ENERGY FOR ALL OF NEPAL: A STRATEGY FOR ACCELERATING THE DEVELOPMENT OF NEPAL'S RURAL ENERGY SERVICES

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List of Acronyms

AEPC	Alternative Energy Promotion Center
CBO	Community-Based Organization
DANIDA	Danish International Development Agency
DDC	District Development Committees
DEF	District Energy Fund
DOED	Department of Electricity Development
EPC	Environmental Protection Council
EES	Energy Extension Service
EHFA	Electric Home and Farm Authority
ESD	Energy Services Delivery
GEF	Global Environment Facility
GFR	General Field Representative
GNP	Gross National Product
GS	Grameen Shakti
HMGN	His Majesty's Government of Nepal
ICS	Improved Cooking Stoves
IREF	Interim Rural Energy Fund
km	kilometer
kWp	kilowatt (peak)
kV	kilovolt
LG	Local Government
MLD	Ministry of Local Development
MOST	Ministry of Science and Technology
MOWR	Ministry of Water Resources
MVA	megavolt-ampere
NDC	National Development Council
NDVS	National Development Volunteers Services
NGO	Non-Governmental Organization
NPC	National Planning Commission
NEA	Nepal Electricity Authority
NPR	Nepalese Rupee
NRECA	National Rural Electric Cooperative Association
PAF	Poverty Alleviation Fund
PBS	Palli Bidyut Samities – Bangladesh Rural Utility
PDF	Power Development Fund
PPA	Power Purchase Agreement
PTA	Performance Target Agreement
PV	Photovoltaic
PVO	Private Voluntary Organization
RADC	Remote Area Development Committee
RE	Rural Electrification
REA	Rural Electrification Administration (US)
REB	Bangladesh Rural Electricity Board
REC	Rural Electric Cooperative
REDS	Rural Energy Development Section
REDP	Rural Energy Development Program
RERED	Renewable Energy for Rural Economic Development
RESA	Rural Energy Services Authority
RESC	Rural Energy Service Center
RUS	Rural Utilities Service (US)

SASEC	South Asia Subregion Economic Cooperation
SARI/E	South Asia Regional Initiative for Energy
SHS	Solar Home System
SPV	Solar Photovoltaic
TBD	To Be Determined
TFC	Tariff Fixation Commission
UNDP	United Nations Development Program
US	United States
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VC	Village Council
VDC	Village Development Committees
V	volt
VH	Village Hydro
WEC	Water and Energy Commission
WECS	Water and Energy Commission Secretariat

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Executive Summary

Reducing poverty especially among the 86 percent of Nepalese who live in villages and rural areas is the primary objective of the Tenth National Development Plan, which begins in mid-2003. The availability of affordable and reliable energy, especially electricity, is key to increasing rural productivity and improving quality of life – reducing poverty.

So, under the Tenth Plan, His Majesty's Government of Nepal (HMGN) is giving the topics of rural electrification and rural energy services prominent attention. At the same time, donor agencies are looking toward a next generation of technological and institutional approaches to accelerate the spread of electrification and modern energy to rural areas of Nepal and throughout South Asia. It is a strategic moment for interested international supporters to work with HMGN to apply the experience and innovations of best practices from the region and worldwide to design and build a new and concerted approach to bringing modern energy to all of Nepal.

This document presents the initial findings of an on-going assessment of rural energy services in Nepal, and proposes an innovative strategy and organizational approach for accelerating rural electrification in the Kingdom. The work is being carried out for HMGN by SARI/Energy (South Asia Regional Initiative for Energy), a program of the U.S. Agency for International Development (USAID) that promotes mutually beneficial energy linkages among Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka.

In March 2002, at the Delhi meeting of the Energy and Power Working Group of the South Asia Subregional Economic Cooperation (SASEC) Program, SARI/Energy offered to facilitate, in coordination with the Asian Development Bank (ADB), transfer to India and Nepal of key management elements of Bangladesh's successful system for electrification through rural utility associations (village cooperatives). The offer was accepted by the Indian and Nepalese delegations (secretary of government level). This report is based on that agreement. It draws from related work under SARI/Energy in Nepal regarding power sector reform and rural energy training programs, and regional work on Best Practices in the sector.

Most of the challenges in Rural Electrification and Rural Energy Development are not technological. The technologies will continue to improve, but they are already widely known and readily available. The challenges are primarily of financing and of organization to construct and maintain the technologies at the community level.

There is widespread agreement that NEA needs to concentrate its efforts on unbundling and eventual privatization; it should not be burdened with the financial and organizational costs of Rural Electrification. Meanwhile, alternative energy sources for meeting rural needs are becoming significant in Nepal. At some point, Alternative Energy Promotion will need to be mainstreamed into Rural Electrification. Currently, two separate energy systems are developing in rural areas. These two different energy systems will increasingly be competing for the same territory, and creating distinct and largely incompatible systems. And because funds and resources of HMGN, donors, and civil society are limited, and skilled development workers are scarce, there is need to focus and concentrate efforts.

The strategy proposed here focuses on the creation of an apex agency that is able to coordinate and integrate these two efforts. The proposed Rural Energy Service Authority (RESA) would bring together national programs for conventional rural electrification, alternative energy promotion, decentralized planning, and grassroots capacity building. It would incorporate selected elements of Bangladesh's Rural Electrification Board (REB) experience, as well as some of the core experience from the US and other successful national rural electrification efforts. And it would build upon recent efforts in Nepal, from the Nepal Electricity Authority (NEA), the Alternative Energy Promotion Center (AEPC), UNDP and DANIDA programs, other donors and NGOs. A holistic approach in accord with the poverty alleviation guidelines of the new Tenth National Development Plan would be applied to create the RESA, which would have three main branches:

- Rural Electrification Service,
- Rural Energy Development Service, and a
- Community Utilities Development Service.

These implementing units would be complemented by a Rural Energy Development Fund, which is already mandated under the Tenth Plan.

