrification.

Across South Asia, parastatal utilities distribute over 90 percent of the total electricity consumed (more so for rural areas as most non-parastatal distribution is in urban areas). In most cases, the major suppliers of rural electricity are the national utilities, which are also the owners, operators and regulators of electricity supply. This has caused concentration of market power, which is very often counterproductive and needs to be addressed by the policy makers. Thus the trend should be towards decentralization of government responsibility for electricity supply. The inability of parastatal utilities to provide adequate service to the rural consumers is quite disturbing. Rural consumers have to contend with erratic power supply, high degree of uncertainty about its availability, frequent load shedding coupled with poor voltage and frequency conditions. Utilities, on the other hand, have the grouse of un-remunerative tariffs, high transmission and distribution losses, power thefts and lack of ample budgetary support in lieu of the subsidized power supply to the rural consumers. For political reasons, parastatal utilities cannot stop supplying electricity in unviable rural areas. The pre-dominate role-played by parastatal utilities in rural electricity supply means that what constitutes current regulation on rural electrification is largely derived from laws establishing and governing parastatal utility ownership and operation. An important aspect of implementing sustainable rural energy supply is sound governance and clear regulation. Strained Utilities-consumers- regulator relations justify a comprehensive policy overhaul. Perhaps, it is pertinent to learn from the sound practices based on the operating experiences within the region.

An alternative in South Asia to a parastatal rural electricity supply entity is through rural electric cooperative societies. A few Indian rural electric cooperative societies (e.g. one in Andhra Pradesh and one in West Bengal) are well run rural electricity distributors with their performance comparable with that of parastatal electricity distribution entities in the same regions.

Off-grid rural electricity supply is miniscule in terms of energy supplied compared with grid-connected supply. These hold some promise in Nepal. However, the legal basis and regulation of off-grid supplies is of growing importance in South Asia because of the relatively recent growth in the number of these systems. This growth is due, in part, to the decreasing ability of some governments to expand and maintain the rural portions of their national electricity grids and in part with major problems with electricity generation adequacy. Very little regulatory attention has been paid to off-grid supply systems and this may impede the increase in the number of these systems and the growth of established systems.

Bangladesh is just starting to implement off-grid rural electricity supply in regions where grid-connection will not be implemented within at least five-years. As currently planned, this will primarily involve household SPV systems with major involvement of BREB and Grameen Shakti (a wholly owned subsidiary of Grameen Bank focussing on energy issues). India, under the Ministry of Non-Conventional Energy Sources (MNES) and its associated State renewable energy development

agencies has implemented one of the world's largest renewable energy supply programs based on off-grid supply systems. Nepal and Sri Lanka are aggressively implementing off-grid village micro-hydropower schemes and SPV household electricity supply.

Along with the government led delivery mechanism, several private, NGO driven and co-operative initiatives for rural electrification have also fared well in various parts of South Asia. Notably, Grameen Shakti and Palli Vidyut Samitis in Bangladesh; Noida Power and Bankura initiative in India; Lamjung Electricity Association in Nepal and solar PV initiatives in Srilanka are some of the models that have, to some extent, supplemented the deficiency of approaches and resources in utility led grid electrification. Most of these models, though having very high potential of replication, so far, have been geographically confined to their area of origination. Several factors, that limit the up-scaling of rural electrification efforts in general and these models in particular, have been discussed in this report with a view of finding workable solutions for South Asia.

South Asia is moving in the direction of replacing its traditional self-regulation of parastatal electricity supply utilities with more transparent and autonomous regulatory frameworks. So far, while implementing such legal and regulatory changes, very limited attention has been given to the rural electricity supply dimension, both grid-connected and off-grid electricity supply. Though Indian Electricity Act 2003 permits private bodies or community entities like Gram Panchayats to get into the area of rural electrification without the hassle of licensing, there are hardly any takers. Issues relating to governance, regulation, subsidies are fairly complex and still need to be addressed. Though rural electrification regulatory issues are not the main focus of this report, some of the major deficiencies have been indicated at various places, in passing.

Review and analysis of most of the rural electrification approaches practiced in South Asia (some of those discussed in the main text) reinforces the critical importance of adequate financing, supportive policy framework, right selection of technology and proper institutional arrangement. An analytical discussion of these aspects have been presented in the report keeping in mind regional qualifying factors. After studying some of the most successful models of rural electrification in the region, it has been concluded that these programs share a number of common features. These features are analyzed to have contributed towards the accomplishment of the successful rural electrification programs. Other rural electrification initiatives in the region can also imbue these features without much need for alteration. Some of them can be summed up as follows:

- Long-term government financial and institutional commitment to support rural electrification initiatives
- Adequate priority to the use of electricity for productive purposes and income generation activities without ignoring the enabling conditions and priorities for rural development
- Load and load mix to ensure efficient use of distribution infrastructure and adequate revenue generation
- Program planning based on transparent economic criteria
- Development and adoption of cost-effective technical designs and standards
- Active consumer participation in their own electrification by fostering an alternative culture and structure
- Design and implementation of tariff structure required for project viability
- Innovative financing mechanism using tools such as micro-finance and proceeds generated through carbon financing

Along with these common characteristics, the successful models in the region have also inculcated certain distinguishing features that address local, area-specific needs and aspirations. The basic

delivery mechanism of rural electricity supply and institutional arrangement has to be designed suiting to local needs. Some of these recommended models depending upon area-specific circumstances are as follows:

- **Areas, where, purchasing power of rural dwellers is high;** private sector driven rural electrification model (aiming at generating sustainable return for the investor) can be the most appropriate model, viz. Noida Power Model in comparatively prosperous villages surrounding Greater Noida, India.
- **Villages, where, purchasing power of the inhabitants is moderate but there is a history of community led participatory activities;** Co-operative society model (aiming at meeting energy needs of the members on not-for-profit basis) can be applicable, viz. Sircilla co-operative society, India; Palli Vidyut Samitis, Bangladesh; South Lalitpur Electric Co-operative Society, Nepal.
- **Villages, where, purchasing power of the inhabitants is moderate but there is no history of community led participatory activities;** Franchise model (concept of rural electricity retailer under a big electricity company) can be most suitable. For example, BSES – an Indian electricity company is mooted this concept in Orissa.
- **Rural areas, where, paying ability of the dwellers is abysmally low,** a government driven and/or supported model (financially and otherwise) may be the only possibility, at least in the short run.

The context is markedly similar across South Asia. Almost all countries in the region suffer from problems like poverty, underdevelopment, low level of technological sophistication, poor institutions, rural-urban divide and socio-political tensions. Rural electrification, for these countries, is one of the most needed and simultaneously one of the most ill-afforded developmental priorities. This along with the poor health of exchequer in South Asian countries demands for the prevention any wastage of resources on inadequately designed rural electrification initiatives. To this end, on the basis of the discussion, which follows in the main text, this study recommends certain measures that can be looked at by various stakeholders in South Asia, before devising any rural electrification program for their area.

Recommendations:

Some of the major recommendations of this study can be summed up as follows:

- Government support and/or subsidy will inevitably be needed under the present circumstances. However, subsidies should be “smart”(streamlined and well-targeted), that is they should not be open-ended.
- Rural electrification programs in the region should give priority to the use of local resources, for example, hydropower based electrification should supercede fossil fuels based electrification in Nepal and Bhutan.
- Electrical supply systems should ideally be owned by those with the most important stake in their success e.g. local community
- Energy intervention should be integrated with other local developmental priorities
- Awareness creation and motivational programmes should precede any rural electrification project (proper social marketing)
- Merit order expansion of rural electrification grid/systems.
- Public-Private Partnership involving local community should be tried at a wider scale in South Asia as an effective approach to achieve higher and sustainable rate of rural electrification.
- Establishment/strengthening of institutions at both local and national level focusing (dedicated) to serving financial needs of rural electrification stakeholders

- Emphasis should be given to reduce the capital and revenue cost of power generation and to make power affordable for rural dwellers. Steps like - integrated approach to the provision of rural services and “bundle” it with other rural infrastructure services - can be handy in this direction.
- For off-grid decentralized systems based electrification schemes like buy-back or banking can be very useful in building the confidence at the end user level.
- As a follow-up SARI/E may like to consider the following :
 - a. Identify options, clarify legal requirements, and assess the ability of rural electricity suppliers to undertake other related businesses and services.
 - b. Promote wider consideration of options such as cooperative societies and rural franchising as solutions to rural energy supply by policy makers and multilateral development banks.
 - c. Provide for information exchange and sharing of procedures for certifying private sector service technicians for household (such as SPV) and decentralized energy systems in South Asia.
 - d. Promote, through information and peer exchanges, the concept of rural electricity suppliers forming apex organizations.
 - e. Support regional networking of individual country rural energy supply programs through information exchange.
 - f. Promote, through information exchange, the development and wider implementation of rural electricity financing mechanisms, such as commercial micro-finance and rural development banks.
 - g. Develop and make widely available a South Asia rural energy database.

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Part I: Rural Electrification Approaches in South
Asia: An Analytical Discussion

Chapter 1: South Asia: The Context

1.1. Economic Overview:

South Asia contains almost 20% of the world's population, out of which 40% are below poverty line. Thus it can be easily figured out that this part of the world is essentially developing in nature. Almost the entire South Asian region faces certain key developmental challenges such as poverty alleviation, health, education, provision of potable water; sanitation and other basic amenities. Recently, some of the countries in the region have reported high rate of GDP growth. However, given their very modest base, it might take them decades to catch up with the rest of the world. Furthermore, the caution must be drawn that the developmental curve for these countries may not be very smooth due to unstable political situation, weak institutional framework, poor policy regime and vulnerability to natural calamities.

There is a marked cultural similarity across the region. Historically, most of these countries were either part of the same country or maintained very close cultural and economic linkages. This indicates that there exists a possibility of greater co-operation between various South Asian countries, in almost all spheres, drawing upon the historic interdependence. Table 1 below summarizes the demographic, economic and social profile of South Asia.

Table 1
Key Economic and Social Indicators

<i>Country</i>	<i>Gross National Income (million \$); 2002</i>	<i>Per capita GNI (\$, 2002)</i>	<i>GDP Growth rate (2001-02)</i>	<i>Percentage of population below poverty line (year)</i>	<i>Adult Literacy (% age 15 and above) 2001</i>	<i>Total Population (millions) ; 2002</i>	<i>Surface Area (thousand square km); 2002</i>	<i>Percentage of population in rural areas;2002</i>
Bangladesh	51100	380	4.4	49.8 (2000)	40.6	136	144	74
Bhutan	512	600	7.7	-NA-	47.0	0.85	47	-NA-
India	494800	470	4.6	28.6 (1999-2000)	58.0	1049	3287	72
Maldives	622	2170	5.6	-NA-	97.0	0.28	0.3	-NA-
Nepal	5500	230	-0.5	42 (1995-96)	42.9	24	147	87
Sri Lanka	16100	850	4	25 (1995-96)	97.9	19	66	77

Source: World Development Indicators; 2004

N.A.: Data not available

1.2. Energy Overview:

In 2001, South Asia generated around 626 billion-kilowatt hours (BkWh) of electricity. Of this, around 81% was from conventional thermal power plants, 17% from hydroelectric plants, 2% from nuclear, and less than 1% from "other renewables" (like wind and solar).

Commercial energy consumption shows an increase of nearly 59% between 1991 and 2001 (from 2.8% of world commercial energy consumption it rose to 3.8%). Despite this increase, South Asia continues to average among the lowest levels of per capita energy consumption in the world, but among the highest in terms of energy consumption per unit of GDP.

The energy-mix within the region varies significantly. Bangladesh's energy mix, for instance, is dominated by natural gas (67% in 2001), while India relies heavily on coal (51%). Sri Lanka and the Maldives are overwhelmingly dependent on petroleum (83% and 100%, respectively). Table 2 presents the energy outlook of South Asia.

Table 2.
Energy Outlook of South Asian Countries

Countries	Per Capita consumption of energy (kgoe); 2001	GDP per unit of energy use 2001(US\$ per kgoe)	Total energy production (thousands of metric tons of oil equivalent); 2001	Average annual % growth rate of energy use (1990-2001)	Commercial Energy mix; 2001
Bangladesh	153	10.8	16200	4.3	Petroleum – 29% Natural Gas– 67% Coal – 2% Hydroelectricity– 2%
Bhutan	N.A-	N.A-	N.A-	N.A-	Petroleum – 26% Coal – 18% Hydroelectricity– 56%
India	515	5.5	438099	3.6	Petroleum – 34% Natural Gas– 6% Coal – 51% Nuclear – 2% Hydroelectricity– 6%
Maldives	-	-	-	-	Petroleum – 100%
Nepal	357	3.7	7338	3.4	Petroleum – 57% Coal – 18% Hydroelectricity–27%
Sri Lanka	421	7.8	4462	3.8	Petroleum – 83% Hydroelectricity– 17%

Source: World Development Indicators; 2004 & Energy Information Administration

N.A.: Data not available

Himalayan countries of Nepal and Bhutan have the highest shares of hydroelectric power in their energy consumption mix. In recent years, natural gas has been growing in importance as a source of

energy in India, especially for use in power generation, fertilizer and petrochemical production. However, the use of natural gas is comparatively modest in other regional countries.

As the case in many other developing regions, South Asia continues to rely heavily on biomass (i.e., animal waste, wood, etc.) for residential energy consumption and, particularly, in rural areas. According to the International Energy Agency (IEA), biomass accounted for about 80% of residential energy consumption in 2000. Given that the primary end uses of biomass are cooking and heating, the expansion of electricity access, used primarily for lighting, is not expected to have a significant affect on biomass use in the future.

Other forms of renewable sources are also being used in these countries. With the ever-increasing population, pressure on the fossil fuel reserves is rising. Renewable sources are now considered an economically viable option for electricity generation. The table 3 gives the status of renewable energy in the six countries:

Table 3
Status of Renewable Energy based Power Generation

	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
World Hydroelectricity Installed Capacity January 1, 2002 (Million KW)	0.23	0.43	25.751	0.00	0.334	1.161
Net Hydroelectric Power Generation, 2002 (Million Kwh)	1040	2000	68000	0.00	1820	3230
Wind, and Wood and Waste Electricity Installed Capacity, January 1, 2002 (Million KW)	0.00	0.00	1.507	0.00	0.00	0.00
Net Geothermal, Solar, Wind, and Wood and Waste Electric Power Generation, 2002 (Million Kwh)	0.00	0.00	4210	0.00	0.00	0.00

Source: International Energy Agency

The region can be termed as energy deficient as far as availability of fossil fuels is concerned. South Asian countries import heavily to satisfy their fossil fuels needs. However, various forms of renewable energy offer exciting opportunities for the region. There is huge commercially/technically exploitable potential of power generation from renewable sources. This may particularly be important in context of rising awareness about the environmental fall-outs of fossil fuels based power generation.

Among various South Asian countries, India is the forerunner in development and exploitation of renewable energy. Indian renewable energy program is one of the most advanced in the world. Presently around is 3700 MW (3.5%) of the total power generating capacity is based on renewables. India has achieved remarkable success in exploiting wind energy, solar power, hydroelectricity, biomass & cogeneration and waste to energy sources.

Neighboring country Bangladesh is also rich in solar energy. The total potential is estimated at 700-900 X 10¹⁸ J/year. Biomass is also used in its traditional form in villages for cooking and heating. However, the potential for other renewable sources seems to be modest.

In countries like Bhutan, Nepal and Srilanka, there is substantial potential for hydroelectricity. In Bhutan, hydroelectricity accounts for 99% of the total power generation. In Srilanka, around half of the electricity is generated by hydropower and in Nepal, around 92% of the total electricity generated is based on hydroelectric sources. The present exploitation in these countries is believed to be only a small fraction of the total potential and there remains substantial potential unexploited. In all three countries, biomass is the preferred source of energy in villages especially for cooking and heating. Use of solar energy is comparatively low; however, off-late is gaining momentum in certain applications. In Maldives, solar energy is used widely for telecommunication.

1.3. Status of Rural Electrification in South Asia:

With a large percentage of population in the rural areas, rural development is one of the foremost priorities for the governments of south Asian countries. Rural dwellers of this region are often disadvantaged in terms of availability of basic amenities like roads, electricity, water, sanitation and health facilities. Rural south Asia also faces additional challenges like unemployment, underemployment, low productivity and low income resulting in high incidence of poverty.

Various studies have shown that provision of efficient and modern form of energy can have highly desirable impact on poverty alleviation, employment generation and improving quality of life of people. Electricity is the most hassle free and versatile form of energy. The advantages of electricity are much more than just the energy needs for villagers. Therefore, rural electrification is a very important issue in south Asia and due attention needs to be given to this field. As depicted in table 4, the level of rural electrification in almost all south Asian countries is appallingly low. This coupled with very low per capita consumption of electricity in these countries suggests that the region is by and large energy deficient.

Table 4
Electricity Access & Consumption

Country	Electrification Level (% of total population)	Per Capita Electricity Consumption (kWh/capita); 2000
Bangladesh	31	96
India	43	355
Nepal	15.4	56
Maldives	93 (1998 statistics)	N.A
Bhutan	20 (1994 statistics)	N.A
Srilanka	62	293

Sources: IEA (2002), ADB (2001), World Bank (1994), and World Bank (2003)

N.A.: Data not available

Against this backdrop, there is an imperative need to intensify the rural electrification programs in almost all SA countries. It is welcoming that Governments in South Asia have set aspiring targets for national electrification (summarized in table 5). Though setting target per se does not have much

meaning, it certainly is an indicator of the government's willingness and commitment to take concerted efforts for electrifying all the village communities.

Table 5
Time targets for National Electrification

Country	Time Frame	Targeted Level of National Electrification ¹ (%)
Bangladesh	2020	85
India	2007	100
Nepal	2007	50
Srilanka	2010	90

Source: SARI Best practices report

Almost all SA countries are taking concerted efforts for rural electrification. Several countries have earmarked special dispensation for rural electrification efforts. Capital subsidy, interest rate subsidy, technical, institutional help is available in almost all SA countries for rural electrification. A brief discussion of rural electrification efforts in all of South Asian countries is presented below:

1.3.1. Maldives:

Maldives consists of a group of small islands. Naturally, centralized large-scale generation and distribution is not feasible in the country. Various islands have the option to opt for either localized grid or off-grid decentralized systems.