This assessment and strategy are presented as a proposal, not as a final project design. This report will be circulated among stakeholders for comment. Review discussions should result in refinements, and hopefully may lead to consensus and commitment of key agencies. With agreement in principle by key agencies, the SARI/Energy project can also provide initial training and technical support to establish momentum while further details of implementation and funding are considered.

Section 1 Rural Energy Supply - Learning from Best Practices

1.1 Background

Nepal's rural energy problems have attracted domestic and international concern since the mid-1970s. The Kingdom faces the classic "other energy crisis" – increasing population, reliance on traditional biomass fuels, deforestation, and poverty, all compounding each other in a vicious cycle that hobbles most efforts at rural and national development.

Limited access to modern energy is both a symptom and a cause of Nepal's underdevelopment. The Kingdom has some of the lowest levels of per capita consumption of electricity and petroleum fuels in South Asia, and the lowest per capita GNP. In recent years, the pace of expansion of the central power grid has slowed, reflecting financial difficulties faced by the Nepal Electricity Authority (NEA) and the serious challenges of serving the rural population. Nepal has some of the best hydroelectric potential in the world, but much of the country is hilly or mountainous, and villages are widely dispersed – most people live more than a day's walk from a road or an airstrip, let alone an urbanized town.

On the positive side, NEA's difficulties have created an opening into which new institutions are entering and evolving – private companies and community cooperatives, owned and managed by rural users themselves. In addition, several innovative small-scale energy technologies have recently shown promise in remote Nepalese villages. International interest in and support for such initiatives in Nepal – both institutional and technological – remain high. Equally important, there is increasing awareness and understanding of what has worked best for rural electrification and energy supply programs in Nepal and its neighboring countries. Taken together, these developments could give a much-needed boost to the continuing efforts of everyone concerned.

1.2 Learning from Best Practices

This document presents the initial findings of an on-going SARI/Energy assessment of rural energy services in Nepal. SARI/Energy (South Asia Regional Initiative for Energy) is a program of the U.S. Agency for International Development (USAID) that promotes mutually beneficial energy linkages among Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka. The program encompasses a range of energy issues: cross-border energy exchange, legal and regulatory frameworks, gas sector development, energy efficiency, renewable energy, rural energy supply, and more.

Since February 2001, SARI/Energy has been investigating best practices in rural energy supply in the region. On a national basis, the most successful model was found to be the Bangladesh rural electric cooperative system, which is characterized by high collection rates, low losses, and a financially manageable and sustainable subsidy. Moreover, as the system

has expanded, it has been shown to be institutionally robust, absorbing service areas with high losses and low collection rates and bringing them up to standard.

In March 2002, at the Delhi meeting of the Energy and Power Working Group of the South Asia Subregional Economic Cooperation (SASEC) Program sponsored by the Asian Development Bank (ADB), SARI/Energy offered to facilitate, in coordination with ADB, transfer of key management elements of the Bangladesh system to India and Nepal. This offer was accepted by the Indian and Nepalese delegations, which were at the secretary of government level. That agreement initiated this report.

In April 2002, SARI/Energy convened a two-day meeting on "Nepal Power Sector Reform" that involved senior staff from NEA and other concerned agencies. During 2002, SARI/Energy training programs were conducted in Kathmandu, and Nepalese energy officials participated in several SARI/Energy courses, conferences, and international technical exchanges. All of these programs have contributed to understanding of the problems facing NEA and HMGN both for reform of the power sector and for rural electrification.

In addition, two recent SARI/Energy studies have reviewed the progress of rural electrification across South Asia. These studies have identified current "best practices" for rural electrification programs[1], and reviewed the legal and regulatory requirements needed to support improved electrification programs in SARI/Energy's member countries.[2] Numerous issues and challenges threaten the sustainability of rural electrification and energy service programs throughout the region. In addition to legal and regulatory barriers, these include low load densities, weak purchasing power, modest institutional capacities, and capital constraints. By identifying, assessing, and sharing best practices, especially those developed or successfully applied within the region, these challenges should be easier to overcome.

For example, the considerable success of Bangladesh's Rural Electrification Board (REB) over the past 25 years offers insights and lessons that Nepal (and other countries in the region) might use. Sri Lanka has been highly successful in introducing home-scale solar photovoltaic systems. There are a number of opportunities for Nepal to replicate or adapt the experience of other countries. And in Nepal itself, new technologies such as peltric turbine systems and pico-power lighting with white-light emitting diodes have been pioneered. These provide genuinely new opportunities for rural electrification, both in Nepal and worldwide.

Formal work on this strategy began at the end of September 2003, when Mr. Andrew O'Neill and Ms. Chau Pho Tung from Nexant[3] visited Kathmandu with Mr. Fred Karlson from CORE

[1] Lalith Gunaratne, *Rural Energy Services Best Practices*, Nexant SARI/Energy Program, www.sari-energy.org, May 2002.

[2] Frederick Karlson. *Rural Energy Services Legal and Regulatory Review*, Nexant SARI/Energy Program, www.sari-energy.org, February 2002.

[3] Nexant, Inc provides the Technical Assistance component of the SARI/Energy program. Nexant is a Bechtel-Affiliated Company that provides comprehensive energy services worldwide. For further information, see www.sari-energy.org, and www.nexant.com.

International.[4] Together with the resident SARI/Energy coordinator, Mr. Mahesh Acharya, they met with stakeholders from key ministries, the Nepal Electricity Authority (NEA), international donors, non-governmental organizations, private energy companies, and nascent electric cooperatives. They also convened a stakeholders' consultation to discuss rural electrification issues.[5] In mid January, 2003, Mr. Will Knowland, Manager of Nexant's Environment and Renewables Group, also spent several days in Kathmandu with Mr. Acharya in follow-up meetings. In February 2003, Mr. Karlson and Mr. Vinod Shrivastava, President of CORE International, collaborated with Mr. Knowland to produce the current draft.

This report draws upon all of those meetings, the SARI/Energy regional studies, and the experience of Nexant and CORE International staff in working with USAID, other donors, national governments, and private sector efforts worldwide. A model entity and implementation strategy are presented – as a proposal, not as a final project design. This report will be circulated among stakeholders for comment. Review discussions should result in improvements, and hopefully lead to consensus and commitment of key Nepalese agencies. With agreement in principle by key agencies, the SARI/Energy project can also provide initial training and technical support to establish momentum while details of implementation and funding are worked out.

The strategy proposed here focuses on the establishment of an apex agency with a national mandate for rural energy development – centered on rural electrification but addressing rural energy supply in a holistic approach. The guidelines for this strategy and new implementing agency are largely contained in Nepal's new Tenth National Development Plan, which comes into effect in mid-2003. Under the Tenth Plan, His Majesty's Government of Nepal is giving the topic of rural energy services high priority. For both Nepalese stakeholders and donor agencies, it is an opportune time to apply the experience and innovations of international Best Practices to Nepal's needs, and to design and build a new and concerted approach to bringing modern energy to all of Nepal.

[4] CORE International, Inc., is the Rural Energy Services Training Contractor for the SARI/Energy program. For further information, see www.sari-energy.org and www.coreintl.com.

[5] A list of their meetings is provided in Appendix A, and a summary of the Stakeholders' Meeting is provided in Appendix B.

Section 2 Rural Energy and Electrification in Nepal

2.1 Rural Energy: Fuels and Power

There is a great energy divide between urban and rural households in today's Nepal. Nationwide, only about 20 percent of the population lives in cities, towns, or villages where there are electric grid connections or off-grid generation.[6] Most urban areas are served, but less than 5 percent of rural households have access to electricity. Since 86 percent of Nepal's population of 23.2 million[7] reside in rural areas, this leaves nearly 20 million people dependent on traditional biomass fuels – wood, rice straw, and dried dung – augmented, for those who can afford it, with kerosene for lamp light. Today, for four out of five Nepalese, "electricity" at best means batteries for a flashlight or cassette radio.

Table 1. Average Energy Mix for Households in Nepal
by percentage (%)

	Petroleum (kerosene, diesel, gasoline)	Coal	Hydroelectric & Photovoltaic	Woodfuel (including charcoal)	Agricultural Residues	Animal Dung
Urban	54	13	22	11	-	-
Rural	1	-	<1	71	18	9

Source: Adapted from US Department of Energy's Energy Information Administration, International Energy Database, May 2002, and FAO, RWEDP[8].

Reliable and affordable access to electricity is almost synonymous with modernization and development – improving the health and welfare of rural households and communities, stimulating cottage industries and raising the productivity of agriculture. Over 80 percent of

[6] New figures, drawn from the Populations Census 2058, appear in the final text of Chapter 14 of the Tenth Plan: "...the people benefiting from electricity at the end of ninth plan are 40 percent, which is twice the initial projection. The major reasons for such a significant difference is due to inclusion of people consuming electricity from alternative energy, consuming electricity in illegal way and procedural changes in the most recent census compared to the last one. This 40 percent includes consumption of 33 percent from the national electricity grid system, and 7 percent from alternative energy sources. Prior to the ninth plan, 57 municipalities of 72 districts and 800 VDCs were accessing electric service, whereas today 58 municipalities of 75 districts are connected to the national transmission system." (unofficial translation.) The terminology used may need more precise definition. In Table 1 of Chapter 14 of the Tenth Plan, it is stated that the 40 percent of "benefited people" was achieved at the end of the Ninth Plan, but the same table indicates that the number of customers served has grown from 828,000 to 878,000 – an increase of only about 6 percent. Furthermore, the target for electricity service is also shown in several places of the Plan as being 30 percent of the population.

[7] Population Census, 2001.

[8] "Nepal Wood Energy Situation:, FAO Regional Wood Energy Program, http://www.rwedp.org/c_nep.html

Nepal's employment is in agriculture. More and better energy for pumping, grinding, drying, and preparing land for cultivation is needed if agricultural productivity is to increase.

In itself, rural Nepal's limited access to electric power and modern fuels represents a chronic and debilitating energy famine. Equally troubling is the fact that even the scarce energy that rural Nepalese do consume is at a high environmental cost.

Figures for non-commercial energy are approximations, but woodfuels still provide about 67 percent of total national energy consumption, agricultural residues 14 percent and animal dung nearly 7 percent. In other words, traditional biomass fuels still provide nearly 90 percent of Nepal's national energy supply. In rural areas, it is virtually 99 percent. Reliance on woodfuels contributes to Nepal's serious deforestation, and use of agricultural residues and dung deprives the soil of needed nutrients and mulch. These fuels are then burned, usually indoors in traditional cooking stoves and lamps. For the users – mainly women and children – this imposes a double burden. They must spend long hours collecting, transporting, sorting, and then tending the fuel in a traditional stove or fireplace – where they are exposed to high levels of indoor air pollution from burning the fuels. Studies of the health problems of Nepalese women and children show that smoke and emissions from burning biomass fuels in cooking, heating, and lighting are a leading cause of respiratory and pulmonary diseases, cancer, eye problems, and complications of pregnancy.

The introduction of improved cooking stoves (ICS) or biogas generators significantly reduces exposure to emissions and frees up time available, especially to women, to improve the quality of family life and to engage in income-generating activities. But it is electricity, able to power lighting, communications, refrigeration, and other productive uses such as milling, grinding, and pumping, that holds the bright promise of economic development.

2.2 Rural Electrification: Basic Constraints

The need to extend the benefits of electric power beyond the 5 percent of rural Nepalese who presently have access to it is clear enough. But there are also obvious challenges to providing electric power nationwide in Nepal. The rural population is dispersed over an area larger than the state of Arkansas, only one-fifth of which is arable, and most of which is forest or wildland. More than a third of the land-locked country consists of steep foothills, and another third is rugged mountain terrain that includes 8 of the 10 highest peaks in the world. These hills and mountains, together with monsoon rains and continental Asian weather systems, give Nepal some of the greatest hydroelectric potential in the world. But the slopes also isolate communities and make any kind of transportation – especially roads and railways – difficult and expensive. More than half of the population resides at least a full day's walk from any paved road. All goods and equipment to these areas move on the backs of people, on foot.