The percentage of the population with access to electricity has rapidly grown over the last decade. In 1990, it was estimated that one third of the nation's population had no access to electricity. The percentage had fallen to 13 percent by 1995 and to 7 percent in 1998. Although access to electricity has improved considerably, electricity supply systems in the outer islands are generally inadequate. Operation hours are often restricted, quality is usually poor, and systems are inefficient (ADB, 2001). Currently, many of the outer island population have access to electricity for only 5-12 hours a day. Also, the efficiency of power supply systems in outer islands is generally low.

In Maldives, electricity is being provided by multiple organisations including the State Electric Company Limited (STELCO)², Island Development Committees (IDCs)³, nongovernment organizations (NGOs), and private companies. STELCO is currently responsible for supplying electricity to Malé and to 20 of the larger outer islands, comprising of more than half of the nation's population.

Maldives' rural electrification program has received substantial external aid from several multilateral/developmental agencies. Maldives received substantial Japanese grant for rural

¹ Here, it may be noted that the definition of rural electrification differs from one country to another. Targeted level of electrification does not automatically convert into percentage of population electrified. For example, according to official rural electrification definition in India; a village is deemed to be electrified if at least 10% of households have access to electricity. Therefore, discrepancy is possible between level of rural electrification and percentage of people electrified.

² STELCO is fully owned by the Government of Maldives and was formed specifically to succeed the utility part of the Maldives Electricity Board, a Government-owned and -controlled institution established in 1982.

³ IDCs are community-based extensions of the Government and are the grass root institutions in the development of the islands in Maldives.

electrification under Atoll Electrification project. Japanese disbursement was to the tune of Rf⁴ 14.4 million in 1999 and Rf 65.9 million in 2000. Under this programme, over a four-year period, about 75 islands have received electricity generators as a free gift to the community. Asian Development Bank (ADB) has also supported village/island electrification projects in the country in various ways.

In addition, Maldives government also runs support programmes for rural electrification. Loans are available for island electrification from two revolving fund schemes of Rf 10 million from the Ministry of Finance and Treasury (MFT) and the Bank of Maldives (BOM). These loan schemes, have provided assistance to a number of island electrification projects. Consequently, the country has achieved remarkable success in electrifying village households. However, at several places the quality of supply is very poor. The current problem is not the accessibility of power rather than quality and reliability of power.

1.3.2. Bhutan

It is often argued that rural development was a neglected aspect of early development programmes in Bhutan. It was also believed that provision of all basic amenities to villages including electricity was grossly ignored. The Seventh Five-Year Plan (1991) reported that over 90% of the population of Bhutan did not have access to electricity. A World Bank Report published in 1994 indicated that the electrification rate in Bhutan is not more than 20% by any estimation.

Government of Bhutan has been undertaking several rural electrification initiatives with its own resources (under various five-year plans) and also with the help of foreign aid and aid from multilateral agencies like World Bank and Asian Development Bank. The rural electrification scheme achieved over 80% of its target in the 7th Five-Year Plan despite financial delays. By the end of the plan the electrification of 107 villages was completed, plus another 47 villages were electrified with grant assistance from the Government of India and from the Dutch Government under the Sustainable Development Programme. Near about 5,990 rural households received electricity during this plan period. During the eighth five-year plan additional 6211 households were electrified. However, these efforts have been taken in a piecemeal manner and any consistent, wide-scale rural electrification program is not existing in the country. Broadly speaking, it can certainly be inferred that rural electrification is a patchy exercise in Bhutan and largely depend upon external resources and persuasion.

1.3.3. Bangladesh

In Bangladesh, supply of electricity is dominated by three Government owned organizations, namely; Bangladesh Power Development Board (BPD), Dhaka Electricity Supply Authority (DESA) and the Rural Electrification Board (REB). In the last few years, as part of the ongoing power sector reform, several other electricity companies have also been established such as the Power Grid Company of Bangladesh (PGCB), the Dhaka Electric Supply Company (DESCO), the Rural Power Company (RPC), and other Independent Power Producers.

Government of Bangladesh considers rural electrification an integral part of a wider national development plan. Energy is treated as a mean to improve quality of life and income generating potential of people. Therefore, due attention is given on the use of electricity for productive purposes. The priority of electricity provision in rural areas is reflected in the several rural electrification programs run in the country (discussed later in this report).

⁴ Rufiyaa (Rf) is the official currency of Maldives. The approximate conversion rate is one USD = 11.77 Rf.

Since its beginning in 1977, the rural electrification programme in Bangladesh has been administered by a government agency, the Rural Electrification Board (REB), and implemented by a number of area electric co-operatives (discussed in part II of the report).

At present, around 31,500 villages have been electrified, which amounts to around 37% of the total villages in Bangladesh. The power grid serves less than 30% of Bangladesh's 130 million people (as per the year 2000 estimates). A small chunk of the population is also served by off-grid electricity. The pattern of grid connectivity is highly weighted towards urban habitants and only about 10% of the rural population have access to the grid. In Bangladesh, with 85% of the population inhabiting rural villages, meeting their electricity needs with grid based conventional means is an economic challenge. Therefore, there are several alternate models that are being developed with support from donor agencies to complement the successful rural electrification program of the Bangladesh Rural Electrification Board. For example, Grameen Shakti (GS) has pioneered the marketing of solar PV systems, modeled after their vast network of Grameen Bank operations.

1.3.4. Nepal

Nepal Power Sector is dominated by Nepal Electricity Authority (NEA) - a wholly owned subsidiary of his Majesties Government of Nepal (HMG/N) - which was established in August, 1985 under NEA Act 1984 by amalgamating the Electricity Department some Electricity Development Boards and Nepal Electricity Corporation (NEC). Private sector participation has been increasing in the production sector in the recent years. . While NEA has been mainly dealing with the national grid, the alternative sources are being promoted by Alternate Energy Promotion Center (AEPC), a government entity, mainly with microhydro and solar energy. Community based small hydro supported by the donors are also providing services in some of the rural areas.

Nepal Electricity Authority (NEA) is responsible for rural electrification, as it owns the transmission and distribution network throughout the country. Its electrification objective is to contribute for the growth of rural economy through use of electricity in agriculture, income generating industries, commerce and supporting infrastructure development. NEA has recently adopted a demand driven rural energy policy where the local communities form cooperatives, establish their own load centers based on own investments for which Rural Electrification Fund (a form of subsidy) is provided, and buy the electricity at bulk rate from NEA. The individual cooperatives are served both by NEA and other supporting NGO organizations by providing free managerial, administrative and technical assistance.

AEPC promotes the off-grid, mini-grid, and decentralized rural electrification in remote parts of the hills and mountains of Nepal, where expansion of grid system of supply is not feasible. In view of tremendous hydro potential, rural electrification based on small hydro, mini hydro, micro hydro and pico hydro is also being pursued aggressively in Nepal. The government provides substantial amount of subsidy to microhydro and solar home systems. It is estimated that out of total 40% electrification in the country, 7% is by these alternate sources. The promoters of microhydro are generally, communities and local entrepreneurs supported by national/international NGOs.

1.3.5. Sri Lanka

As shown in table 4, near about 62% of the total population in Sri Lanka is connected with the electricity grid. However, as the case is in other south Asian countries, in Srilanka also urban communities have grabbed most of the advantage of electrification. Rural areas are so far neglected. Only around 14,000 of total 38,000 villages are electrified.

In Srilanka, provision of electricity to rural areas is the responsibility of Ceylon Electricity Board (CEB)⁵. Although the private sector is involved in electricity generation, it is not allowed to distribute electricity to end users on a commercial basis; electricity that is produced must be for an entity's needs or sold to the CEB. Because of this regulation, no private entrepreneurs currently want to invest in or be involved in rural electrification schemes in Sri Lanka.

It was realised that it may not be possible for CEB to take the entire responsibility of rural electrification based just on its own resources. Consequently, Government of Sri Lanka initiated several schemes to support the CEB in its efforts to electrify more rural areas. These schemes include the provision of funds through external assistance, government grants, and decentralized budgets. Some new concepts are now being developed, such as electricity consumer societies (ECSs) that own and manage hydro schemes, and that distribute electricity to their members. This is allowed only because it was felt that ECSs would provide specific services to their members, not just the distribution of electricity.

Some progress has also been made in rural electricity supply based on off-grid decentralized systems. Till now, there are about 20,000 solar PV systems sold by the private sector to rural households. About 3,500 households benefit from 110 off-grid micro (village) hydro projects initially developed by NGOs, but now supported by the provincial level governments as well, developed commercially with government, World Bank and GEF funded Energy Services Delivery project (ESD).

1.3.6. India:

In fifty years after independence⁶, India has made remarkable progress in rural electrification. Before independence, only 3000 villages had electricity. Today, most of the 5.6 lakh villages have been electrified. The number of villages electrified as on March 2001 was 5,08,515 out of the total number of 5,87,258 villages (near about 87%). Special attention was paid on use of electricity for agricultural/irrigation purposes. Consequently, more than 18 million pumps have been energized as of now. However, the current success in terms of number of villages electrified clearly masks several big deficiencies in Indian rural electrification programme. It should be noted that though 87% of the villages are electrified according to estimates, only 31% of the population in and around these villages have electricity in their homes. The anomaly existed because of the very complacent nature of the definition that was adopted by Government of India for rural electrification⁷.

Government of India has set itself an ambitious target of electrifying all rural villages by 2007 and all households by 2012. Significant contribution from non-conventional energy sources has also been envisaged. Out of around 80,000 unelectrified villages, 18000 villages are so remote and isolated that extension of grid is not economically viable. These villages have been envisaged to be electrified with the help of decentralized off-grid renewable energy systems.

⁵ CEB was established in 1969 by an act of Parliament. CEB is responsible for the generation, transmission, and distribution of electricity in Sri Lanka.

⁶ India became an independent country in 1947.

⁷ Before announcement of the Rural Electrification Policy, a village was deemed to be electrified if electricity was used in the revenue boundary of the village for any purpose whatsoever. However, according to the current rural electrification policy, a village will be considered electrified if at least 10% of the total households are electrified.

Rural Electrification, aimed at bringing about a rural urban continuum by bridging the gulf between them, received attention only after the Independence when the State Electricity Boards (SEBs) were formed under the Electricity supply Act, 1948. The Rural Electrification Corporation (REC), formed in 1969, was entrusted with the responsibility to administer the Central Plan outlay and to provide loans to the SEBs and Rural Electric Co-operatives for implementing schemes of rural electrification. Besides this, from the Fourth Plan onwards, rural electrification schemes attracted substantial loan assistance from the Agricultural Refinance Development Corporation (ARDC), the Agricultural Finance Corporation (AFC), Commercial Banks and the State Land Development Banks. The focus on rural electrification has only increased in recent years. Government of India has set itself a target of electrifying all villages by the year 2007 and all households by 2012, popularly known as 'Power for All' program. Substantial budgetary allocation has been made to this end, including a provision of Rs. 2000 crore in the recently announced Union budget 2005-06.

The key goal of the power sector is supply of electricity to all areas including rural areas as mandated in section 6 of the Indian Electricity Act. Consumers, particularly those who are ready to pay a tariff which reflects efficient costs have the right to get uninterrupted twenty four hours supply of quality power. About 56% of rural households have not yet been electrified even though many of these households are willing to pay for electricity. The Government of India in April 2005 launched a new scheme Rajiv Gandhi Grameen Viduytikaran Yojana, to be implemented through Rural Electrification Corporation, to provide Ninety per cent of the capital cost of the programme by the Central Government as grant for creating:-

- (a) Rural Electrification Distribution Backbone (REDB) with at least one 33/11 kv (or 66/11 kv) substation in every Block and more if required as per load, networked and connected appropriately to the state transmission system
- (b) Emanating from REDB would be supply feeders and one distribution transformer at least in every village settlement.
- (c) Household Electrification from distribution transformer to connect every household on demand.
- (d) Wherever above is not feasible (it is neither cost effective nor the optimal solution to provide grid connectivity) decentralized distributed generation facilities together with local distribution network would be provided so that every household gets access to electricity. This would be done either through conventional or non-conventional methods of electricity generation whichever is more suitable and economical. Non-conventional sources of energy could be utilized even where grid connectivity exists provided it is found to be cost effective.

The scheme provides for free of cost connection to all rural households living below poverty line. Further, there will be no discrimination in the hours of supply between rural and urban areas. The earlier focus of electrification in rural areas had been primarily for irrigation and it has been done generally by extending the LT lines in a piecemeal manner resulting in unreliable and limited hours of power supply. The new programme aims at a qualitative transformation of the rural electricity infrastructure. It envisages that there will be no discrimination between urban and rural areas in respect of hours of supply. 24 hours supply of good quality power would also enable dispersal of small industries, khadi and village industries in the rural areas. It will also facilitate delivery of modern health care, education and application of information technologies. This is aimed at accelerated rural development, employment generation and poverty alleviation.

The scheme also lays special emphasis on sustainability of rural supply through collection of the cost of electricity from the beneficiaries. To achieve this objective, it is proposed that franchisees like

NGOs, consumer associations etc. will be deployed with appropriate involvement of Panchayati Raj institutions. The State Governments will be free to provide appropriate targeted subsidy to poor households.

The Central Government has also offered the project implementation and management expertise of its Central Power Sector Undertakings like NTPC, NHPC, PGCIL and DVC to the States who are willing to make use of these services for ensuring timely completion of the project in this scheme. The scheme has a target of electrifying 1,25,000 un-electrified villages and giving access to 7.8 crore uncovered rural households in next 5 years. Total estimated cost of the scheme is Rs.16000 crores.

The new program proposed by Government of India is undoubtedly very ambitious. It has overlooked the limitations of the present apparatus- public and private utilities and demand –supply gaps. The crux of the unresolved areas is the precarious financial health of the public utilities, need for increasing the infrastructure for power generation, distribution, setting up the rural distribution companies, resolving contiguous issues relating to tariff fixation by the regulators, metering/billing and power thefts. Power Reforms have to be re-oriented and vigorously pursued.

Chapter 2: Technological Options

Today wide ranges of technologies are available to electrify rural areas. These include conventional technologies like diesel or petrol gen-sets and non-conventional technologies like solar, biomass and wind. Various technologies and technological approaches for rural electrification can be clubbed under three broad heads:

- Grid based centralized rural electrification
- Localised grid/mini grid
- Decentralized stand-alone systems

2.1. Grid based centralized system:

If the objective is to provide electricity to rural households in the most cost-effective, sustainable, and environmentally benign manner, one should be equally receptive to all options. This study reinforces the proposition that the option of grid extension should not automatically be dismissed as unaffordable on the basis of poorly designed rural electrification projects found around south Asia. Rather, there is a need to reassess the commonly assumed costs of grid extension and to be receptive to new designs that more cost-effectively meet rural needs. In south Asia itself, we can find various grid connected models that have been very effective and cost efficient in meeting rural electrification needs of the people. Some of such models – Palli Vidyut Model in Bangladesh and Noida Power model in India – are discussed in section II of the report.

Generally speaking, low level of electricity consumption, low disposable income, high construction and staffing costs and logistical difficulties encountered in serving rural consumers are all factors that have prevented a large segment of the rural population from accessing grid electricity. Furthermore, while those in industrialized nations make extensive use of electricity in all their daily activities, in developing south Asian region, the provision of electricity in rural areas is often debated to decide the priority over other developmental needs. It is sometimes felt that financial resources used for electrification can rather be used to support other, more critical infrastructure development efforts like water and health infrastructure. Providing electricity through grid is seen by some as too costly an exercise. These factors sometimes work as limiting factors to grid extension projects.

Nonetheless, grid extension remains the priority technological approach for rural electrification in South Asia and the world. Despite few disadvantages, there are certain merits with this approach, which some times assume great importance. These merits (presented below) should be factored in favor of grid approach, while deciding the right technological choice for rural electrification.

- Grid supply in several cases represents lowest cost source of electricity due to the advantage of economies of scale.
- Flexibility in supply side management: Grid allows the demand centre and generation centres to be different from each other and thus permits power to be produced at various places with varying technologies in the most cost effective manner. Power generated through all technologies such as coal thermal, gas, nuclear, hydro and other sources of renewables can be integrated in an optimum manner
- Versatility and convenience: Grid connection is also most desirable method of getting the electricity from the consumer point of view due to its versatility and convenience

Along with the merits, it is also necessary to know about various shortcomings of grid approach:

- In case of grid based electrification. Though per unit generation cost may be low, significant transmission and distribution cost is incurred. The problem of high T & D loss is particularly relevant in South Asian context as almost all SA countries have unusually high T & D losses.⁸
- The management of subsidy is difficult for grid based electrification compared to off-grid systems. This is another important point in south Asia, where management of government subsidy to electricity sector has become a crucial issue.

Irrespective of these merits (demerit), connection to the national electricity grid is not a very common occurrence in rural areas of the developing world. In south Asian regions, it is estimated that majority of the rural poor (as tabulated in chapter 1) are deprived from the national grid. This deprivation is neither by chance nor by design. Rather, there are many reasons, both technical and economic, that make grid connection unfeasible. These issues, in context of the region need further elaboration.

2.1.1. Technical Issues:

2.1.1.1. Distance from existing grid

If the community to be connected is a very long way from the existing grid, then there'll have to be consideration of whether the cost of extending the grid is justified in economic or social terms. There is often a cut-off distance at which grid extension is not viable. Also, the terrain between the grid and the village must be considered to see if there are difficulties, such as mountains or marshes, which can make line extension very difficult in these circumstances. It is such locations, where, grid extension are extremely difficult in these circumstances. Naturally on such locations stand-alone systems are most effective.

2.1.1. 2. Load density

The density of the load (the quantity of power demanded in a specified area), if high for an area then there will be a strong justification for a grid connection in that area. Where loads are very dispersed, it may be more practical to consider supplying household systems, such as photovoltaic systems, rather than community systems that may require extensive distribution network. Alternatively, a central battery charging system may be an alternative to distributing power to individual households.