Rural electrification in Nepal, just as elsewhere in the world, has expanded outward from the centers of demand and supply. This has worked well enough for the Kathmandu Valley and much of the lowland Terai. But for most of the country the mountainous terrain and

remoteness of prime sites for large-scale hydroelectric power generation are formidable physical constraints to developing an integrated grid system.

The socio-economic barriers are also formidable. Terrain, distance, and isolation make the costs of normal grid connection prohibitively expensive – typically $10,000 to $30,000 per kilometer. Where line extensions are installed in rural areas, they are characterized by poor reliability and low per customer utilization. NEA reports line losses at 27 percent as a countrywide average – and they may well be higher on rural lines. Demand per household is likely to be very modest – a few light bulbs and perhaps a television or other appliance. At the same time, NEA is expected to perform as a private utility, leading eventually to full privatization. Consequently, NEA must concentrate on providing efficient and reliable service to its customers, with full cost recovery. For NEA and for most private power companies, efforts to electrify remote rural areas are costly distractions from their efforts at efficiency and profitability. So the hard reality is that, at current rates and trends, the majority of rural Nepalese cannot conventional electrification within the next 30 years, if ever.

2.3 HMGN'S Programs for Rural Electrification

2.3.1 Electrification in National Development Planning

Rural Electrification from the Fifth through the Ninth Plans (1975-2002)

Rural electrification has figured prominently in Nepal's national development planning since the mid-1970s. In the Fifth and Sixth National Development Plans (1975-1980 and 1980-1985), rural electrification was recognized as a tool to contribute to the development of rural industry and agriculture. The Seventh Plan (1985-1990) dealt more extensively with rural electrification, and set goals for both small hydro and grid extension to "develop and expand agriculture development and cottage and small scale industries." Also, irrigation from groundwater was to be expanded with increased electricity access. Under the Eighth Plan (1992-1997) rural electrification was to be carried out through the extension of the national grid as far as practical. The Eighth Plan provided for a program to support rural electrification in locations identified under a Ten Year Rural Electrification Study.

The Ninth Plan (1997-2002) also emphasized the need to continue rural electrification "as a driving wheel of rural development." Significantly, the Ninth Plan focused on poverty as its number one priority. The target was to reduce the poverty level from 42 percent of the population to 32 percent. At the time of the mid-term evaluation of the Ninth Plan, the level had been brought down to 38 percent. But due to sluggish economic growth, it remained at 38 percent through the last two years of the plan.

The Tenth Plan (2003-2008)[9]

The Tenth Plan is even more firmly focused on reducing poverty and improving the rural economy. Its target is to reduce poverty to 30 percent of the population. The target set for access to electricity is also 30 percent.[10,11]

In 2001, a new Hydropower Policy had also highlighted rural electrification, specifically calling for the creation of a central rural electrification fund to support development of rural electric supply. This idea is incorporated into the Tenth Plan (2003-2008), which makes rural electrification one of HMGN's highest development priorities. The Tenth Plan specifically calls for creation of a central entity with the mandate of developing rural electricity supply. The Electricity Sector Logframe from the Tenth Plan for the Ministry of Water Resources is reproduced here in Table 2.

Since electricity services in urban areas are relatively adequate, but lacking in rural areas, during the Tenth Plan emphasis will be given to Rural Electrification. Ninety-five percent of the sector's budget for Distribution is to be used for Rural Electrification. Similarly, 65 percent of this budget will be allocated to the Eastern, Mid-Western and Far-Western development regions, which currently have the lowest levels of grid connection and electric service.

During the period of the Tenth Plan, from 2003-2008, more than 17,000 kilometers of transmission and distribution lines are to be added. These will bring the national grid to an additional 1,050 Village Development Committees, encompassing some 705,600 people. (See Table 3.)

Implementing such general plans, however, has proven difficult in the past. It is widely perceived that a clear and consistent strategy for developing rural energy is lacking. While there are obvious complementarities between rural energy development and the development of agriculture and forestry sectors, and each of these sectors relates to national programs for poverty alleviation as well as for decentralization and village development services, there has been little coordination of effort across sectors. Rural electrification and alternative energy development projects have been administered by numerous government and donor-funded programs. There is no one organization that oversees and coordinates efforts to develop the sector.

The Nepal Electricity Authority (NEA) currently has a mandate for developing rural electric supply via extension of the national grid. But off-grid micro-hydro and solar photovoltaic projects are channeled through the Alternative Energy Promotion Center (AEPC), which was established in 1996 under the Ministry of Science and Technology. Various donor-funded

[9] Information in this section is drawn from the unofficial translation of the final draft of the Plan, available on the National Planning Commission's website: http://npc.gov.np:8080/index.jsp.

[10] Parallel goals under the Tenth Plan include: literacy 70 percent, infant mortality at 45 percent, life expectancy 62 years, access to drinking water at 64 percent, and telephone service to every Village Development Committee.

[11] At some points in the Tenth Plan, the target figure is given as 30 percent, at other points it is given as 43 percent.

programs are implemented either through these channels or independently by the donor organizations themselves. Off-grid rural electrification programs have had limited success. Frequently if not usually, within several years of operation or once donor assistance has ended, village electrification projects have faltered or failed; the communities have lacked the technical and financial resources to maintain the systems "given" by an outside organization.

Planning and Coordination for Rural Energy Programs

The **National Development Council** (NDC), chaired by the Prime Minister, is the country's highest level planning body. NDC provides guidelines to the National Planning Commission (NPC) for periodic and annual planning.

The **National Planning Commission** (NPC) is primarily an advisory body, entrusted with preparing long-term vision, periodic, and annual plans in coordination with sectoral ministries under the direction provided by the NDC. It also advises in allocation of resources and works as a central body for monitoring and evaluation of development plans and programs.