2.1.1.3. System power losses

A feature of many rural electrification systems, is the significant power loss in the transmission and distribution systems. This is particularly the case where lower voltage transmission lines, say 11kVA or 33kVA, are extended over very long distances. Power losses of over 20% are not uncommon in rural systems across south Asia.. This results in;

- Costly power supply,
- Poor service to rural communities due to frequent load-shedding, and
- Instability in the power supply, with fluctuating voltage and frequency, at the end of a long rural transmission lines

Extending the rural electricity network without increasing the country's capacity for power production can often further worsen the quality of the electricity service. Decentralized power production can help to alleviate the power supply problems for rural communities.

⁸ T & D loss in is approximately around 40% in Bangladesh, 33% in India and 25% in Srilanka.

2.1.2. Economic Issues:

2.1.2.1. Low Purchasing Power of People:

As discussed earlier, the per capita income of south Asian countries is very low compared to world average. As shown in table 1, a significant percentage of population in most of these countries is below poverty line. Further, most of the below poverty line people are rural dwellers. This definitely implies very low purchasing power and low paying ability of the villagers. Therefore, supply of electricity to rural areas in these countries suffers from great risk of non-payment. This issue becomes more important when seen in light of low electrification rate of village households. As known, the upfront cost of electrifying a household is very high (cost of metering, cabling, wiring). Under most of the delivery mechanism prevalent in the region, individual households are required to bear the upfront cost of electricity connection. As a result of which, a sizeable number of the households do not opt for electricity connection though electricity is accessible in the village.

2.1.2.2. Poor fiscal health of central (and/or state) government and poor financial condition of government utilities:

More often than not, governments across south Asia runs in heavy budgetary deficit. This makes it difficult for them to allocate any material dispensation for rural electrification. In these countries, electricity utilities are also at brink of bankruptcy and it is not possible for them to extend electrification grid to rural areas based on its own resources.

2.1.2.3. Perception of electricity as a free public good:

In some of the south Asian countries, electricity to rural areas and particularly for domestic and agricultural purposes is being heavily subsidized. For example, in India, some of the states provide free power to villagers for agricultural uses. This practice has taken its heavy toll on financial health of state utilities. Concomitantly, it has created an unwarranted perception among farmers across the country that electricity is a free public good.

2.1.2.4. Lack of other infrastructure:

In most of the cases, these villages also lack other infrastructure such as roads, civil amenities etc. This makes the electrification work more costly and time consuming for these villages.

2.2. Localised/Mini grid type systems:

One way of avoiding the prohibitive costs of distribution network is to decentralize the power generating capacity and install local small-scale, low-voltage grids, otherwise known as micro/mini grids. This tends to be the main thrust of the work being carried out on rural electrification in some countries at the present time. Localized grid networks allow local renewable resources to be exploited. Energy sources such as small-scale hydropower, solar (photovoltaic), wind power and biogas are all being harnessed successfully in rural electrification projects in the South Asian countries.

- This approach bypasses the need for grid set-up, which is costly
- Due to low load factor in rural areas there is excess capacity with grid, hence this option would better suite the rural communities.
- Better utilization of available resources.

- Funds are easily mobilized (from government, multilateral agencies or may be through CDM route).

There is a wide range of technologies available that may be suitable for localized generation. This include conventional sources/technologies like diesel engines, petrol engines, small gas turbines etc; non-conventional sources like biomass, small hydro, wind, micro-hydro, pico-hydro, Solar Photo voltaic etc and hybrid systems like wind-diesel, wind-SPV, biomass-diesel etc.

2.2.1. Conventional technologies:

In south Asia, Diesel (or gasoline) based internal combustion engine is a popular way of generating and supplying electricity in a localised grid. These sets come in a wide range of commercially available sizes, from about 5 kW to about 30 kW. They are long lasting and will usually have a useful life-span of about 7 to 10 years (30000 hours running time). These sets can run on few alternative fuels other than diesel/gasoline (box 1). Gas based generation of power is also very popular (particularly in Bangladesh) and is increasing in its prominence. This is due to the efficiency and convenience offered by one of the gas based generation technology – combined cycle gas turbine (CCGT).

Box 1

Alternative fuels

IC engines have been designed to operate on petroleum fuels; however, their operation is not confined to these fuels. Ethanol and methanol (also known as alcohol) substitute directly for petrol (gasoline), and vegetable oils can substitute directly for diesel fuels. Ethanol is already used commercially as an engine fuel in Brazil and when blended with petrol to form the blend known as gasohol, in a number of other countries.

These conventional technologies are well proven and the generation/electrification systems based on these technologies are widely available across south Asia. These technologies may not require much elaboration. Therefore, in this report, we have limited our discussion on conventional technologies and instead have presented a more comprehensive view on non-conventional technologies.

2.2.2. Non-Conventional Energy Sources:

Renewable energy technologies are to be discussed considering the increasing importance they have gained in view of global warming and climate change and enormous potential of these sources in south Asia, Renewable based localized grid has been very successful in some of the south Asian countries. Particularly, hydro-power village electrification projects in Nepal and Srilanka and biomass based island electrification project in Sunderban, India are notable examples of successful renewables based localized grid.

2.2.2.1. Biomass:

Biomass has been an important source of energy for many centuries. Until recently, it's been the only form of energy that was usefully exploited and is still the main source of energy for more than half the world's population for domestic energy needs.

The extraction of energy from biomass can be split into three distinct categories:

- Solid biofuels
- Biogas

→ Liquid biofuels

Electrification with all three forms of biomass has picked up in South Asia; for example, in India, there has been widespread development and dissemination of gasification technology to meet variety of rural energy needs – like irrigation pumping and village electrification. With high reserves of biomass, Government of India (GOI) is actively taking steps to harness energy from this source for its rural electrification programs.

Many biomass conversion technologies for rural applications are easily manufactured by local artisans or by small and medium sized engineering workshops. For instance, in India, biogas plants are produced in great numbers by local artisans. Arguably, greater use of this technology in south Asia can also have desirable effect of solving local unemployment problems.

2.2.2.2. Wind:

Wind power is being increasingly used to generate power. Currently India is the fifth largest country to harness wind energy. Wind projects have also been set up in Bangladesh and Srilanka on a test scale. Modern wind turbine generators are highly sophisticated machines using the latest materials and production techniques. Wind power is now an economically attractive option for commercial electricity generation in the right conditions.

In remote rural areas, where households are dispersed or where grid costs are expensive, battery charging is an option. In such areas only a few tens of watts of power is sufficient for lighting and a source of power for a radio or television. Batteries can be returned to the charging station for recharging. This reduces the inconvenience of fluctuating wind speeds.

The cost of producing electricity from wind is heavily dependent on the local wind regime. High wind speed increases electricity generation and reduces unit costs. For wind based systems, capital costs are high but running costs are low. Therefore wind can be a viable technology for villages located in high wind regime, particularly when it is packaged with access to subsidies, grants or low interest loans.

2.2.2.3. Micro-hydro and Mini hydro power

This is widespread in Nepal and Srilanka. It's now agreed that micro-hydro schemes have an important role to play in economic development of remote rural areas, especially mountainous ones. The micro hydro is defined as the plants with capacity less than 100 kW and further the plants with capacity less than 5 kW is defined as the pico-hydro.

The best geographical areas for exploiting small-scale hydropower are those where there are steep rivers flowing all year round. Like the hill areas of countries with high rainfall, or the great mountain ranges and their foothills, like the Himalayas.

Since the fuel for hydro power is free, the plant becomes more cost effective if run for a high percentage of the time. If the turbine is run only for domestic lighting in the evenings then the load factor would be very low and the cost cannot be justified. The major cost of the scheme is for site preparation and the capital cost of the equipment (in chapter 4 cost comparison of some of the micro-hydro projects in Nepal is presented). In general, unit cost of power generation decreases with a larger plant and with high heads of water.

In Nepal, and also in some of the other SA countries, the target sites for the micro-hydro schemes are the isolated areas, which are not connected to the national grid. Its comparative advantages are⁹

- Schemes are simple in nature
- Components can be locally manufactured
- The scheme can be locally built, managed, operated and maintained with local people participation.
- Government subsidy is available for these kind of projects.

There are a number of mini hydro power plants developed in Nepal with the aim to electrify the district headquarters and business centers in the remote areas. Mini hydro definition ranges from 100 kW to 1000 kW in Nepal. Most of the mini hydro plants connected to isolated grids are owned and managed by NEA and some are leased to private parties. Some of the mini-hydro plants are built as part of the bigger project like Khimti Hydropower Project (60 MW) where 500 kW Jhankre was built for power and later used for rural electrification with community participation in the surrounding area.

2.2.2.4. Solar photovoltaic energy:

Solar photovoltaic (PV) systems have an important use in remote areas, away from grid. Some of the uses are lighting, water pumping, vaccine refrigeration, and telecommunications among others. Almost all south Asian countries have abundant solar potential and if the technology can be made cost competitive, it may have wide applicability across south Asia. Benefits of photovoltaics are depicted in Table 5 below:

Table 5
Solar Photovoltaics: Benefits & Demerits

Advantages	Disadvantages
<ul style="list-style-type: none"> • Reliable • Easy to maintain • Long panel life, no moving parts • Low environment impact • No heat, noise, pollution 	<ul style="list-style-type: none"> • Difficult to repair • Components add to the cost • Batteries need to be looked after • Can be easily stolen

PV technology is sophisticated and manufacturing plant is expensive. India is a very large producer of PV panels. There are over 60 companies producing solar cells and systems in India. In Srilanka also there are several companies in the business of manufacturing and marketing SPV systems.

2.2.3. Issues with localised grid based electricity supply:

2.2.3.1. Difficulty in load management:

One of the very crucial issues facing localised grids is the difficulty in load management. Most of the times these localised grids are owned/managed by agencies, which have less than adequate technical and managerial expertise.

⁹ The advantages of microhydro projects have been discussed here in Nepalese context. However, they may be equally relevant for other SA countries as well.

2.2.3.2. Operation and Maintenance:

In a localised grid model, it is both desirable and effective if local communities take the charge of maintenance and repair. This may be slightly difficult for poorly educated locals. Therefore, local capacity building may be necessary.

2.2.3.3. Ownership Issues:

In south Asia, it is often found that village societies are very heterogeneous in nature. Several coexisting caste, creed and faith sometimes create issues in ownership of public and quasi-public properties. Ownership of any localised grid for electricity generation also is likely to be an issue of dispute. As indicated in chapter 3 and discussed in part II of the report, very robust institutional framework is required to overcome these difficulties.

2.2.3.4. Precludes the advantages, which may arise due to 'Economies of Scale':

The per unit cost of power generated based on stand-alone localised grid may be more compared to centralised grid due to the later having advantage of economies of scale. This may particularly be true, when the system is based on fossil fuels.

2.3. Off-Grid Decentralized system based Rural Electrification:

Under off-grid decentralized system based rural electrification, electricity is generated at the individual household level. Technologically, there are several options available ranging from a diesel generator; a battery based 12-Volt DC power system, a small wind generator to a biogas generator system or a micro hydro. Futuristic technologies such as fuel cell/hydrogen can also become option of choice for power generation at household level. However, at present Solar PhotoVoltaic and battery based DC systems are the two most commonly used technologies in south Asia.

The relevance of off-grid decentralised systems has been well recognised by different countries in the region. Government of India has set itself a target of electrifying 18,000 remote villages with the help of off-grid decentralised technologies. There are already several successful models working in south Asia based on this approach. These include marketing of solar PV by private entrepreneurs in India and Srilanka and by Grameen Shakti in Bangladesh (discussed in part II of the report).

In rural electrification literature, often decentralised off-grid systems are compared with centralised grid and most of the time the former is rated as a superior alternative. However, this may not necessarily be true always. Before any decision making, merits and demerits of both of these technologies should be taken into account. The final decision should fit the priorities and specifications of the project. To help in developing better understanding of the pros and cons of these two technologies (from the perspective of local communities), presented below (table 6) an indicative comparison.

Table 6
Merits and Demerits of decentralized ownership and management of rural power supply:

<i>For</i>	<i>Against</i>
Centralized management of grid	

<ul style="list-style-type: none"> • <i>Financial risk on utility</i> • <i>Management capacity already exists</i> • <i>Technical capacity already exists</i> 	<ul style="list-style-type: none"> • <i>No stake in power supply, so lack of interest in maintaining it</i> • <i>Operation and maintenance staff often brought in from outside community</i> • <i>Bureaucratic management</i> • <i>Repairs take longer because they must be approved by central management</i> • <i>Tariff collection expensive</i> • <i>Disputes between utility and community possible</i>
Decentralized management (community owned stand-alone scheme)	
<ul style="list-style-type: none"> • <i>Repairs made quickly</i> • <i>Less bureaucracy</i> • <i>Local person employed as operator</i> • <i>Local people provide labour, reducing initial capital required for scheme</i> • <i>Utilisation of local resources</i> 	<ul style="list-style-type: none"> • <i>Financial risk placed on community</i> • <i>Technical training required</i> • <i>Management training required</i> • <i>Outside assistance required for major repairs (costly)</i> • <i>Local disputes possible if management breaks down</i>

2.4. Factors to be considered, while deciding suitable technology option in South Asia:

Selection of right technology is a very crucial issue for any rural electrification project in South Asia. More so when resource constraints limit the possibility of any corrective measure. Besides the usual parameters of geographical factors, demand pattern, local resource availability and the like; following additional factors should be taken into account before making any technological choice for rural electrification in south Asia:

1. **Least cost solutions :** Electrification should focus first on those areas with high economic growth potential and lowest cost. Identify economic limits to extensions to the grid and the economic potential of lower-cost options, alternative energy sources and evolve the least cost solutions.
2. **Commensurate load demand:** Ensure commercial viability to assure RE's sustainability after accounting for other goals such as social equity, agricultural development and generation of local jobs leading to reversal of rural-urban migration. RE should ideally be introduced in areas where there is already a demand for electricity-using services--usually where there is agricultural growth, rural businesses and rural incomes. It is most important to provide a framework which will allow rural users to articulate their own demand patterns and to decide how these can best be met from a range of energy supply options. However, to increase and accelerate the development impact, technical assistance and rural business services could be provided to stimulate power demand. Assured reliability of power supply to the consumers is mutually beneficial to the customer and power distribution companies.
3. **Cost Cutting:** Low purchasing power of the rural community demands that emphasis should be given on bringing down the cost and making power affordable to the end users. Initial connection charges are a greater barrier to rural families than the monthly electricity bill. One way of dealing with the high initial costs of rural energy services--lowering system costs through

design innovations. Many distribution companies design systems with the capacity to deliver between 3 and 7 kilowatts of service and that require heavier wires, larger transformers, and generally more expensive distribution systems components. The entire system design can be lightened to provide service at less cost. The costs of installation and wiring provided by utilities are also high, but these can be lowered by simplifying wiring looms with connection boards, as in Nepal and using load limiters (circuit breakers) to encourage affordable levels of consumption. Other examples of cost-cutting strategies include using cheaper utility poles and involving local people in construction and maintenance.

4. **Local Suppliers:** adopting the technology that is domestically available is a big advantage. The cost of maintenance and spare parts also reduces. Since capital costs are high for most of these technologies, the cost of the components are likely to be very high too. Availability of skilled service agencies in the close vicinity is very useful..
5. **Emerging Technologies:** There are a number of technologies that offer the potential to assist progress in rural areas. These span power generation, transmission, storage, metering and billing, and include lower capacity limited-current supplies, Single Wire Earth Return systems, gasifiers, certain hybrid systems and, pico or micro hydel plants. In principle, the renewable energies, such as solar and wind power, should find good application despite playing a minor role at the current time, taking adequate care for capacity building and safe guards such as after sales services by the suppliers.
6. **Technical Standards:** Some element of consumer protection is needed if the market for off-grid systems is to grow. The setting of appropriate technical standards is an important aspect of quality control. Without such standards the lowest capital cost is likely to dominate, with unacceptable compromises in reliability. There is a need to emphasize the need for high maintainability and customer education on safety and demand side management.

Chapter 3: Delivery Options

Delivery options (institutional mechanism) is probably one of the most important aspects of rural electricity supply. As we have discussed, there are several involved issues such as ownership issues, payments of bills, capacity building, community involvement etc, which make rural electricity supply far more complex compared to supply of electricity in the urban regions. These issues demand that right kind of delivery mechanism should be chosen/carved out to ensure that electrification program is successful and sustainable.

3.1 Models

Electricity to rural dwellers can be delivered in a variety of ways and institutional arrangements. Four typical models in vogue are highlighted in the following sections.

3.1.1 Entrepreneurship model:

Entrepreneurship model is basically a private investor driven model, where basic aim is to generate sustainable return on the investment by offering rural energy services. Under this model, the entrepreneur sees supply of electricity to unelectrified rural areas as a business opportunity. The advantage of this approach is the efficiency and innovative approach, which a private player can offer. Generally, private investors look for opportunities where they can generate maximum returns and supplying electricity to rural masses in South Asia may not be an attractive business proposition. However, there are many unelectrified villages across south Asia, where per capita income is significantly high. Such type of villages are definitely suited for entrepreneurship approach. Here, it may be useful to mention the example of Noida Power- one of the Private Electricity providers in India. Noida Power has succeeded in electrifying many villages (of the area, where it holds the distribution license) on a cost recovery basis. The model is discussed elaborately in Part II of the report.

3.1.2. Franchise model:

The franchise model, in many respect, is an extension of the above mentioned entrepreneurship model. Though some of the private companies may have technological and financial resources. They may not have the administrative, managerial and human resources to implement rural electrification projects in a wide area. Therefore, scaling-up by individual entrepreneurs/private companies may be difficult after a certain point. Under this model, private companies (franchiser), after installing the system (or helping the systems to be installed) gives the responsibility of operation, maintenance and revenue collection to a local entrepreneur (known as franchisee). The returns generated through the provision of electricity supply is shared between the two parties.

3.1.3. Not-for-profit model:

Under this model, provision of electricity is made through community led participatory approaches. The implementing organisation is generally a civil society organisation, or a co-operative society. The basic objective of the implementing body is not to make profit rather to meet local developmental priorities through the supply of electricity. Few examples of this model have been discussed in part II of this report.

3.1.4. Government owned model:

This is the most commonly practiced model in South Asia and elsewhere in the world. Under this model, government assumes the responsibility of electrifying rural communities. This is done through the extension of electricity grid. The entire capital cost is born by the respective government

(or government department) and the operation, maintenance etc is also being taken care of by the government.

All four types of delivery models presented here have their own peculiarities, merits and demerits. Any one delivery option can not be rated as better than the others, however, under individual set of circumstances, it is certainly possible that one model is more appropriate than others. Table 7 below presents the summary of these common delivery options:

Table 7
Delivery options commonly practiced in South Asian countries

Delivery models	Players	Objective	Examples in South Asia
Entrepreneurship model	Entrepreneur, customers	This model aims to generate sustainable returns for the entrepreneur through the provision of energy service that customers will purchase.	Noida Power model, India; Isolated grids built by NEA, but leased to private sector operators, Nepal; Bhutwal Power Company, Nepal,
Franchise model	Franchiser, franchisee, customers	This model aims to generate sustainable returns for a franchiser and a franchisee (local entrepreneur) through the provision of electricity service that customers will purchase.	Being considered by BSES for Orissa village electricity supply through their three distribution companies, India
Not-for-profit model	Implementing body (civil society organisation, government, international organisation, cooperative) consumers	This model aims to provide energy service to the community that will facilitate local development priorities.	Island Cooperative Society (West Bengal, India), Palli Vidyut Samitis, Bangladesh; Hukeri Co-operative Society, India
Government owned model	Utility, customers	This model aims to extend grid electricity connection to rural dwellers, very often on social and sometimes on political consideration rather than on purely business consideration.	State Electricity Boards, India; Cylone electricity Board, Srilanka

3.2. Selection Criteria for the delivery models

3.2.1 Basic Issues

Villagers do not need micro-hydro, they need milled flour. They do not need a photovoltaic cell; they need lighting in the house. They don't need a biogasifier, they need to cook. Analysing user needs in any service industry is crucial for success. This exercise is particularly important in rural energy because, although energy will benefit communities, very few projects have developed appropriate service delivery models with wider applications. Energy consumption in rural communities is dependant on demographics, environment, local economies and even culture; therefore, energy distributors must invest time to understand successful delivery models. For example, one innovative delivery model might be to provide customers with a connection and a light bulb so that they purchase hours of light instead of kilowatt-hours of electricity. Appropriate delivery models that incorporate community involvement will be the key to stimulating energy demand in rural areas.

There could be several innovative and effective delivery models, each tailor-made according to the local needs, resources and developmental priorities. There may not be a universally applicable, time-tested formula to guarantee the success. But surely, certain factors may be helpful in making delivery models successful:

3.2.2 Assessing energy service requirement:

An assessment of energy service requirement will determine what demand there is for new energy sources. It'll answer questions as, how much energy is needed where it is needed? What form is needed? Understanding users needs can be achieved by proper surveys of consumption demand and needs. Rural energy demand can be broken down into several sectors, including households, subsistence farming, agriculture, livestock, industry, commerce, offices, transport, services, such as schools and hospitals and so on. To properly understand the energy service requirement of rural communities, involvement of villagers right from the planning stage, may be required, and can make the task simpler. The energy service delivery model can be then formulated to meet these energy service requirements.

3.2.3 Social Marketing:

One common problem for several villages and particularly (remote and forest-fringed villages) is the very low level of awareness about the merits of electricity consumption and use. This results in passive attitude of villagers towards electricity services. In such situations, communities are not very forthcoming in participating in energy planning exercise or taking advantage of electricity. Therefore, it is very necessary that proper social marketing of energy services is done before embarking on system construction exercise. Advantage of electricity, its various uses, potential in raising standard of living of people should all be impressed upon villagers.

The social marketing concept should not be confused with awareness creation. Awareness creation is only one component of social marketing. Another component could be creating incentive among villagers to use electricity. This could be done by introducing villagers to modern entertainment and electricity gadgets. Rural energy service providers besides selling electricity can sell such gadgets.

3.2.4 Focus on productive use of power:

The delivery option should prioritize the use of power for productive purposes that can help rural communities augment their earning capacity. This will improve the revenue collection of rural electrification projects and will make them sustainable.

3.2.5 Local community involvement:

For the success of any energy service delivery model, involvement of local community is very crucial. Local community involvement can significantly reduce the project implementation and operational cost and effect a more efficient delivery of energy services. Community participation is now widely accepted as a pre-requisite for ensuring equity and sustainability of rural electrification. Projects are more likely to be viable and sustainable if local stakeholders are involved in their design and implementation. In some cases (e.g. Bangladesh, Nepal), the community has made contributions of capital or labor, thereby helping to defray the costs of the program. Labor-intensive activities in the distribution and customer services function may be contracted out to village-level organizations on a fee-for-service basis.

One way to approach this is to set up a Rural Electrification Committee to help assess level of demand, educate consumers, and promote the wider use of electricity. This may also help reduce potential problems over rights of way for the construction and maintenance of electric lines. The contiguous issues of developing a range of options, arriving at a consensus on the scope of

electrification, tariff setting, power thefts and realization of service charges from the defaulting consumers can be amicably resolved by active dialogue between the community and power supply companies.

Chapter 4: Financing Options

Many studies show that the key constraint to energy supply for rural communities is access to the initial capital needed to buy the equipment to harness the resource. This leads rural communities to choose energy options that are cheap on a day to day basis, but which offer a poor quality of energy supply and are expensive over the longer term, particularly when indirect cost is taken into account.

There are also other barriers, which prevent rural communities from choosing efficient, and cost-effective energy options. Institutional aspects, infrastructure, and access to technical and other support, for instance must all be taken into considerations in rural energy policies. This chapter provides a review of the key problems with rural electrification financing, instruments available, and indicates some innovative ways of securing finances for rural electrification projects in South Asia.

4.1. Rural Electrification financing problems:

The financing problem for rural electrification projects (particularly in context of south Asian countries) can be divided into two basic categories:

- Financing problems of capital nature (up front cost of plant/equipment, erection etc.)
- Financing problem of revenue nature (revenue being generally lower than cost of power)

The capital cost per unit of power supplied to rural areas is often higher compared to similar costs for urban and peri-urban consumers across various technologies. This is because of the low and dispersed demand for electricity in rural areas, and consequently low loads, which precludes rural electrification projects from reaping the advantage of 'economies of scale'. High capital cost of rural electrification projects can also be associated with the high logistics cost involved in commissioning such plants/systems due to poor infrastructure like roads, railways etc. Projects, which are of centralised grid-connected type; cost of grid extension also has to be taken into account.

It is well known that purchasing power of rural dwellers is lower than their urban counterparts. This means that electricity tariffs to villagers should be kept at reasonable level. In most of the south Asian countries, rural electricity supply is often subsidised by the parastatal electricity utilities. Even where supply of electricity is done by a co-operative/private supplier, efforts are made to keep the tariff as low as possible. However, it is found that bill collection for rural areas is very poor. Consequently, a significant number of rural electrification projects (both grid-connected and off-grid) have accumulated huge revenue losses.

High capital cost and poor recovery seriously impairs the rural electrification efforts. This is reflected in the slow pace by which electricity connection is being extended to villagers. Sometimes projects are abandoned on financial considerations, even if they are technically feasible and socially desirable. Therefore, it is imperative that adequate attention should be given in finding methods of financing and sustaining rural electrification projects.

4.2. Modes of financing rural electrification projects:

Several modes of supporting and financing rural electrification projects are in vogue in south Asian countries. Several other financing methods, though are not in fashion currently, can be quite productive, if considered. These modes of financing can be summarised as follows:

a) Grants

Grants may appear to be the least expensive source of funding for the recipient. However, lessons from the projects funded entirely on grant basis, show poor quality of management, maintenance,

and lack of responsibility from the beneficiaries. In India, several schemes are operational, which can provide grant as high as 90% of the total project cost. These include Pradhan Mantri Gramodaya Yojana (PMGY), Minimum Need Programme (MNP), Kutir Jyoti Programme (KJP), Accelerated Rural Electrification Programme (AREP) Besides, grants for rural electrification projects can also be procured from Member of Parliament Local Area Development Scheme (MPLADS) and Integrated Rural Energy Programme (IREP). In Srilanka also, government runs several grant schemes to support utilities like Cylone Electricity Board to undertake rural electrification projects. In Nepal, NEA has opened a separate Community Rural Electrification Department, which provides subsidy for rural electrification and supply electricity to the community at a bulk rate (often lower than average).

b) Equity facility:

Government, development agencies and financial institutions can support rural electrification projects by becoming equity stakeholders in the projects. The equity may be provided on a concessional basis, which can help defray the high up-front cost of rural electrification projects. The equity participation can be of minority shareholding in order to maintain interest of the promoter. Such type of participation can become extremely meaningful, as most of the private project developers need some additional financial resources for their projects but at the same time are wary of going through cumbersome loan disbursement process. Further, loan can increase their business risk, which can be considerable for rural electrification projects in the region.

c) Self-financing by Parastatal Utility

Provision of electricity to rural areas is considered as a moral responsibility of electricity supply utilities. Over the years, SEBs in India, NEA in Nepal, CEB in Srilanka have undertaken rural electrification projects, drawing on their own resources. This has been the most common practice of financing rural electrification projects in the region. However, the rapidly deteriorating financial health of the utilities have put a question mark on the sustainability of this model and have necessitated alternatives to be found.

d) Credit

Loans are a relatively new concept in financing energy supply for rural communities and they are often implemented by NGOs or cooperatives, which provide the guarantees required by the financial institutions. Loans even with subsidized interest rates provide a minimum of guarantees that communities are interested in the acquisition of a particular technology and the maintenance of the scheme.

In case of India, Government of India through Rural Electrification Corporation (REC) provides soft credit to State Electricity boards and State Governments to extend electricity connections to rural areas. REC offers various schemes to suit the requirement of different types of rural electrification projects. REC also provides credit to rural electricity co-operative societies. Table 8 below provides an indicative list of local FIs active in financing rural electrification projects in various countries.

Table 8
Financial Institutions active in financing rural electrification

Country	Institutions
India	Rural Electrification Corporation (REC)
	Power Finance Corporation (PFC)
	Indian Renewable Energy Development Agency (IREDA)
Bangladesh	Infrastructure Development Company Limited (IDCOL)

Srilanka	Development Finance Corporation of Ceylon (DFCC)
	National Development Bank (NDB)
	Private Sector Infrastructure Development Company (PSIDC)
Nepal	Alternative Energy Promotion Center (AEPC)

In the case of photovoltaic systems, where the beneficiaries are very often individuals, credit is granted on individual basis. Various forms of loan have been developed and, very often, interest rates for these loans are below normal commercial rates. In Bangladesh, Grameen Shakti offers micro credit to individual households to help them buy SPV systems. Selco Solar Ltd., India and solar energy companies in Srilanka also facilitates micro credit with the help of some agreement with the local bank.

e) Funding from multilateral agencies:

Multilateral developmental institutions like World Bank, Asian Development Bank and United Nations Development Programme have also been very active in supporting rural electrification projects and approaches in the region. Support to various projects have been extended in the form of grant, subsidised loans and technical assistance.

f) Funding through CDM route:

Rural electrification projects based on renewable energy sources are eligible to avail additional funding under Clean Development Mechanism (CDM) of Kyoto Protocol. According to Kyoto protocol, any project (including renewable based rural electrification projects) in non-Annex I countries¹⁰, which lead to reduction in the emission of green house gases can sell the certified emission reductions (CERs) to any Annex I country at a mutually determined price. The generated fund flow can provide additional resources for several rural electrification projects to become viable. Though this financing scheme is not very common as of now, in the future it is expected to gain momentum.

g) Venture capital:

As discussed, rural electrification projects in South Asia are high-risk projects. Therefore, these projects might be suitable for venture capital funding. Venture capital funding is also possible in micro-credit institutions, which can be diverted for financing electricity devices.

h) Manufacturer's Loans:

Sometimes, manufacturers of rural electrification systems extend short and medium term credit to the project developers. These manufacturer loans reduce the initial capital cost requirement for rural electrification projects. Credit extended by manufacturers can be paid back from the annual revenue of rural electrification projects.

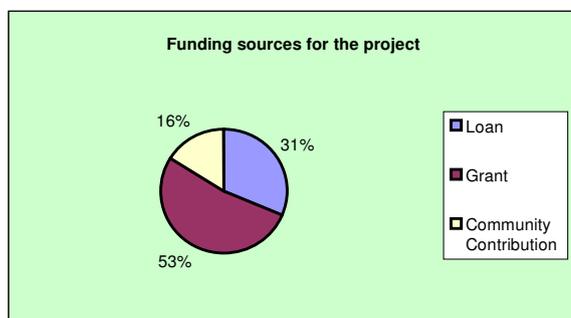
i) Mixed financing involving local community:

Increasingly the common pattern for financing rural energy schemes involves a range of types of funding such as grants, subsidies, loans, and contributions in kind. The following example of Nepal gives a good idea of this trend.

¹⁰ All South Asian countries are under non-Annex I category according to UNFCCC listing.

The 25kw micro-hydro plant located in the village of Muktinath (mustang district) was funded by USAID and intermediate technology, a loan from the agricultural bank of Nepal and a contribution from the village as depicted in Fig1.

Fig 1 : Cost break –up for Muktinath Micro- hydro Project



The loan (which includes an interest rate of 14% was to be paid in 8 installments over eight years, but was in fact cleared before the deadline. The beneficiaries, who are the owners, contributed towards labor and transportation of the materials. Around 98 households in the Purang district benefited from the scheme. This includes 12 lodges for tourists (trekkers), who represent a good source of income from the community.

The scheme was managed by 11 members of the community who form the electricity management committee that decides, among other things, the tariff rate at which power will be made available to users. The users pay a fixed tariff based on the capacity of their supply. Their supply is limited, using simple and cheap current limiting devices, and the scheme therefore avoids the use of electricity meters that are very expensive.

4.3. Financial performance and decision making:

Financial performance is one of the fundamental factors to be considered when selecting energy options for rural villages. Although there may be non-financial benefits with particular technologies, such as environmental gains, improved environmental health aspects, or greater social benefits, it is often the financial performance of the technology that is the deciding factor. There must be consideration of the upfront capital costs, the daily running and fuel costs, annual maintenance costs, and any income generated from the sale the energy. To compare the overall costs and benefits of the various options for supplying energy needs, it is essential to make a detailed analysis of each option.

This is necessary for two reasons:

- To compare the various options in financial terms, and
- To ensure that the energy project is financially viable

The cost calculation may become more important when choice has to be made between competing technologies. In such cases, the rule of thumb is to calculate net present value (NPV) for all the technological option and select the one, which has maximum net present value. However, an NPV calculation presupposes the certainty in retail tariff and cash realisation. This may be an unrealistic

assumption for several rural electrification projects in South Asian region due to unstable policy regime and low and fluctuating level of bills collection. Under such circumstances, an alternative methodology could be to calculate the annualised cost of power generation by different technologies (taking both capital cost and revenue costs into account) and then to select the one where the cost is lowest. In passing, it may be noted that when the comparison is between a conventional energy based rural electrification project and a non-conventional source based rural electrification project, different discounting rates may be used under specific circumstances. The discounting rate typically depends on the cost of raising capital from the market for a particular project. In several South Asian countries, it is possible to raise capital for renewable based rural electrification projects below the commercial rates. The lower discounting rates, when factored in NPV calculations, can make several renewable based rural electrification projects viable vis-à-vis conventional power based projects.

4.4. Estimating cost of rural electrification projects in South Asia:

Cost of various rural electrification projects depends on several geographical, demographic and technological factors. Any precise estimation of cost is project specific and can be determined only after detailed study. However, following discussion about the cost structure of various rural electrification projects in South Asia can provide a tentative idea of the range of cost applicable on various types of rural electrification projects in the region.

4.4.1. Cost of some Micro-Hydro projects in Nepal:

Similar to other rural electrification projects, micro hydro project cost is also site-specific and varies according to gradient and other physical features of the site, cost of civil work and type of generating equipment. However, the table below will give range of the project costs per kW and the cost break-up.

Table 9
Cost break-up for Micro-hydro Projects In Nepal

Name of the Project	Civil Construction cost in \$ (%)	General Equipment Cost in \$ (%)	Electric Lines, \$, (%)	Total Micro Hydro cost per KW in \$
Gaura Rice Mill, Baglung	379 (29.6%)	578 (45.2%)	322 (25.2%)	1279
Radhalaxmi, Ilam	435 (24.2%)	574 (31.9%)	788 (43.9%)	1797
Bhujung MHP	1170 (56.6%)	380 (18.4%)	517 (25%)	2067

Source: Paper “ Cost and Revenue Structures for for Micro-hydro Projects in Nepal under contract with Alternate Energy Promotion Centre by Dr. Vaidya”

The above cost break-up suggests that there is no uniformity in the structure of cost. The variation between different heads is huge. For example, in Bhujung MHP, the civil construction cost per kw of power capacity is 1170 \$, as against 379\$ in Gaura Rice Mill project and 435\$ in Radhalaxmi project. However, the equipment cost for Radhalaxmi project is far lower than other two projects. The total per unit cost of power installed also varies in a very broad range that makes any generalisation very difficult.

4.4.2. Cost economics of some Biomass based rural electrification projects in India:

Desi Power India Limited has implemented several biomass based rural electrification projects in India. On the basis of experience gained in different projects, typical cost economics of biomass projects has been provided.

No of houses in the village = 200 nos.