The NPC is also chaired by the Prime Minister. The Commission has a full-time Vice-chairman, five members and a member secretary. The Chief Secretary and Finance Secretary are *ex officio* members. NPC is supported by the National Planning Commission Secretariat (NPCS), and the member secretary of NPC is also secretary to the NPCS. Work is carried out through eight divisions:

- Macro-economic Management Division,
- Central Monitoring and Evaluation Division,
- Plan and Policy Co-ordination Division,
- Poverty Alleviation and Employment Division,
- Agriculture and Land Reforms Division,
- Water Resources, Electricity and Physical Planning Division,
- Human Resources Development Division, and
- Local Development, Transport and Environment Division.

The Secretariat is also assisted by Regional Offices located in each of the Development Regions: Central, Eastern, Western, Mid-Western and Far-Western. The Central Bureau of Statistics is responsible for generating, processing, and disseminating information required for planning purposes. In addition to its planning and monitoring roles, the NPCS manages the National Development Volunteers Services (NDVS) and the Poverty Alleviation Fund (PAF).

There are also a number of umbrella councils and commissions, which are overseen by NPC. These groups coordinate sector plans and help ensure that sector policies are consistent with the government's broader development and investment policies. For energy development, the coordinating group most directly concerned is the Water and Energy Commission (WEC).

The Water and Energy Commission (WEC) is comprised of representatives from various ministries and the private sector. It serves both as an advisory body to the MOWR, and as an inter-agency coordinating group in support of the National Planning Commission. WEC has

a small secretariat of professional staff. The Water and Energy Commission Secretariat (WECS) undertakes studies on the water and energy sectors. These studies are discussed by the Commission, which makes recommendations to the Ministry of Water Resources (MOWR). Since the WEC The Tenth Plan explicitly extends WECS' mandate to conduct policy research for the sector, including the projection of national electricity demand, initial identification of hydroelectric projects, and development of electricity.

District and Local Government: Nepal has a two-tier system of local governance. Village and municipal bodies comprise the lower tier and district bodies the higher tier. There are 75 Districts, each with its own District Development Committee (DDC). The DDCs are responsible for, among other activities, district energy planning.

The village bodies are called **Village Development Committees** (VDCs). **Municipalities** serve the same function in town areas. Currently there are 3913 VDCs, and 58 Municipalities. Each village or VDC consists of nine wards. Municipalities have a minimum of nine wards. Wards are the smallest units of local governance. Each ward has a committee (WC) made up of five elected members, one of which must be a woman. VDCs and municipal committees run local affairs. There are also Village Councils (VCs) and Municipal Councils (MCs). These are comprised of the VDC chairpersons, vice-chairpersons, ward members and six nominated members representing women and disadvantaged groups. Municipal Councils (MCs) have a similar structure but the number of members is limited to a maximum of twenty. These councils meet biannually to review and approve the policies, programs and budgets of the VDCs and Municipalities. The Local Self Governance Act (1999) established the functions, duties, and powers of the Local Government (LG). The Ministry of Local Development supports LG and the strengthening of all of these local bodies.

Table 2. Tenth National Plan: Logframe 9.5 for Ministry of Water Resources under the Electricity Sector

MAIN NATIONAL OBJECTIVE: *To alleviate the scale of poverty of the Nepalese people in a sustainable way.*
Greater Sectoral Interest: *Appreciable contribution of hydroelectricity in national development.*

Objectives	Policy	Indicators	Confirmation Basis	Major Programs	External Risk Factor
Purpose (sectoral objectives): Economic structure of water resource will be developed in a sustainable manner	- Promote private participation in electricity production. - Expansion of electricity through participatory approach. - Unbundling NEA. - Facilitating industries based on power. - Promoting use of electricity in agricultural production and industrialization. - Encouraging export of electricity	- For exchange of 150 MW of electricity between Nepal and India, 132 KV transmission line constructed at three places. - Production of 214 MW of electricity from the private sector.s - Increase in agricultural and industrial productivity based on use of electricity. - Increase in distribution of electricity per purchasing capacity and demand of local bodies and communities. - Qualitative & quantitative increase in business and service based on electricity.	- Water Resource Ministry, NEA, Electricity Development Department quarterly and annual progress report. - Special Survey Report.	-Increasing capacity of electricity production. -Expanding electricity service, and making it more qualitative and trustworthy. -Carrying out feasibility study of various hydroelectric projects. -Policy and relevant institutional reform.	- Fluctuation of the electricity market.
Conse-quences/ Results: 1. To increase the capacity of electricity production.	-facilitating private sector involvement in electricity development -encouraging the development of pondage projects -developing small, mid and large scale projects. -not including the cost of transmission line and road construction in production cost to reduce cost of electricity.	- to meet internal demand and export, 143 MW and 214 MW electricity are produced by the public and the private sectors respectively. - Construction has started for production of 1,896 MW electricity. One Pondage Project constructed from public sector after study of a list of pondage projects.	-Water Resource Ministry Quarterly and Annual Progress Report -NEA Quarterly and Annual Progress Reports. -Water Resource National Strategic Report -Electricity Projects Progress Details.	- producing electricity from the private sector - producing electricity and transmitting with help from users groups and the private sector. - producing electricity and transmitting it from the effort of the private sector and the government sector. - Carrying out feasibility study of the pondage project and initiating the construction work. - Providing for power producers to use the National Electricity System.	Availability of market for the export of electricity produced. Availability of the capital. Capacity of the people to consume electricity.