Power required for each house = 250 watts

Hours of operation = 6 hr/ day and 365 days in a year

Table 10
Economics of Biomass Gasification System based Rural Electrification Projects

Assumptions (Based on Experience)			
Description	Unit	Amount	Conversion in US \$, where ever applicable
Plant Capacity	kw	50	
Average number of hours of operation per day	Hr/day	6	
Average number of days of operation per year	Days	365	
Number of hours of operation per year	Hr/Yr	2190	
Average plant load factor	%	25.35	
Number of houses to be electrified in a village	No.	200	
Power required for each house	W/house	250	
Number of units generated yearly	Kwh/yr	109500	
Biomass cost per kg (Approx.)	Rs./kg	1.00	0.022
Consumption of biomass in PG Mode of operation	Kg/kwh	1.30	
Manpower requirement per shift	Nos	2.00	
Shift per day	Nos	1.00	
Monthly salary per person	Rs/month	2000	43.48
Maintenance cost Rs. Per hours	Rs/hour	30.00	0.65
Economics			
Capital Cost			
Total Cost of Power Plant without subsidy: Biomass Gasifier Including Cleaning & Cooling system, Structures, Basic Price of Gas Engine including Adaptation charge for Producer gas mode, AMC for the engine (Mandatory), Cooling tower for gasifier system and gas engine with accessories, Water treatment plant, Erection & Commissioning, Biomass cutter, Civil works (building, pump etc) and contingency.	Rs	3512500	76358.7
Cost for conduction detail survey and preparation of feasibility report, Training of locals and O&M Manual	Rs.	100000	2173.91
Total Cost	Rs.	3612500	78532.6
Fuel cost			
Biomass consumption	Kg/yr	142350	
Total biomass cost	Rs/month	142350	3094.57
Total fuel cost	Rs/month	142350	3094.57
Cost of manpower			
Annual cost per person	Rs/month	2000	43.48

Total cost of manpower per year	Rs/year	48000	1043.48
Cost of maintenance			
Maintenance cost	Rs/Hr	30	0.65
Yearly cost of maintenance	Rs/yr	65700	1428.26
Total yearly maintenance cost	Rs/month	65700	1428.26
Total yearly cost of operation	Rs/month	256050	5566.3
Total unit generation	Kwh/year	109500	
Total unit generation	Kwh/year		
Unit cost	Rs/kwh	2.34	0.05

Source: DESI Power

Note: The cost of power pertains at the generation plant and does not include the transmission and distribution cost.

4.5. How to make rural electrification projects viable:

Given the low-income level of rural communities in south Asian countries, the best strategy to make rural electrification project financially viable is to keep the up-front capital cost¹¹ as low as possible. This will minimise the interest and repayment burden for such projects and help reducing the per unit cost of electricity supplied. Mentioned below are some of the possible methods of reducing the cost of rural electrification projects:

4.5.1. Load limited electricity supply:

The marginal cost of conventional metering-and-tariff connection is far too high for many low-income households. In order to overcome this constraint, a favorable option is that of 'load limited supply'. Such supplies attract capacity tariff, with the consumer being charged a fixed monthly fee (according to the load limit) irrespective of the total amount of energy consumed. The household does not have a costly meter but is equipped with a load limit device.

Load limiters work by limiting, to an agreed amount, the current supplied to the consumer. If the current exceeds this value then the device automatically disconnects the supply. Some types of load limiter must be reset manually, while the others automatically reset when overload is removed. Such supply options are often best marketed as economy or un-metered, in order to overcome the negative connotations of limited supplies.

The main advantages of load limited supplies are:

- Low revenue collection costs.
- Reduced cost of transmission, distribution and generation.
- Low initial capital costs.
- Easier budgeting of payments by consumer.

The main disadvantage of load limiters are:

- Increased opportunity for fraud and theft
- Poor reliability restricted electricity usage
- Poor accuracy
- Uneconomical use of electricity.

¹¹ The capital cost includes up-front cost of plant/system and up-front cost of electricity connection to households.

4.5.2. Prefabricated wiring systems:

House-wiring is a major expense that can deter household from subscribing to a connection. The labour costs for conventional wiring are especially high for houses of traditional construction where installation is difficult. A solution to this problem is the use of low-cost versatile house-wiring systems. These come in two forms; wiring harnesses and 'ready boards'. Conventional wiring systems as used in the west are too expensive and inflexible for low-income households in some countries.

4.5.3. Prepayment meters

Prepayment meters require the consumer to purchase units of electricity from the supply authority in advance. With most existing systems, the consumer purchases a magnetic cards which has a magnetic card which has a number of units recorded on it. The consumer inserts this into their meter, which then record the new units as credits. The meter then automatically cancels the code on the card so that it cannot be reused. The meter displays the total no. of credits available and, depending upon the make may also indicate the rate of consumption and/or provide warnings when the credits are almost exhausted. The advantage for supplier of electricity under this mechanism is manifold. First, there is 100% collection of user charges. Second, the heavy transaction cost of bill collection can be avoided. Third, the revenue stream precedes cash outflow and therefore, the supplier can always maintain cash reserves with him, which is absolutely free of cost for him. The reserve can be used to meet working capital need of the supplier. A portion of this reserve can also be invested elsewhere to earn some returns on that. The benefits accrued under this mechanism is certainly expected to be passed on to the consumers in terms of lower tariff of electricity supplied.

4.5.4. Community involvement to reduce cost:

Community participation in activities like planning, installation of system, maintenance and tariff collection can help in minimising the cost of energy supply. The community can decide what it wants and how much it is willing to contribute. The community can lobby for a supply and encourage electrification by committing themselves to taking a given number of connections. They can facilitate planning by advising on the routing of the distribution lines and by assisting with any right-of-way disputes. They can elect a committee to aid communication between the utility and the community. The in-kind contribution from local community and particularly in terms of labour supplied for commissioning and erection work can result into huge cost saving. The project developer can share the ownership of the plant/system with the local community by distributing shares to them on quid pro quo basis.

However, the suitability of this option will depend on local social and economic factors. Such ownership will be suitable where there is a history of community planned and owned development activities or where local NGOs are able to facilitate participative planning of the supply. In fact, participation is important for the success of all privately owned schemes. The approach was successfully practiced in Andhi Khola project in Nepal and now is being replicated at several other places in South Asia.

4.6. Innovative ways of financing rural electrification in South Asia:

Despite the financial constraints for rural electrification projects in South Asian countries and low-level of return available, there could be several innovative approaches, that could be practiced in order to make rural electrification projects financially viable and sustainable. Some of such approaches are discussed below:

4.6.1. Enabling non-recourse financing:

In south Asian countries, non-recourse financing for rural electrification projects is very difficult due to the high risk involved with such projects. Commercial banks show a tendency to lend on the basis of balance sheet of the promoters, which has its own limitations. One of the possible methods to enable non-recourse financing for rural electrification project could be if governments and multilateral donor agencies could participate in as many projects as possible by providing them a certain percentage of loans. Government and donor agencies can assume lower priority in loan repayment to give higher comfort to commercial banks and private lenders. This approach has tremendous merit, as it will increase the coverage of rural electrification with given amount of government/donor agency resources. The government/donors money, instead of being used for providing 100% finances to few projects, can be utilised to make many more projects viable by providing the little extra, what these projects might need.

4.6.2. Special long-term bonds to be issued to finance rural electrification projects:

For majority of the rural electrification related projects, generating quick commercial returns may be very difficult. However, in the longer term reasonable amount of return on the investment can surely be expected. DESI Power in its own field experiences found that return on investment on rural electrification projects, in the longer run, can be very close to returns available on other projects. This is because of the virtuous cycle, which starts in the village with energy intervention. It can be noted that provision of electricity help augment the earning capacity of the households, which in turn increases the tariff collection for electricity provided. Therefore, many projects though loss making initially may turn out to be profitable in the future. Therefore, a good method for financing rural electrification projects could be if money could be mobilised for such projects through long term issuance of bonds. In order to encourage the off-take of such bonds, income tax benefits may be extended to individual purchasers.

4.6.3. Linkages with marketing societies:

In some south Asian countries, several rural marketing societies are operating, which buy rural produces like agricultural produces, handicrafts, dairy products and forestry related products from rural areas and then to resale it to urban localities or industrial establishments. Some of them are government owned and some are private agencies or co-operative societies. For example, in India, agricultural produces are generally bought by NAFED (government owned) and e-chaupal of ITC (private); forestry related products by TRIFED; milk by several milk co-operatives and handicrafts by some of the lesser known marketing societies. As mentioned, the access to electricity can increase the productivity of rural households and will enable them to generate additional income. This additional income can be traced as the increased purchases and payment by marketing co-operatives. A part of the additional payment made by co-operatives to the individual households can be used directly to adjust the electricity bills of those households. The payment by the marketing co-operative to any villager should be made after deducting an agreed amount in lieu of the electricity purchases of that villager. This can be done with the help of an agreement between rural energy service provider and the marketing society operating in that village. The terms of the agreement can also be communicated to households. Marketing societies can charge a moderate service fee from the electricity provider for the services rendered by them. The envisaged mechanism will reduce the business risk associated with rural electrification projects and will help them in accessing cheaper capital for financial closure.

After getting the revenue stream assured, as indicated above, the next task would be to use this revenue stream for securing loans. Loan security backed by revenue stream (when it has been ascertained) will enlarge the scope of loan disbursements and will lead to greater off-take of rural electricity projects. The process of making the aforesaid security proceed can be summed up with following steps:

- a) A special purpose vehicle (SPV) has to be created as an intermediary mechanism between rural electricity project developers and lenders/investors. The SPV will raise money from investors/lenders by issuing pass through certificates (PTCs) and make the subscription proceeds.
- b) SPV will lend money to rural electricity project developers against the guarantee of revenues inflow to the later. SPV will also take the services of credit enhancement by an insurer after paying premium to provide full payment security to the investors.
- c) A special account can be created to keep track of the account receivables of the electricity provider. Marketing societies (as discussed in the previous section) may put the money directly into the specified account instead of paying to rural electricity providers. SPV from time to time as per the requirement can use the specified account to make the PTC payments (loan repayment with interest).

4.6.4. Enabling marketing societies to supply electricity:

An alternative mechanism to point 4.6.3, could be if these marketing societies are franchised by the utility to the societies for billing and related functions. Franchisees may be provided the requisite training and additional need based support and some incentive based on the business transacted by the partner utilities. These entities may be most appropriate in the majority of villages and small towns which are beyond the reach of the main grid and where the loads are poorly developed. It provides an opportunity to the societies to expand their business into a growing area beyond their traditional sphere of activity.

This approach can have some advantages. The local organization has the advantage of reduced overheads to establish and operate the enterprise. Better Community involvement would be ensured due to the experience of the marketing society in the village and relationship with the people. The marketing agency can itself offset the electricity bill of an individual from the payments it makes to him in lieu of the goods/commodities purchased from the individuals as a result the financial risk involved particularly with respect to bills collection is reduced. Problems relating to revenue leakage and customer-utilities interactions are expected to be managed with due diligence. The agency may distribute handouts, documentary films and videos in the local languages to create interest in the products /services related to electricity supply.

Chapter 5: Private Participation in Rural Electrification

It can be easily noticed that across the south Asia, private participation is very low in rural electrification projects. Government owned parastatal utilities lack required motivation and resources to extend the electricity network to rural areas. Further, in view of several problems associated with rural electrification projects, the success of rural electrification projects (both grid and off-grid) requires innovative financing, institutional and delivery approaches that is tailor-made according to local needs specifications. Parastatal utilities whether self regulated or regulated by an independent agency works on a very rigid, pre-defined path and there is very little scope of flexibility and innovation. Therefore, either rural electrification projects are neglected or even if they are undertaken in some instances they have very high probability of becoming unsustainable in the long run.

Private players can contribute to rural electrification efforts with their technology, finances, entrepreneurial spirit and managerial efficiency. It has been found that wherever private players are involved with rural electrification projects, results are much better. Here again the example of Noida Power Limited can be quoted. As discussed in the second part of this report, the company could very successfully and effectively undertook rural electrification work.

Though private participation in rural electricity delivery is highly desirable, the actual level of private participation in south Asia is not very encouraging. Several reasons have been identified for the lackluster participation of private players in rural electrification projects. These reasons can be summarised as follows:

5.1. Factors affecting private participation in rural electrification:

- ⇒ High business and financial risk
- ⇒ Regulatory hurdles
- ⇒ Implementation and operational difficulties
 - Lack of other infrastructural facilities
 - Unwillingness of employees to work in rural areas
- ⇒ Incompatibility with existing support scheme

These factors could be elaborated further:

5.1. 1. High business and financial risk:

As mentioned earlier, the high capital cost of rural electrification projects coupled with very low paying ability of rural customers and low level of bill collection puts undue risk on the investors. Private investor, with having main motive of maximisation of returns on capital employed, naturally shy away from such projects.

5.1. 2. Regulatory hurdles:

In some of the south Asian countries, the generation and distribution of electricity including to rural communities is done by government agencies. In countries like Srilanka, special license has to be obtained for this purpose. In India, the electricity act 2003, has greatly simplified and enabled the participation of private parties in power sector including rural electrification. According to the act, rural electrification can be carried out by any entity such as village Grampanchayat, local NGO, co-operative, private entrepreneur, or any other community based organisation. The need for license has been completely done away with. It is expected that this will definitely help enable greater commissioning of rural electrification projects. In countries

like Nepal, some of the rural electrification projects have though undertaken by community based organisations, involvement of private investors is still very low.

5.1. 3. Implementation and operational difficulties:

Generally speaking, all across south Asia, villages are very geographically dispersed with poor connectivity and sometimes located in difficult terrain. Availability of other infrastructure like roads, rails, water etc. is also very poor. This makes it very difficult to implement any kind of project including rural electrification projects. Another problem is the unwillingness of staff members to travel and stay in rural areas due to security and various other factors.

5.1. 4. Incompatibility with several support schemes:

In India, government runs several support schemes to promote rural electrification projects. Together, these schemes constitute significant amount of resources, which is available to be used for rural electrification projects. Pradhan Mantri Gramodaya Yojana (PMGY), Minimum Need Programme (MNP), Kutir Jyoti Programme (KJP), Accelerated Rural Electrification Programme (AREP) and Rural Electrification Corporation (REC) loan assistance schemes are some of the major government programmes to fund rural electrification projects. Besides, support can also be mustered from Rural Infrastructure Development Fund (RIDF); Member of Parliament Local Area Development Scheme (MPLADS) and Integrated Rural Energy Programme (IREP). However, under these schemes, grants and soft loans are given only to state governments or any government entities like state electricity boards/electricity departments' etc. Private project developers are not supported under this framework. Similarly in Srilanka, government runs some schemes to support Ceylone Electricity board to extend the grid network to rural areas. But private players are not eligible to avail these finances.

Apparently, there is a need to find solutions to encourage private participation in rural electrification projects to supplement government efforts. This report discussed two of such methods to encourage private participation in such projects – Public – Private partnership approach and by developing suitable policy and market instruments.

5.2. Public-Private Partnership for rural electrification:

Public-private partnership combines social responsibility and public accountability of public sector with finance, technology, managerial ability and entrepreneurial spirit of the private sector to derive optimum results. This approach can be seen as a viable alternative to full privatization. Public – Private Partnership (PPP) is a term used to describe a spectrum of possible relationships between public and private actors for the co-operative provision of infrastructure services. The right relationship is the one that best meets the needs of the partners in the local context.

For rural electrification, public private partnership (PPP) approach can help encourage private participation by reducing the risk for private participants. PPP approach mitigates the risk for private players in following ways:

- Acquisition of land, construction, installation of systems and all the legal issues related to it is easier to deal with due to the involvement of the government.
- Government grants/soft loans can be mobilised for such projects and it may give additional comfort to private participants.
- Government can assume lower priority in the recovery of investment to reduce financial and economic risk for the investors.

In many south Asian countries, electricity sector is in the midst of transformation from government owned and run model to market mechanism. Conditions are still not ripe for full privatization in these countries. Private sector is also not very forthcoming in assuming the entire responsibility of rural electrification due to the various risks involved. Under such circumstances, PPP can certainly be a viable, suitable interim solution in these countries.

5.3. Policy and Market instruments to promote private participation in rural electrification:

Governments all across south Asia have been trying to evolve mechanisms to encourage private participation in rural electricity business. Several policy level incentives and market instruments have been identified that can have desirable impact on private participation. These may take the form of tax incentives, or import duty waivers/concessions or competitive tenders for private generation for grid-connected generation schemes or for decentralized power supply.

- **Tax incentives and import duty concessions**
These can take the form of a waiver of import duties for imported equipment destined for rural energy supply purposes. Differential rates for renewable energy equipment to reduce the cost relative to the equipment for fossil fuel burning equipment may also be used to encourage reduction of dependence on these fuels.
- **Depreciation:**
Where developers are allowed to accelerate the depreciation of RE equipment, this offsets the high up-front costs of RE developments. High depreciation rates therefore provide an investment incentive. This policy instrument is used, for example in India. This instrument could also be applied to bodies carrying out; say, rural electrification or biogas supply programmes.
- **Tax Holiday:**
In the same way, tax holidays on income generated by RE schemes are used worldwide as an investment incentive, to offset the capital-incentive nature of RE. Such instruments can also be used where rural entrepreneurs install rural energy supply schemes.
- **Target subsidies:**
Subsidies for rural energy should focus on two categories: (1) households for whom modern energy is a high priority, and (2) the poorest existing customers, whose consumption is very small because of high prices and lower incomes. These may be households below the poverty line. To be cost-effective, efficient, and useful for rural and poor people, energy subsidies should have two main goals: (1) to assist the rural poor in gaining access to higher quality energy services, and (2) to provide incentives to business to serve rural and poor consumers.

*In general, subsidies should be applied to access or connection costs, not to operating costs or on-going consumption. In general, demand-side subsidies involving partial funding of connections work better than fuel or supply-side subsidies because they have better targeting properties and provide stronger incentives for expanding coverage and sustaining services. The downside of demand-side subsidies is that they require an administrative and institutional superstructure to identify and verify target beneficiaries independent of the service provider. On the other hand, supply-side subsidies, such as low rates for all rural areas or standardized unmetered charges, have poor targeting characteristics and provide weak incentives for efficient service delivery.

* Based on “ Subsidizing Rural Electrification- An Introductory Guide, April 2004 under the aegis of the South Asia Regional Initiative/ Energy (SARI/Energy)

Chapter: 6. Characteristics of Successful Rural Electrification programs

Successful broad-based RE programs around South Asia have been found to share a number of common features. In order to implement viable programs, these features should either be present in the already existing electrification programs in the region; otherwise, interventions are required to put them in place. Some of these interventions require a considerable level of effort and may only be cost-effective to implement if broad, country- or state-wide rural electrification programs are being considered. Points below summarize conditions/attributes that lead to the development of viable R E programs.

- **Long-term government financial and institutional commitment** to supporting an effective rural electrification program.
- **Creation of utilities** that focus on meeting unique needs of electricity distribution in rural areas, subject to particular conditions and constraints encountered.
- **Adequate priority to the use of electricity for productive purposes and income generation activities without ignoring the enabling conditions and priorities for rural development.**
- **Load and load mix to ensure efficient use of distribution infrastructure and adequate revenue generation.** demand side management to spread the load over time are desirable.
- **Metering and billing the Consumers for the Consumption level** using electro-mechanical, electronic energy meters, pre-paid meters
- **Program planning based on transparent economic criteria**, eschewing political interference. Cost-effectiveness but not at the cost of social equity and need to provide universal access of electricity to the people.
- **Developing and adopting cost-effective technical designs and standards.**
- **Careful expansion planning, efficient billing, a cross-subsidizing rate structure, responsiveness to customers and good marketing of the RE program by utilities.**
- **Assured reliability of power supply** to ensure revenue stream.
- **Design and implement tariff structure required for project viability**, with enforcement and carefully designed subsidies where necessary. Incentive-based tariffs for rural energy supply may also be appropriate.
- **Facilitating consumer connection to electric service** by lowering system costs through design innovations and giving rural consumers access to credit.
- **Active consumer participation in their own electrification by fostering an alternative culture and structure** to meet a demand meeting high consumer aspirations in terms of electricity, and a high level of willingness to pay for reliable service.
- **Innovative financing mechanism using tools such as micro-finance**

Chapter 7: Recommendations

7.1 Technical

- Local resources should form the ground for any rural electrification program (e.g. hydro in Nepal and Bhutan)
- Cost cutting comes handy in spreading RE programs(examples include using cheaper utility poles, reducing costs, such as staffing levels involving local people in construction and maintenance.)
- The use of decentralized and renewable energy systems which provide a sustainable and environmentally benign electricity supply and sustainable option will gradually pick up. Often such technologies have been found too costly, prone to failure and difficult for local people to install and operate as against the claims of proponents that these are technically mature and simple, robust and easy to run. Training and information transfer to overcome these major barriers are the most important tasks to support these technologies besides setting up requisite repair and maintenance services facilities.
- Energy services should be offered and provided first to income generation activities. It would be best to integrate it with other programs supporting rural agriculture and other production activities. The initial attraction for private developers may be in relation to specific productive end uses - e.g. grain milling in Nepal where the power unit is also used for battery charging or for domestic electricity supplies.
- Least cost option appears to be appropriate strategy after taking a balanced view of the initial cost and variable costs for operating while planning the rural energy system.

7.2 Financial

- Financial logic indicates that electrification should focus first on those areas with high economic growth potential and lowest cost. However, other goals such as social equity, agricultural development and reversal of rural-urban migration may force utilities /Governments to compromise their financial objectives.
- Subsidies on the conventional energy sources, electricity for agricultural purposes are a central but unresolved issue in South Asia. This adversely affects the growth of renewable energy and other viable options. However, some preferential taxation might still be needed, such as the small subsidies and tax breaks for supporting commercial applications of feasible conventional or renewable options.
- Subsidies are a major component of rural electricity tariffs. The subsidies should be “smart”, that is they should not be open-ended, they should be transparent and they should be available to the users (not suppliers) for the initial capital cost, not running costs.
- Development and implementation of processes to ensure sustainable electricity supply for rural consumers, particularly single households is a crucial element in the RE program design. Development of more transparent and efficient processes for setting rural electricity supply subsidy levels is called for. Experts from the SAARC region may periodically meet to review developments and make recommendations on improving the design of subsidies for rural energy programs.in this regard, a study under the aegis of the South Asia Regional Initiative/ Energy

(SARI/Energy) reviewed subsidies and financial mechanisms aimed at expanding the access of rural households to energy services in several of countries – India, Nepal, Bangladesh, and Sri Lanka and developed a preliminary guide to some and certainly not all, of the recent and current rural energy programs in the region and the subsidies that they use.

- Financing is a major constraint for most of the countries in South Asia. Innovative measures are required to ensure public private partnerships. Private finance is more commonly a loan component complementing a mix of government grant/subsidy and local equity capital. Where such private sources of credit are not available there can be a role for the development finance institutions to provide bank guarantees or credit packages specifically for community micro-hydro.
- There is currently little interest towards RE projects from conventional banks, but they may be encouraged to lend at least a proportion of the capital if the schemes are “accredited, or supervised” by an intermediary agency - as they are in Sri Lanka.
- Several models exist in South Asia that has succeeded in similar context. These models can be emulated in various aspects. The capital cost of decentralized rural electrification is best met in the medium term from a mixture of local equity capital (community or private), and a loan component from a bank or other conventional credit organization, at commercial rates backed if necessary by loan guarantee funds.
- If credit is needed for individual household connections the most effective way to supply it is to build it in to a higher tariff or by supplier credit or micro finance scheme (e.g. for solar home systems). Poorer consumers will prefer flexible tariff arrangements, with low standing charges.
- Establishment/strengthening of institutions at both local and national level focusing dedicated to serving financial needs of rural electrification stakeholders is crucial at this juncture. Suitable owners may be community based organizations, electrification co-operatives supported by local NGOs, or branches of national NGOs. In Sri Lanka the Electricity Consumers Society own operates and manages rural electrification systems. Guidelines for developing a range of options and arriving at a consensus on the scope of electrification and on tariffs, have been developed and used successfully in Sri Lanka, Nepal.
- Adequate financing. (Greater involvement of private sector, multilateral funding and CDM funding should be enabled). Micro Financing is desirable to expand the market of decentralized electricity systems.
- The business objectives of electrical utility companies generally do not encourage them to invest in electrification schemes with low levels of demand. In any case they are rarely well placed to work effectively with electrification communities in a supportive manner. It is suggested that there is a need for institutional support at the national and local level, but most particularly at an intermediary level. Government may consider creating special purpose Vehicle for financing rural electrification efforts.
- For off-grid decentralized systems based electrification schemes like buy-back or banking can be very useful. The National Level where the formulation of policy and plans for rural development provides the legal and regulatory framework within which the sector will develop.

7.3 Institutional

- The trend towards decentralization of government responsibility for electricity supply will affect the legal and regulatory frameworks applied to rural electricity providers. This appears to be the result of the inability of parastatal utilities to provide adequate service. The reason for this lack of interest needs to be better understood. Development of processes to ensure adequate rural electricity supply under rural electricity distribution privatization is under infancy stage of development. Potential activities by the SARI/Energy program to help address these issues include help build appreciation and consensus on the need to provide for rural electricity supply within new and revised Electricity Acts and by newly formed regulatory commissions.
- Under aegis of SAARC, there is a need to compare and communicate to regional policy makers and stakeholders the legal modalities for governance of rural electricity suppliers and help identify the advantages and disadvantages of various models. Besides the forum may explore and communicate to policy makers and stakeholders the approaches, resource requirements and advantages of decentralizing rural electricity supply regulation.
- Electrical supply systems should ideally be owned by those with the most important stake in their success. Such schemes may also be suitable for private development and operation particularly where there is potential for integration with the grid. Community ownership may be most appropriate in the majority of villages and small towns which are beyond the reach of the main grid and where the loads are poorly developed. The management of these schemes may be contracted out or handled by the community (as in Sri Lanka). Ownership may also be franchised by the utility or the State to a commercial operator.
- Experience with electrification co-operatives is somewhat mixed and depends on the local culture and the extent to which all members of a community have been involved in decision making (e.g. women's groups, farmers clubs, chamber of commerce, etc). Practical planning guidelines for community electrification schemes have been developed in Sri Lanka and there has been useful experience in many countries that could usefully be shared.
- There has been more success where intermediary organizations such as NGOs have helped the local planning process. In small private schemes the equipment supplier may provide all the technical advice and support (Nepal), or the engineering and supervision may be the subject of a separate contract.
- Concerted efforts to promote wider consideration of options such as cooperative societies and rural franchising as solutions to rural energy supply may be supported by policy makers and multilateral development banks.
- Awareness creation and motivational programs should precede any rural electrification project (proper social marketing). NGO interface can be helpful in local capacity building. It is most important to provide a framework which will allow rural users to articulate their own demand patterns and to decide how these can best be met from a range of energy supply options.
- Public-Private Partnership involving local community can be one of the most effective ways of electrifying villages and the approach should be tried at a wider scale in South Asia. Successful decentralized rural electrification requires a co-coordinated institutional approach with an enabling policy environment created by government, suitable local organizations supported by a regional or national intermediary body.

- External technical assistance is also likely to be needed for the design and management of electrification schemes and the presentation of proposals for funding to appropriate sources of finance. The role of the intermediary level institutions such as NGOs includes a) provision of appropriate guidance and support for policy formulation, b) advice on development of a national rural energy strategy, including definition of grid coverage, c) development of networks within the sector to guide communities on sources of advice, expertise and equipment d) Support and advice to manufacturers, d) facilitating financing, e) information brokering – e.g. preparation of “Yellow Pages” in Sri Lanka, f) providing simple guidelines for working out energy service needs, and presenting the technical options available with their costs, benefits, advantages and disadvantages, f) Facilitating community planning, g) identification of training requirements, running training courses for manufacturers, developers, operators, local government, communities, h) developing proposals for technical standards and setting standard suppliers’ contracts to include technical support and warranties, i) setting the framework for tariff options, j) promotion of rural electrification and electricity use, k) coordinating Research and Development. Need based support from NGOs may be utilized by the promoters & financial institutions.
- Technological and manufacturing capability varies greatly among various south Asian countries. Free trade (zero or low tariff and NTBs) among SA countries will enable harnessing regional expertise to its fullest.
- Integrated approach to the provision of rural services and “bundle” it with other rural infrastructure services – water, health, women empowerment etc. is more useful. Social benefits may be more significant than economic benefits for poorer people. Community participation in planning for electrification is likely to lead to more successful and sustainable schemes. Careful preparation is needed and locally appropriate guidelines prepared, and an external facilitator is recommended.
- Legal restrictions on the independent generation and sale of electricity may need to be lifted. Flexibility in tariff setting may need to be sanctioned. Targets for the coverage of electrification by grid extension and decentralized schemes are also needed at this level to stimulate and focus activity. Rural communities need to know when, if at all, they can expect to have access to grid extension.
- The South Asia Regional Initiative/Energy (SARI/Energy), which has been playing a catalytic role in regional energy cooperation, has been involved in developing policies aimed at enhancing the availability of energy to meet regional development needs. These efforts need to be continued, expanded and sustained with active support of the stakeholders. SARI may take initiatives to :
 - a) Identify options, clarify legal requirements, and assess the ability of rural electricity suppliers to undertake other related businesses and services.
 - b) Promote wider consideration of options such as cooperative societies and rural franchising as solutions to rural energy supply by policy makers and multilateral development banks.
 - c) Provide for information exchange and sharing of procedures for certifying private sector service technicians for household (such as SPV) and decentralized energy systems in South Asia.
 - d) Promote, through information and peer exchanges, the concept of rural electricity suppliers forming apex organizations.

- e) Support regional networking of individual country rural energy supply programs through information exchange.
- f) Promote, through information exchange, the development and wider implementation of rural electricity financing mechanisms, such as commercial micro-finance and rural development banks.
- g) Develop and make widely available a South Asia rural energy database.

**Part II: Case Studies of some rural electrification
models in South Asia**

In this part of the report, some of the most successful models of rural electrification in South Asia have been discussed. These models have been picked up from all three basic technological delivery mechanisms - centralized grid based systems, off-grid centralized systems and off-grid decentralized systems. Case studies presented highlight a mix of technology oriented (PV, Biomass, Grid, etc.) and institution models (franchisee, entrepreneurial, etc.) prevalent in the South Asia.

1. Centralised Grid based systems:

1.1. Rural Electrification Board (Palli Vidyut Samitis) model, Bangladesh

1.1.1. Background:

Before 1970, there was no well-planned and organised rural electrification program in Bangladesh. The Bangladesh Power Development Board (BPDB) was the only agency to take up electrification work and it was mainly limited to urban centers and their peripheries. Electrification needs of villages was largely ignored. Sensing the need for intensive rural electrification, the Government of Bangladesh engaged two consulting firms of USA to carry out a comprehensive feasibility study on rural electrification in Bangladesh. The firms after in depth study recommended creation of Rural Electrification Board (REB). The Government of Bangladesh (GOB) set up REB in 1977 as a statutory Government organization primarily responsible for implementing countrywide rural electrification.

1.1.2. Objectives of the Program:

- Improve the quality of life for rural people in Bangladesh by way of community led participatory approaches of energy management
- Provide reliable and sustainable electricity to the rural people at affordable price.
- Improve economic condition of the rural people by using electricity in agriculture, cottage and agro based industry.
- Bring about entire rural Bangladesh under RE program on an area coverage basis.

1.1.3. Functioning:

The board adopted co-operative model to achieve the aforesaid objectives and established Palli Bidyut Samities (PBS) ¹²based on the model of Rural Electric Co-operatives in USA under the universal principle of co-operative, democratic decentralization and ownership of consumers. A PBS, which owns, operates and manages a rural distribution system within its area of jurisdiction is an autonomous organization registered with REB. The member consumers participate in policy making of PBS through elected representative to the PBS governing body known as Board of Directors. REB works like an umbrella organisation for all PBSs and help them with the following:

- Initial organizational activities.
- Training of manpower.
- Operational and management activities.
- Procurement of funds.
- Providing liaison between Bangladesh Power Development Board, Dhaka Electric Supply Authority (Bulk power supplies), concerned Government and Non-Government agencies.
- Conducting election of PBS.

Under the area coverage principal, REB has formulated a long-range plan, which envisage to bring the entire country under the power distribution network in five phases. The physical infrastructure to be created under the plan involves construction of approximately 1,50,000 KM of distribution lines and required number of 33/11 KB Sub-Station. The area coverage concept generally comprises 5-10

¹² Palli Vidyut Samiti means Rural Electric Society.

thanas¹³ having a geographical area ranging between 1500-2000 sq. km. For each PBS load forecast is made for the next 20 years based on detailed study and accordingly load centers are set up in order to identify the location of the distribution Sub-Stations. The cost of the distribution system is given on a thirty-three year's term loan to the PBSs with first eight years as grace period with an interest rate of 3% per year. To maximize consumer welfare, the PBSs operate on the financial principle of "No-loss & No-profit" basis.

1.1.4. REB/PBS Model: The Success Story

Rural electrification in Bangladesh is rightly viewed as one of the most successful rural electrification programs. Relatively low System loss in the range of 15% and high rate of bill collection nearly 100% is the achievement widely appreciated by the Development partners and International agencies. This has been possible due to the unstinted and unflinching support that the Government of Bangladesh has placed in the operation and philosophy of Rural Electrification.

The greatest result of Rural Electrification program has been achieved in the agricultural sector. Due to the provision of electricity by PBSs, popularity of electric irrigation pumps among farmers of Bangladesh has grown up in past years. With less than 2000 electric pumps in 1981-82 Fiscal Year, the number of pumps come under electrification has increased tremendously exceeding 82,000 in FY 1999-2000. The role of Rural Electrification Board and GOB in popularizing electric pumps in agricultural sector was very important. Although tariff of all other categories of consumers has gone up over a period of time, tariff for irrigation consumption remains almost same for last five years. It enables the farmers to keep cost of production low and price of products competitive in the market.

Table 11
REB Achievements at a Glance

Date of commencement of REB activities	1978
Number of PBS organised	67
Number of Thanas included in the RE program	424 out of total 464
Number of villages electrified	31,314 out of total 86,038
Total distribution line constructed and energized	123,510 Km
Total 33/11 KV sub-stations constructed and commissioned	255
Installed Capacity of Sub-stations	1761 MW
Total number of consumers	3,188,484
Total number of irrigation pumps connected	82,253
Total land under irrigation scheme	1.864 Million Acres

1.1.5. Factors behind the success of REB/PBS model:

1.1.5.1. Standardisation of construction materials and units:

REB has standardised all construction materials including hardware, tools, construction units and methods. Restricting the use of non-standardised materials coupled with the collective buying (to the extent possible) helps in keeping the system/equipment cost low.

1.1.5.2. Tariff Management:

¹³ Subdistricts

PBS purchase electricity from BPDC or DESA at 33KV level and the present bulk rate is Taka 1.77 per unit (2004). Each PBS sets its own tariff with the approval of REB. Flexibility is given to PBSs in setting up tariff according to the average cost, load profile and paying ability of the different class of customers viz., domestic, commercial, irrigation, Industries etc. This helps them in recovering the cost and generating sustainable returns on the investment.

1.1.5.3. Bills Collection:

The bill collection rate for PBSs is nearly 100%. A part of this success can be attributed to the co-operative approach, which gives a sense of ownership to villagers in rural electrification schemes and the other to the ease and convenience with which the bills can be paid. Regarding collection of bills, the consumers can pay their bills at the cash counter of the PBS office. Alternatively, they can pay through designated banks, which are authorized to collect electric bills of the consumers living in every 3 sq. miles of service area of a PBS.

1.1.5.4. Performance target agreement:

It is aimed to improve the performance of these PBS regarding the quality of their services and ensures the accountability of the officers and employees. As a part of formal method of performance evaluation, entire activities of PBSs are thoroughly analysed. There is monthly monitoring of these PBSs by REB. Implementation of corrective measures to achieve target is ensured. There is a method of evaluation of PBS and between REB and PBS and then annual review of the performance. Sometimes, incentives – penalty is linked to the achievement of performance target agreement.

1.1.5.5. Construction Management

PBSs are generally not technically equipped to handle such exercises. Therefore, major construction work of rural electric distribution is managed by REB. REB's vast experience comes handy in keeping the capital cost of distribution system low, which is ultimately passed on to the end user. For construction management, REB has six Superintending Engineers offices in different zones assisted by Executive engineers and local engineering consultants make electrical and construction designs to co-ordinate and supervise the construction done by the contractors and authorise issue of materials from REB store to the contractors. The PBSs are encouraged to keep the overheads costs low. Several approaches are practiced to this end. For example, all the PBS staffs perform a variety of jobs and thereby effectively reducing the number of manpower needed.

1.1.5.6. Strict by-laws:

Functioning of PBSs (financial, operational and managerial) is governed by very strict by-laws prepared by REB. These are very elaborate and provide a very comprehensive set of dos and donts to the PSBs. These by-laws have helped in enforcing strict discipline among the societies.