Objectives	Policy	Indicators	Confirmation Basis	Major Programs	External Risk Factor
2. Expanding the service of electricity supply and its quality and reliability	- Expanding rural electrification - Encouraging the use of electricity in agriculture, industry and social service sectors - Imparting responsibilities to local bodies and users' groups in electricity distribution	- Participation of users' groups in electricity expansion and consumption - 43 percent of the total population receiving electricity from the National Electricity Grid - Transmission lines expansion 659 km and distribution lines 17,043 km - Additional 705,600 users. - Capacity of transmission sub-stations increased to 426 MVA and that of distribution sub-stations to 149.5 MVA. - 2,600 VDCs receiving electricity service - Electricity leakage less than 18 percent - Maximum use and result of electricity in industry, agriculture, irrigation, education and health sectors	- Water Resource Ministry Quarterly and Annual Progress Report - Nepal Electricity Authority Quarterly and Annual Progress Report. - Documents of the National Planning Commission - Special Survey reports.	- Expansion of rural electrification through participation of local agencies and users' groups. - Conducting programs to facilitate the use of electricity in industry, agriculture, irrigation and health sectors. - Conducting programs so as to delegate the task of electricity distribution and operation of the municipalities to the local agencies and private sectors.	-Capacity and readiness of users to consume electricity. - To-be-paid electricity bills.
3. Carrying out feasibility studies of various hydro-electric projects.	-Public sector study of hydroelectric projects to facilitate private sector involvement in electricity development. -Private sectors studies. -Maintaining regional balance while carrying out the study. -Encouraging study of pondage projects	- Feasibility study of large, medium and small scale pondage and run-of-river hydroelectric projects every year. - Feasibility study of various hydroelectric projects totaling 13,376 MW of energy.	- Electricity Development Department quarterly and annual progress report. - Nepal Electricity Authority Quarterly and Annual Progress Report.	-Carrying out feasibility study of projects selected through the process of screening and ranking. -Carrying out study of screening and ranking process at regular intervals. -Carrying out systematic study of river basin hydroelectricity development and carrying out feasibility study of the identified projects. -Identifying multipurpose and poundage projects and carrying out their feasibility studies.	- Insufficient allocation of budget.

Objectives	Policy	Indicators	Confirmation Basis	Major Programs	External Risk Factor
4. Policy reforms and proper institutional reforms	Carrying out institutional reforms per the Hydroelectricity Development Policy, 2058.	- Reviewing the institutional structures of the agencies set up for water resource development and use. - Adequate availability of suitable human resources for water resource sectors. - Use of latest technology for water resource development. - Quantitative and qualitative growth of projects developed with participation of the community and local agencies. - Increase in internal and foreign investment for water resource development.	- Institutional structure of the Ministry of Water Resources - Quarterly and Annual Progress Report of the Ministry of Water Resources and its subordinate units - Annual Progress Reports of local bodies.	Conducting periodic review of structure of agencies working in the field of water resources Making provisions of suitable human resources to facilitate the development of water resources with the use of appropriate technology. Enhancing the participation of the government, private sector, local bodies and users' groups for water resource development. Mobilizing internal and external resources for water resource development.	Continuity of participation of concerned agencies. Continuity of participation of locals.

Table 3. Targets for Electricity Distribution and Rural Electrification under the Tenth Plan (2003-2008) as presented in Chapter 14, Annex 5 of the Plan

Projects	New Transmission and Distribution Lines			Additional VDCs connected	Additional customers connected	33/11 KV Distribution Sub-Station Capacity to be added (MVA)	Number of new transformers	Projects Completion Date
	33 kV	11 kV	400/230 V					
Transmission Line and Rural Electrification Projects	583	2,605	5,920	532	5,29,000	34.5	3,170	Will Continue
Mid and Far-Western Rural Electrification Project	152	620	491	145	15,000	9.5	197	2003/04
Kailali, Kanchanpur Rural Electrification Project	0	579	1,836	29	30,000	16.5	490	2004/05
Distribution System Development	35	432	794	60	26,000	6.0	296	2004/05
Rural Electrification and Distribution System Reform Project	130	1,154	1,663	272	1,05,000	83.0	1,265	2004/05
Small Hydroelectric Construction and Rural Electrification	0	19	30	12	600	0	15	2004/05
Total	900	5,409	10,734	1,050	7,05,600	149.5	5,433	

2.3.2 Existing Institutional Structure

At the national level, line agencies with direct responsibilities for implementing the national plans for rural energy and electrification include:

The **Ministry of Water Resources (MOWR)**: The MOWR largely controls the electricity sector, playing several key roles. MOWR is responsible for framing the legislation that is considered by Cabinet and parliament. It also has regulatory oversight for power generation, transmission and distribution. Under the Electricity Act, operating licenses for NEA and private entities are approved by MOWR, through its **Department of Electricity Development**.

The **Department of Electricity Development (DOED)**, established under the Electricity Act of 1992 as the Electricity Development Center, was upgraded to department level in 2000. It has a three-part mandate:

- *Regulating the Electricity Industry*: DOED provides the operational capacity for HMGN to implement economic, technical and safety regulations for the power industry – both public and private companies and entities;

- *Promoting and Facilitating Private Power Development*: DOED develops programs and approaches to solicit private investment for generation, transmission and distribution; to act as a "one-stop window" for private investors to develop and operate power supply facilities;

- *Technical Support to MOWR*: DOED undertakes national level power planning activities, such as basin studies and inventories of potential hydro projects; project-specific investigations, surveys and studies for multi-purpose projects; and provision of technical backup to MOWR for bilateral and multilateral talks and negotiations on technical matters, agreements, and financing arrangements.

Under the Tenth Plan, DOED will continue to be developed mainly as a research and promotion institute, identifying and establishing the feasibility of multipurpose projects in order to attract and encourage private sector investment.

The **Tariff Fixation Commission (TFC)** was also established under the Electricity Act of 1992, primarily to review and approve retail electricity tariff structures. At least five persons drawn from the government sector and professional community serve on the Commission. Currently there is a full-time Commissioner and a technical assistant, and, as a temporary measure, DOED is providing technical support. The Commission can draw upon professional accountants, economists and tariff analysts as needed. As prescribed by the Electricity Act, NEA is required to apply to the TFC for tariff increases. The TFC reviews the application and has sole authority for deciding the tariff levels, balancing the commercial and financial viability of NEA with social considerations.