1.2. Noida Power model of rural electrification

Noida power model is a corporate led model of rural electrification. Under this model a private company assumes the responsibility of extending the grid network to the rural community and runs it with a motive to earn sustainable returns. The Noida Power Company Limited (NPCL), a private distribution company based in India. The company adopted an innovative approach to provide electricity to few villages in its distribution circle. Noida Power Limited hired Xavier Institute of Management to work as a social intermediary for the project. It has so far completed the following activities in ten villages. In 18 more villages these activities are under various stages of development.

- Rapport building exercise was carried out, followed by steps to convince and motivate the consumers to form Village Vidyut Sangh (VBS) in the villages under operation.

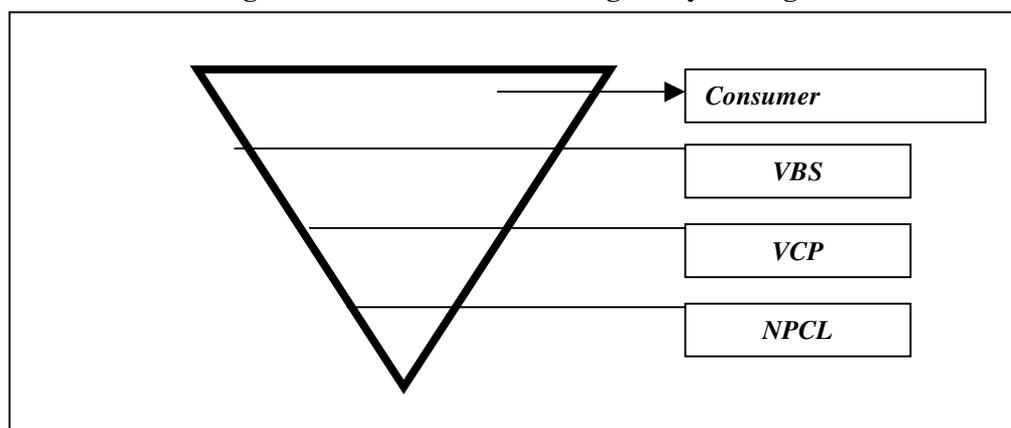
- Comprehensive electrical drawing of consumers, in the GIS format has been completed following network engineering.
- A Village Contact Person (VCP) has been appointed in 8 villages. These VCPs have been engaged by NPCL under financial terms to carry out several activities like bill distribution, due collection, consumer dispute resolution, theft surveillance etc.
- All the un-metered consumers have been motivated (with help of the VBS & VCP); to clear past dues and to apply for round the clock metered supply (by depositing requisite estimates).
- NPCL has provided the consumers with metered round the clock supply, and their respective status have been duly modified in the billing database thus consumers are receiving proper bills as per actual consumption.
- VCPs have been trained about the field realities of power distribution & basics of customer care, complaint handling, and special care have been taken to make them proficient in skills of credit collection.
- For the agricultural consumers a campaign was designed to convince them, to opt for energy efficient pumps plus metered supply.

1.2.1. Organisational Structure:

The organisational structure under the NPCL led rural electrification model has been woven with the basic objective of maximising the involvement of local community/people in the provision of electricity. Xavier Institute of Management was hired as a social intermediary for this project. XIM was vested with the responsibility of encouraging local community to actively participate in rural electrification program and setting up a self-sustaining organisational structure with distinguish role for private participation. XIM is presently in the process of formulating electricity self-help groups named as Village Vidyut Sangh (VBS) in the villages. These VBSs in several ways replicate the functioning of electricity co-operative societies. However, they generally represents smaller number of customers and assume the limited responsibility of co-ordinating with NPCL, overseeing bills collections and addressing any grievances with the help of NPCL officials. NPCL and XIM are also in the process of identifying/appointing one person from each village to work as Village Contact Person (VCP). The primary responsibility of these VCPs is to help in activities like like bill distribution, due collection, consumer dispute resolution, theft surveillance etc . Fig 2 below depicts the organisational structure being set up in villages.

NPCL is now trying to provide training to VBS via workshops aimed at cultivating - attitudinal development, improving peer communication, and harnessing problem-solving skills (apart from other required skills), so that the VBS becomes self sustainable. Xavier Institute of Management is supposed to exit from the project, once, the above-mentioned organisational structure is firmed up in all villages and project reaches some satisfactory level. The initiatives taken so far have started showing results. Some of the impacts have been mentioned in the next section.

Figure 2
Organizational structure - Village Vidyut Sangh



1.2.2. Impact:

- As contemplated and desired, the collection to billing ratio has reached 95% for the villages of VCP operation at the same time the commercial losses have been kept under limits.
- Several farmers have responded to the NPCL campaign of energy efficient pumps. Energy efficient pumps with HT lines have been installed and several farmers have started paying as per metered tariff, on actual consumption (not fixed charges on the basis of load).
- 100% of electricity connections to households are metered.
- Village Contact Persons and Transformer Users Associations are actively promoting the cause of metered supply.
- The intervention is having a perceptible impact on the life style of the consumers – because now they have access to reliable electricity supplies thus improved livelihood options.
- The Community has developed a sense of social fencing towards Loss control activities.

Table 12
Achievements at a glance
(Till end of year 2003)

Application received for metered supply	3400 (against a yearly target of 2600)
No of Services installed	2808
Application from Agricultural consumer	25 cases (For metered supply)
Average % of 'Collection to bill'	95 (for 9 villages.)
No. of villages where VEC has been formed	8

2. Off-grid systems:

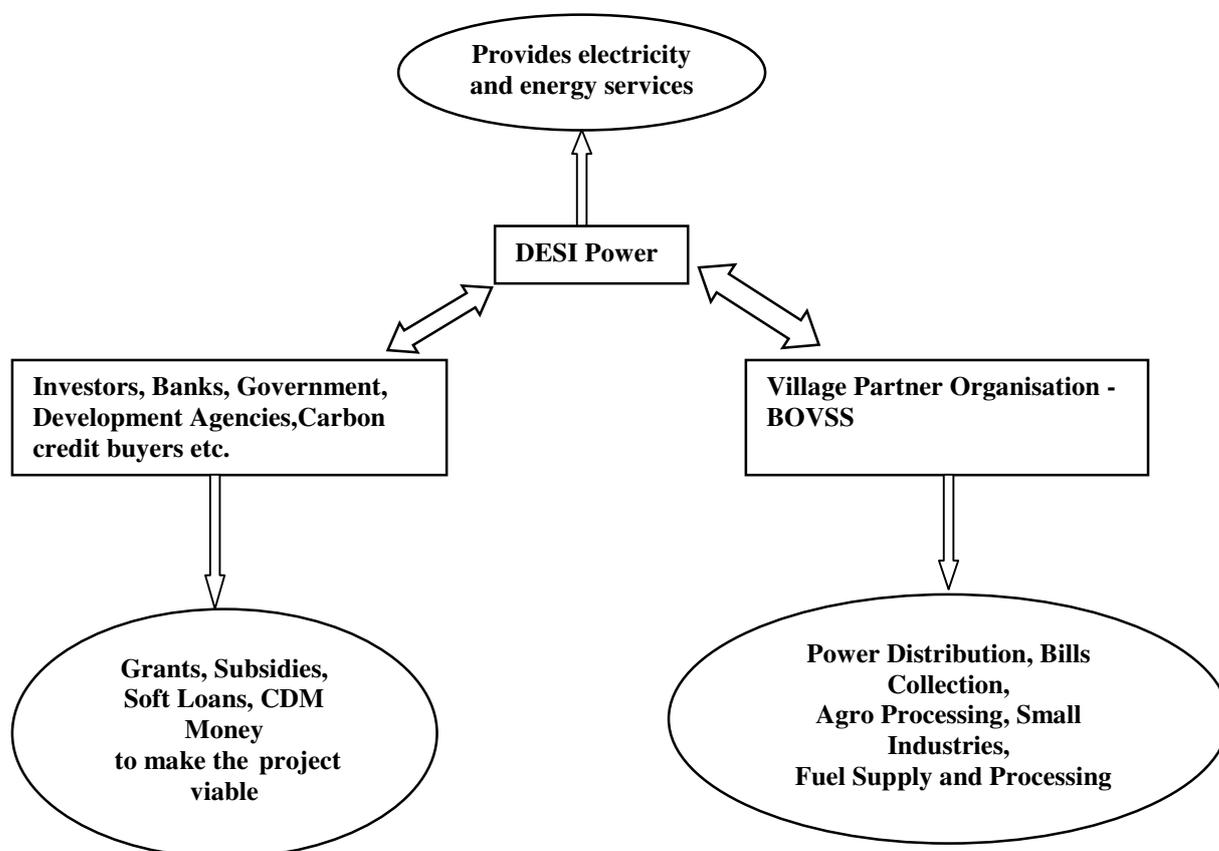
2.1. Baharbari Udyogic Vikas Swablambi Shakari Samiti (BOVSS)

BOVSS rural electrification project is located in village known as Baharbari in Bihar state, India. BOVSS, is a co-operative registered under Bihar self-supporting co-operative society act 1996. The society was set up with the technical, managerial and financial help of DesiPower, an Indian power producer that advocates decentralised energy. Desi Power and its local partner (BOVSS) is jointly implementing the rural electricity related activities in the village (Fig 3 depicts the model).

Under the project, DESI Power acts as an independent rural power producer. Local partner assumes the responsibility of distribution of power and bills collection. DESI Power also encourages local partner to establish small-industries, business, agro-forestry etc. with a view of creating employment opportunities. These economic activities and several other social activities are supported by Desi Power. This has helped in building trust between local community and electricity supplier. Now, the local community is very appreciative and very supportive of any activity/initiative undertaken by Desi Power. The rapport has also helped in attaining higher bill collection rate. Some kind of social pressure has been built against the people who default on their bill payment.

Desi Power explore all the possibilities to make the project financially viable and to get it funded. Generally, banks, development institutions, government all possible sources are explored to get grant or soft loan. These grants and soft loans becomes necessary for project like Baharbari in order to reduce the cost of capital and make power affordable to the people. In this case, Desi Power also generated some resources by selling of carbon credits.

Figure 3
Baharbari Udyogic Vikas Swablambi Shakari Samiti Model



The project was initiated with the objective of providing electricity to the village along with energy services and local job opportunities. A major part of power generated is used for pumping irrigation water on sustainable basis. As a result of the provision of the electricity, the farmers are planning to grow three crops per year, which will increase the farm output and provide more farm employment. Electricity is also used for agro processing, the battery operated lighting systems, battery charging and other micro enterprises.

2.2. Sagar Island Solar PV Project

2.2.1. General Information

Sagar Island is one of the several islands in the Sunderban area of West Bengal State, India. The population of Sagar Island is spread across its 16 villages. The island can not be conveniently and economically connected with the grid of the mainland. Before the energy intervention, kerosene and diesel were the main sources of energy. Kerosene was generally used for lighting and cooking and diesel was used to energise some of the diesel gensets. However, these two fuels needed to be transported from the mainland with significantly high transportation cost. Sagar Island is known for its rich biodiversity and therefore a need was felt to provide the island with environmentally friendly and modern alternatives of energy.

Ministry of Non-Conventional Energy Sources (MNES), Government of India and Government of West Bengal initiated the solar PV project on the island with the help of local administration and Zila Parishad. It was found that the per capita income of the village is low and therefore a need was felt to keep the per unit tariff of power low.

2.2.2. Technical Specification of the System:

The Sagar Solar PV project was initiated with the twin objectives of demonstrating the viability of solar PV technology and to provide quality power to remote rural settlements. The project capacity is 26 kW having 522 PV modules each of 50Wp. Technology related details are tabulated below:

Table 13
Technology details for Sagar solar PV Project

Type	Stand – alone Solar PV Power Plant
Installed capacity	26 kWp (522 PV modules each of 50 Wp)
Battery Bank capacity	1400 Ah
Inverter capacity	3 Nos. 15 kVA each
Type/Application of Load	Domestic connection for lighting and appliances and commercial load

Besides replacing the use of kerosene for lighting, the System has found wider applicability to Power Street lights, rural hospitals, to pump potable water and few other commercial usages.

2.2.3. Institutional Mechanism:

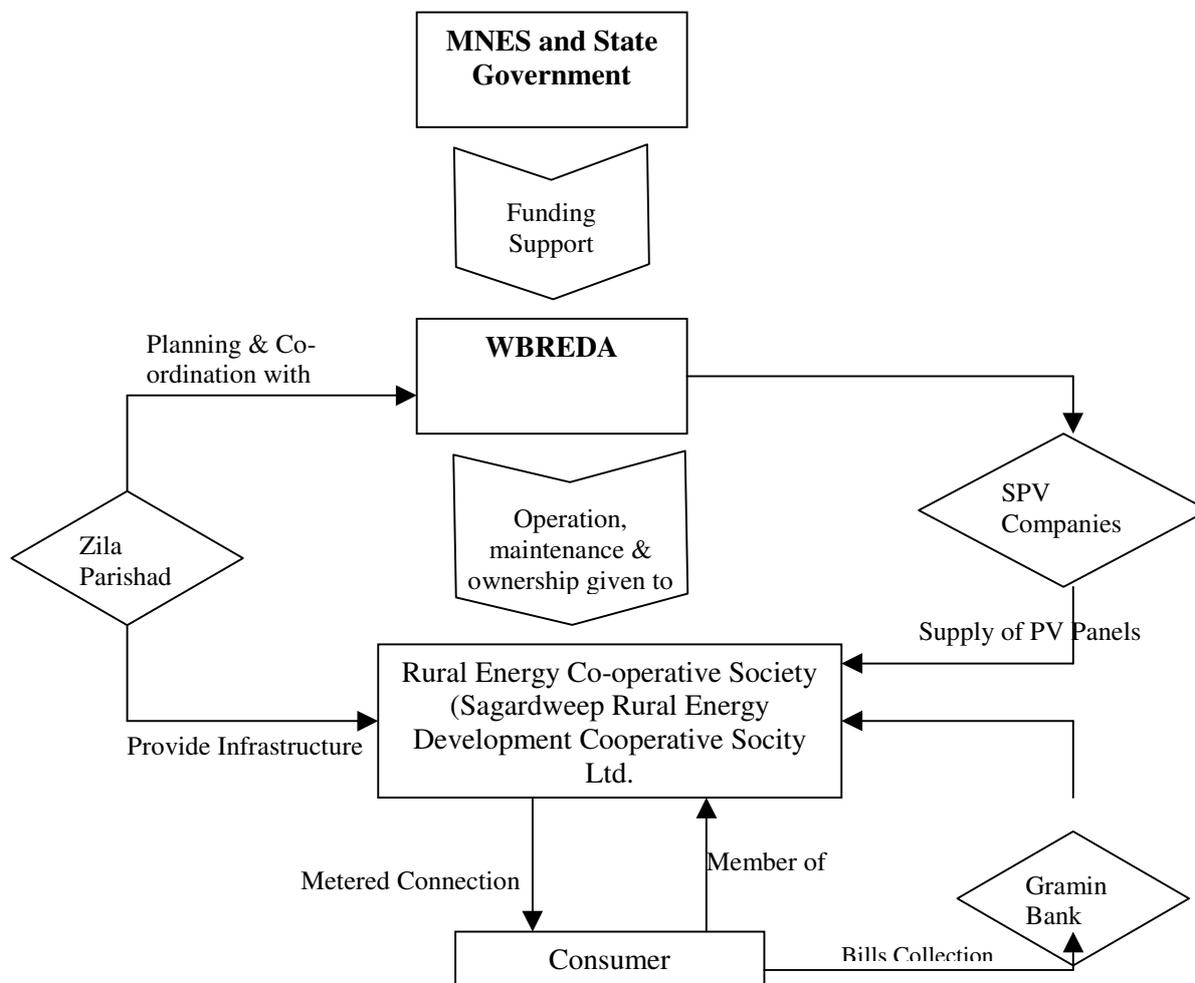
The project is conceived, implemented and operated by the West Bengal Renewable Energy Development Agency (WBREDA), a state nodal agency promoted by the Ministry of Non-Conventional Energy Sources (MNES). MNES grants and other indirect financial incentives have helped in keeping the capital cost low for the project¹⁴. WBREDA approached Zilla Parishad, to develop project for providing solar electricity to the villagers. Zilla Parishads have assumed the responsibility of promoting development and meeting the infrastructural needs at the village levels. Under the project, WBREDA facilitated the installation of systems and technical designing. WBREDA also helped in floating a consumer co-operative society named as “Sagardweep Rural Energy Development Cooperative Society Ltd.” responsible for establishing power connections to the interested households as well as for day to day operation and management. WBREDA has signed a Memorandum of Understanding (MoU) with the co-operative society delineating its various roles and responsibilities. The property rights of the system created and/or managed by the co-operative society for electricity supply purposes are with the society only and not with the individual members. However, members help in creating these assets and it is collective responsibility of all members to maintain the systems.

For the collection of the bills, existing Gramin Bank has been introduced as an intermediary. Every connection is metered and Gramin Bank collects the bill, based on the actual consumption within the overall limit set by the society keeping in view the overall capacity and minimum load requirements to operate the Solar PV power plant. Though the maximum permissible consumption level by consumers are stated in the schedule to their agreement with the Society, but minimum charges

¹⁴ MNES subsidy to the extent of Rs. 200,000 / kW of PV array capacity or 50% of ex-works cost, whichever is less and Rs. 10,000 as service charges can be obtained for such projects.

irrespective of the consumption levels are to be paid to maintain the load factor. The officials of the Society regularly inspect the energy meter and other accessories.

Figure 4
Institutional Model for Sagar solar PV Project



2.2.4. Financial Model:

The cost of Solar PV electricity in India varies between Rs. 10/kwh to Rs. 15/kwh on a life-cycle basis. Sagar island inhabitants, having very low per capita income, can not be expected to pay hefty tariff. To make the project viable, it was planned to subsidise the capital cost with MNES/State Government funds and the customer is charged only to the tune of operation and maintenance cost. Nearly 50-50 % of capital cost was shared by MNES and State Government. There is no liability for the rural co-operative society to recover the capital cost. The goal of the society is to sustain the operation of the system and thus aim at recovering the maintenance costs. Society is charging roughly between Rs. 2.5 – 3.75 per unit against the estimated 10-15 Rs/unit for SPV systems. The

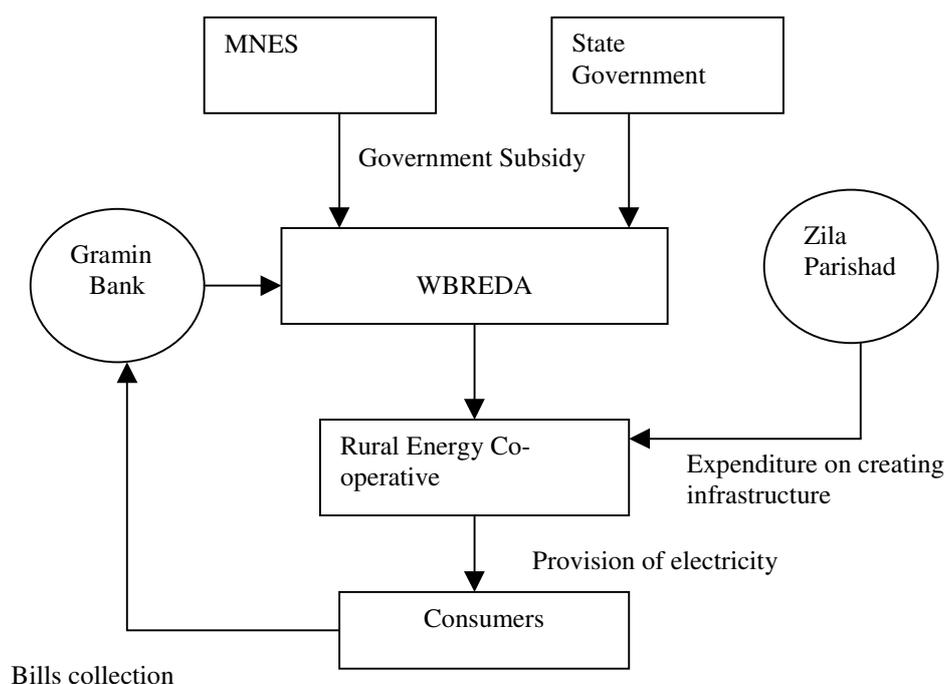
beneficiaries of the project provided the cost of external electric connection and a security deposit of Rs. 400 (later increased to Rs. 1000). A minimum connection charges has to be paid by consumer (based on the criteria mentioned in table below) irrespective of the actual consumption.

Table 14
Minimum Connection Charges for Different Consumers

Criteria	Rate (Rs/month)
100 W connected load and 4 hours of operation	30
200 W connected load and 4 hours of operation	60
200 W connected load and 4 hours of operation (Commercial consumer)	90

As mentioned earlier, the bill collection is by the local Gramin bank. So far, the bill collection rate has been appreciably high. The rules and regulations governing payment/non payments are very stringent. The defaultee is supposed to be disconnected immediately after the expiry of the notice period. He is connected again only after payment of disconnection charges, reconnection charges and applicable surcharge. Figure 5 below summarises the financing model of the project.

Figure 5
Financial model of Sagar Island solar PV Project



2.2.5. Impact:

Sagar island project has demonstrated the success of decentralized solar power generation systems in meeting the energy needs of island villages where grid electricity is not practical. The project has gone well beyond just simply providing electricity to villagers. The extended day light hours, made possible due the project, have opened several avenues for the villagers. Electricity for water supply for irrigation and drinking water has enhanced income of farmers and has improved the quality of life. Entertainment through Solar powered TV, radio , music system is now commonplace in the village. Villagers also use electricity for social and community functions like marriages and festivals. The solar panels also power rural hospitals. So far, the project supplies electricity for fixed hours in the evening and operates at a very low load factor. However, the demand for electricity is

expected to grow slowly and gradually. There has been a growing interest in the region due to benefits demonstrated under this project.

3. Stand alone systems:

3.1. Grameen Shakti Model

The rural electrification programme of Grameen Shakti (GS) favours Solar PhotoVoltaic technology for electrifying rural households. GS runs with its 88-field offices spread all across Bangladesh and provides total solution to customers (from demonstration and marketing of panels to repair and maintenance). Salient features of the programme are tabulated below:

Table 15
Grameen Shakti at a glance

Incorporated	1996
Main Programme	Solar Home System
Number of district covered	42 out of 64
Number of Upazila covered	150 out of 460
Number of villages covered	2000
Number of Island covered	8
Total beneficiaries	150,000
Field office	88
Field staff	300 (mostly electrical engineer)
Total Installations	20,500 SHS
Current installation rate	800 SHS/month
Future plan by 2008	1,00,000 SHS

It is really worthwhile to note that GS has been fairly successful as a result of its worthy leadership, effective management and proper designing of the model. Old customers are spreading the word across and bringing in new customers. GS has also been able to muster government support and the support from international donor agencies. The model has been framed with great precision to cater to local needs and aspirations. Some of these factors have been discussed as follows:

- Continuous nature of GS Program:

One of the basic problems with some of the solar-based electrification programs introduced in the region is that they are introduced and sustained only for a short duration. Some of these programs required customer's contribution to provide them Solar panels. Before making any partial/full payment for solar panels, customers invariably demand after sale maintenance, repair and sometimes buy-back services. Customers often have grievances against these schemes due to lack of proper repair and maintenance facility, their equipment becomes unproductive and their investment is wasted. Consequently, at several places SPV programs are less likely to succeed due to this kind of cynicism.

However, this kind of problem is not there in case of Grameen Shakti. It is believed to be an ongoing, ever lasting, continuous program. It's credibility is further reinforced by its parent organisation – Grameen Bank. Under GS program, any kind of assistance including repair, maintenance and buy-back of the equipment (if need be) is guaranteed. GS experts are available for

all practical purposes round the clock. Any improvement in the technology is also quickly disseminated to customers through the wide network of GS. GS undertakes several other activities that go well beyond the energy service alone and help develop trust between GS and local communities. Educational loans, gift schemes etc are some such examples. Further, most of the customers of GS are members of Grameen Bank, that's why there is a family like relationship between GS and its customers. These features, though seemingly trivial, contribute in a big way to the success of GS. It can be seen that in other countries, where rural electrification approaches miss out the spirit of a programme, the outcome is generally unsatisfactory.

- Innovative financing and micro-credit

As mentioned earlier, GS programme takes care of the local needs and aspirations. Financing models has also been designed accordingly. GS offers four modes of payments (table below) for the equipment supplied according to the customer's convenience. Further, micro-credit is easily available under all of these modes to buy the system. After the warranty period, customers are encouraged to sign annual maintenance contracts (AMC) with GS at a very nominal rate of \$ 5 per annum. Therefore, the financing scheme perfectly blends with customer's paying ability.

Table 16
GS Financing schemes for the purchase of SPV Systems

Modes	Mechanism
Mode 1	<ul style="list-style-type: none"> • 15 % to be paid upfront by the consumer • 85% can be paid in 36 monthly installments including 12% service charge
Mode 2	<ul style="list-style-type: none"> • 25% of the total price as down payment • Remaining 75% in 24 monthly installments with 8% service charge
Mode 3	<ul style="list-style-type: none"> • 15 % to be paid upfront by the consumer • 85% can be paid with 36 post dated cheques including 10% service charge
Mode 4	<ul style="list-style-type: none"> • 4% discount is allowed for cash purchase

- Buy-back facility:

GS offers customers the option of buying back the SHS in case they do not need/want it any more. This situation is quite possible if grid is likely to reach the village. In such cases, reasonable amount of depreciation is charged and customers are refunded the money. This gives a lot of credibility to GS and shed people's inhibition to make investments under this programme.

- Customer awareness and motivational programmes:

Before venturing into any village, GS organises awareness and motivational programmes to encourage villagers use electricity to improve their quality of life.

- Community involvement and social acceptance:

The very basis of GS operations is community involvement. GS enjoys wide social acceptance and locals are actively involved in GS activities.

- Minimum implementation cost and overheads:

GS has a very smart strategic way of managing very vast operations (wide geographical coverage and range of activities) with the help of only 300 field staff. Most of these field staffs are engineers and they look after several activities simultaneously (marketing, commissioning, demonstration, training to locals, repair and maintenance etc.). The savings are ultimately passed on to customers in terms of lower rate of equipment and services.

- Extensive training:

GS provides local capacity building through a) extensive training to their staff for multiple services to village communities b) training to communities to repair and maintain the system locally .

- Focus on applications:

GS focuses on productive applications of solar energy like for education, charging mobile phones, lighting rice/saw mills, fisheries, clinics etc.

3.2. Bankura Community Development Project: A corporate-NGO-Govt. partnership model

3.2.1 Background

This is a noteworthy example of corporate led off-grid decentralised rural electrification model. The model was implemented in Ranibandh block of Bankura district, West Bengal State, India. Bankura is predominantly rural (92% of population in rural areas), SC/ST dominated (42%) and is very backward - in terms of socio- economic indicators. Agriculture, which is seasonal in nature, is the main source of livelihood; work force migrates to other areas for the rest of the year.

3.2.2 Goal

Bankura Project is essentially an NGO led consortium project aimed to impact an integrated community development with solar energy intervention. This pilot project in three villages helped to appreciate the benefits for decentralised community development program and bringing in rural energy transitions.

3.2.3 Stake holders & contributions

The lead agency under this model was Tata BP Solar Ltd., a leading Indian solar PV manufacturing company which provided and installed solar panels (to 250 individual households based on their contribution of one time payment with application and Rs. 25 per month for 5 years). Home Lighting Systems were provided with two years free maintenance followed by three years AMC. The project equipped the Multi purpose Community Center with one 5 KWp and power plant and arranged support services for training in Health, Education and Micro -entrepreneurial activities.

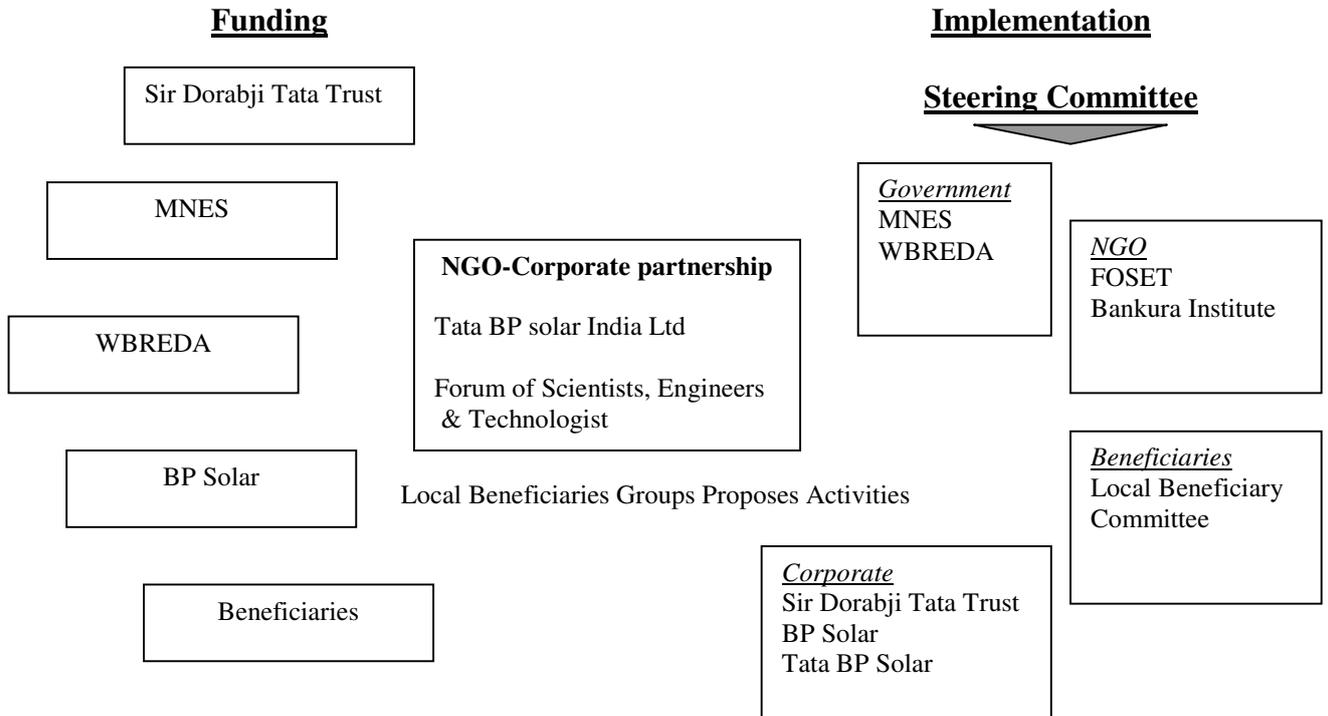
The Project also helped setting up the proper institutional mechanism for proper functioning of the electrification system. Revenue was collected by FOSET and local Beneficiary Committee. Corpus of Rs.5 lacs (Initial payment from the households , amounting to Rs. 375,000 and subsidy of Rs. 125,000) generated funds enough to replace the battery while monthly revenue of Rs. 6250 met (and is meeting) the O&M expenses. Lot of attention was given on establishing rapport with local community. The project also supported/started several social development initiatives. Following activities were started in the area with the financial, institutional help of the project developer.

- Literacy and continuing education program
- Community Health program & Health Services
- Vocational training for small entrepreneurship development
- Technology transfer packages for better resource utilization in farming and non farm sector
- Communication and application of IT as a part of overall development

3.2.4 Institutional/Operational Framework:

As mentioned in the description of earlier models, Solar PV is a very capital-intensive technology, which requires substantial initial grant. In the Bankura project, Tata BP Solar mobilised funding from several agencies. These agencies include Ministry of Non-Conventional Energy Sources (MNES), West Bengal Renewable Energy Development Agency (WBREDA), Sir Dorabji Tata trust and BP Solar. Local beneficiaries also made financial contributions in terms of payment for the systems.

Figure 6
Bankura Community development Project Model



To supervise/monitor the functioning of the project, a steering committee was formed having adequate representation from corporate, government, NGOs and local beneficiaries. With the help of local NGOs, Tata BP Solar conducted training programs in the village aiming at inculcating repair and maintenance skills among villagers. Solar panel can provide electricity only for few hours in the village. Still the impact on local community is substantial (compiled in the table below).

Table 6: Impact of Solar Panels

<i>Scenario before the intervention</i>	<i>Scenario after the intervention</i>
<ul style="list-style-type: none"> - Main occupation- Agriculture - Villagers used to produce rice & vegetables, which was only sufficient for 5 months - Rest of the time villagers used to migrate to nearby towns & cities to work as daily labourer - Some villagers used to earn modest income in a highly unstructured manner through preparation and sell of Babui grass rope, Sal leaf plates, Neem sticks, Baskets with antari lata & firewood 	<p>Home lighting changed the entire life style of the village:</p> <ul style="list-style-type: none"> - Number of working hours have increased - Kerosene consumption reduced by half to two ltr per week per household thereby leading to an average saving of thirty rupees per week - School going boys and girls are inspired to study and do homework - Risk of fire hazards & snake bites reduced. - Villagers trained for operation and maintenance (additional employment)
<p><u>Earning of different classes</u></p> <p>Average Earning – Rs 40 per head pre day</p> <p>Cultivator – Rs 45 per head per day</p> <p>Agricultural labourer – Rs 40 per head per day</p> <p>Marginal worker – Rs 35 per head per day</p> <p>Earlier Expenses – Rs 50 per month on kerosene for light</p>	<p><u>Impact on earning</u></p> <p>Grocer’s income increased by Rs 200 per day due to extended hours of working</p> <p>Households make 2 kg/days additional Babui ropes due to extended working hrs resulting in an increased income of Rs 15 per day</p> <p>Villagers who used to make babui ropes & sal leaf plates have increased their daily output of rope by 2kg/day & plates by 200 per day thus augmenting their gross income by Rs 30 / day</p>

Bibliography:

- Barnes Douglas et al, Rural Electrification in the developing World: Lessons from Successful Programs, World Bank; 2003
- Barua C Dipal, An Integrated Approach to Rural Energy Service, Grameen Shakti; 2004
- Ehrhardt David, Impact of Market Structure on Service Options for the Poor, June 2000
- Experiences in Co-operative Rural Electrification and Implications for India, NRECA International Ltd., June 2002
- Gokak A V, Gokak Committee Report on Distributed Generation, Ministry of Power, Government of India
- Gunaratne Lalith, Private Public Partnerships in Rural Electrification in Sri Lanka, 2003,
- Martinot Eric and Reiche Kilian, Regulatory Approaches to Rural Electrification and Renewable Energy: Case Studies from Six Developing Countries; World Bank, 2000
- National Rural Electrification Policy, Ministry of Power, Government of India; 2003
- Peterson Jane A, Micropower: The Next Electrical Era, World Watch Institute; July 2000
- Rahmatullah B D, Country Paper: Bangladesh, June 2003, United Nations Economic and Social Commission for Asia and the Pacific
- Ravindranath N H, Sagar Solar PV Power, ECOFys
- REB - PBS Model Bye-Laws, Rural Electrification Board, Bangladesh, 1985
- Renewables for Power Generation: Status & Prospectus; 2003, International Energy Agency
- Renewables Information; 2002, International Energy Agency
- Report and Recommendation of The President to The Board of Directors on a Proposed Loan to The Republic of Maldives for The Outer Islands Electrification (Sector) Project, Asian Development Bank; 2001
- Rural Energy Services: Best Practices; 2002, Nexant/SARI Energy
- Saran H N, Sustainable Energy for Rural Progress through Employment and Power (EmPP) Partnership Programme, 2004, Desi Power
- Shrestha M Ram et al., Institutional Reforms And Their Impact on Rural Electrification: Case Studies in South and Southeast Asia, Asian Institute of Technology, 2004
- Shrivastava K. Vinod, Innovative Approaches for Financing Rural Energy Services - An Overview, Energy & Development Newsletter, April 2004, Core International Inc.
- Status Report, 2004, Grameen Shakti, Bangladesh

The Rural Electrification Board Ordinance, 1977; Ministry of Law and Parliamentary Affairs,
Government of The People's Republic of Bangladesh

Tomkins Ray, Extending rural electrification: A survey of innovative schemes,

Vaidya Dr., Cost and Revenue Structures for Micro-Hydro Projects in Nepal, AEPC

World Development Indicators; 2004, The World Bank

World Energy Outlook; 2002, International Energy Agency