Nepal Electricity Authority (NEA): NEA was established in August 1985 by merging various small electricity entities existing at that time. A state-owned enterprise, NEA's mission is "to provide accessible and reliable electricity to consumers at a reasonable price." As the national power utility, NEA develops and operates generation, transmission, and distribution systems. Its principal roles include:

- **System planning**: NEA is responsible for the planning required to meet fluctuating and growing demands throughout its service area; it must also determine the amount and timing of power required from independent generation to complement its own power plants.

- **Power purchaser**: NEA negotiates and enters into Power Purchase Agreements (PPAs) with private producers, and can also enter into supply agreements with independent transmission and distribution companies.

- **Integrated grid maintenance and development:** NEA is responsible for operating, maintaining, and developing the national transmission grid.

- **Scheduling and Dispatch**: NEA maintains the control center for the national grid, which must integrate the scheduling and dispatching from private producers as well as NEA's own stations.

NEA is expected to remain the dominant player in development of hydropower and other power generation, as well as in transmission, wheeling of power, and in distribution and sale of electricity. NEA's viability is central to the successful evolution of Nepal's power sector.

Historically, NEA has relied on concessionary financing from multilateral and bilateral sources, or lending from HMGN at commercial rates. These governmental and donor sources require long lead times for planning, approval, and processing. Delays in obtaining public sector financing have affected NEA's efforts to promote private power development. For example, NEA's ability to arrange timely construction of transmission and connections has been a concern in several of its PPA agreements.

Alternative Energy Promotion Center (AEPC): AEPC is a semi-autonomous body under the Ministry of Science and Technology (MOST). Its mandate is to popularize and promote the use of renewable energy technology to raise living standards of rural people, protect the environment, and develop commercially viable alternative energy industries. Although established in 1996, the Alternative Energy Promotion Center (AEPC) did not begin formal operations until 1999, so it is still a very young agency.

An Interim Rural Energy Fund (IREF) became operational under AEPC in April 2001, with primary support from the Danish International Development Agency (DANIDA). IREF provides subsidies to renewable energy projects in rural areas in accord with standard subsidy levels set by AEPC. In a little more than a year, IREF has disbursed NPR 75.1 million (approximately US$1 million) to support more than a thousand solar home systems. Another NPR 23 million (US$ 290,0000) has been disbursed in support of micro-hydro projects.

Under the Tenth Plan, IREF would be converted into an on-going Rural Energy Fund that would be able to channel funds from various donor agencies and government sources.

AEPC is not designed to implement projects directly, but rather to work through local government entities, particularly, District Development Committees (DDCs) and District Village Committees (DVCs), donors, and NGOs. It designs, monitors, and evaluates projects for rural micro- and mini-hydropower, solar, biogas, wind, and improved cooking stoves.

Ministry of Local Government and Local Bodies

The **Ministry of Local Development (MLD)** has undergone a number of organizational changes since its origin as a department under the Home and Panchayat Ministry in 1971. It has been in roughly its present form since 1990. The basic objective of the Ministry is to promote and strengthen decentralization of governance, building capacity of local bodies, and facilitating poverty alleviation and economic development programs at the local level. Responsibilities include:

- Formulation, implementation and monitoring of policy and programs on Remote Area Development, integrated rural development, and Local Governance;
- Policy formulation, program implementation and monitoring of programs relating to decentralization;
- Demarcation and mapping of VDCs, municipalities and districts;
- Coordination and support of local development programs;
- Local human resource development and mobilization of peoples' participation;
- Coordination of international support to local governance and development;
- Local infrastructure including agricultural roads, rural drinking water and sanitation;
- Management of solid waste;
- Appropriate technology development at the local level;
- Works related to deprived, disadvantaged and ethnic groups; and
- Liaison and coordination among local bodies.

All of these responsibilities are central to the success of the Tenth Plan, and MLD will play a key role in implementing and coordinating many of the Plan's programs.

2.4 Private Sector Participation in Rural Electrification and Rural Energy

The government's ability to develop rural energy services is constrained by financial and economic factors, as well as physical realities. As already noted, Nepal's mountainous terrain and dispersed population make conventional grid-based electrification very expensive. Off-grid and on-site generation from renewable sources are also costly, at least in their up-front investment costs. On the demand side, the combination of low incomes and low energy use by rural people generally does not even recover the full operating costs, let alone pay the capital costs of conventional electrification infrastructure. As a result, rural electrification programs throughout Nepal have generally proven to be financially unsustainable. Substantial

subsidies have usually been needed to construct, operate and manage rural electric supply systems.

In Nepal as in other countries, the private sector faces the same physical and many of the same financial and economic challenges that government programs do. But companies and entrepreneurs often have more flexibility in dealing with these challenges.

Private sector participation is encouraged and supported under the Electricity Act of 1992. The Department of Electricity Development (DOED) has responsibility for promoting private sector investment, and has shown considerable success, especially on medium and larger scale hydroelectric projects. Currently, private companies provide some 115 MW of the nation's total 527.5 MW of grid-based production capacity.

Private companies have an even larger role in off-grid rural electrification with small-scale hydropower development, as well as in solar electric, wind, or biogas systems. In Nepal, small hydropower plants are those from 1-10 MW. Mini-hydro is generally considered to range from 100 kW - 1 MW, and micro-hydro at less than 100 kW.

The government's 2001/02 budget made private investment in small- and medium-hydropower projects high priority, arranging a fund of NPR 100 million (US$ 1.3 million) from commercial banks for the purpose. There are also a number of fiscal and administrative incentives in place for mini- and micro-hydro development:

- no licenses are required to conduct surveys or to build and operate the plants;
- no royalty is imposed on the electricity generated;
- income tax is exempted;
- the private producer itself may set the selling price for its electricity; and
- where a licensee plans to distribute electricity in an area where a plant smaller than 1000 kW is already operating, the licensee is obliged to offer to purchase the existing plant and distribution system.

Other promotional efforts for private sector involvement in rural electrification include:

- The Water and Energy Commission Secretariat (WECS), under the Ministry of Water Resources, has prepared an inventory of approximately 200 potential sites for mini-hydro development. This inventory identifies the 10-15 most viable micro-hydro power sites in each of 63 districts.
- The Remote Area Development Committee (RADC) has initiated an "Integrated Rural Community Development through Village Electrification Program" at selected sites in districts at or near the border with Tibet.

As already noted, the Alternative Energy Promotion Center (AEPC) was established recently under the Ministry of Science and Technology to promote development and monitor activities within the alternative energy sector, including micro hydropower.

Total installed capacity of micro-hydro power in Nepal is currently about 4,600 kW.[12] This includes nearly 950 micro hydro installations owned and operated by the private sector, located in 59 out of 75 districts of the country. In addition there are an estimated 5 MW of micro-hydro units serving 100,000 rural households. These are used primarily to grind grain, but some 170 of these (20 percent) have add-on electricity generation for domestic lighting.[13] Another 120 (13 percent) are dedicated community electric generating systems.

Some 38,000 household photovoltaic systems (typically 36/60 peak watt capacity) are in operations. More than two thirds of these have been installed within the last five years. While promoted under the UNDP Rural Energy Development Program, other donor projects, and now facilitated by the Alternative Energy Promotion Center (AEPC), most of these systems have been supplied installed by private companies

Another area in which the domestic private sector has become active is in construction of small-scale biogas digesters. Families need at least two cattle to supply sufficient manure, with home-scale plants costing NPR 20-25,000 (about US$ 300). Most digesters in use today have drawn upon German and Dutch bilateral assistance funds and HMGN subsidies, which typically cover about a third of the cost. Some 44 private companies are certified to construct plants. The plants have high reliability with nearly 98 percent of them reportedly working well after three years of operation. Biogas provides substantial benefits to the users from reduced indoor air pollution, reduction in firewood collection and cooking times for women, and improved sanitation and hygiene to the 45 percent of plant owners who build toilets alongside and attach them to the biogas plant. By the end of 2001, some 100,000 families in Nepal were using biogas for cooking, with around a quarter of the users also using it for lighting. An additional 24,000 families were expected to purchase digesters during 2002.

2.4 User Associations

In the last decade, HMGN began to limit its role in implementing development, and instead concentrate on facilitating, monitoring, and regulating functions. Local government, the private business sector, and civil society -- through not-for-profit non-governmental organizations (NGOs) and community-based organizations (CBOs) -- are expected to provide services that historically were provided by the central government. This approach will be continued and strengthened further under the Tenth Plan. The Tenth Plan aims specifically to promote the role of community user groups and cooperative associations in rural electrification and energy services.

In 1994, as a condition for a rural electrification concessional loan, NEA established the Lamjung Electricity Users' Association. The Association functions much as a cooperative,

[12] Surendra Lal Shrestha, "Micro Hydropower for Rural Development in Nepal: History, Policy, Program and Performance," *VIKAS*, Vol. 21, No.2 January 2002, National Planning Commission, Kathmandu.

[13] Center for Energy Studies (CES) 2000a. Renewable Energy Perspective Plan of Nepal, 2000-2020. An Approach Government Enabled Market and People Based Renewable Energy Development (GEMP-RED). Volume 1, Main Report. Submitted to Alternative Energy Promotion Center (AEPC), Kathmandu, Nepal (CES, 2000).

and currently serves 6,300 rural consumers. More recently, the South Lalitpur Electric Cooperative Ltd. was formed. It is expected to start supplying electricity early in 2003. Also, the Danish International Development Agency (DANIDA) is funding the formation of up to 16 rural electric cooperatives in the Kanchanpur and Kailali districts in southwestern Nepal.

The Lamjung Electricity Association leases an 11 kV distribution line from NEA, but does not have a distribution license. It initially provided service to 26 villages (3,500 consumers), but has been able to expand to 40 villages (6,100 consumers). All of the Association's consumers (members) are metered.

The Lamjung Electricity Association primarily operates the business side of rural electricity distribution and depends heavily on NEA for technical support for maintenance and extension of its distribution system. It has proved to be effective in meter reading, consumer billing and collections, and promoting new connections. It reportedly collects 99 percent of its billings, which is considerably higher than NEA in its rural service areas. The Association has organized its members into 46 sub-units based on Transformer Committees. This has provided transparency as to who is paying their electricity bills and who is not. The use of Transformer Committees and sound billing practices are significant factors in the Association's success in billing collection.

The Association is free to set the tariffs it charges its customers, so long as its rates do not exceed the national retail tariffs charged by NEA. The bulk electricity supply tariff that NEA charges the association is set by the TFC and is currently NPR 2.69/kWh. The Association's current weighted average electricity retail tariff is NPR 5.77/kWh. This allows the Association to operate with a positive operating margin -- total revenues exceeding total costs including lease payments to NEA -- and reportedly it has accumulated significant cash reserves.

The South Lalitpur Electric Cooperative Ltd was registered in 1999 under the Nepal Cooperative Societies Act. This is Nepal's first co-operative society for electricity supply. NEA is currently constructing the distribution system for the cooperative and was to hand it over in mid 2002. This will likely take the form of a lease similar to that used for the Lamjung Electricity Association. The Cooperative will depend on NEA for technical services, and NEA will be the main regulator of the Cooperative.

Initially, the South Lalitpur Electric Cooperative plans to serve 10,000 households plus about 800 other consumers located in 200 villages. As in Lamjung, the local Cooperative's tariff cannot exceed NEA's retail rates.

Through implementing both the Lamjung Electricity Association and the South Lalitpur Electric Cooperative, NEA has demonstrated its willingness to consider approaches to rural electricity supply in addition to direct operation. It is considering similar approaches for the isolated small electricity grids it currently owns. Support for such alternative approaches to rural electricity distribution is being provided by DANIDA, which, is planning to fund up to 16 rural electric cooperatives in the Kanchanpur and Kailali districts in southwestern Nepal.

2.5 Donor Programs

2.5.1 UNDP: Rural Energy Development Program (REDP)

Of all the donor-assisted efforts to improve Nepal's rural energy situation, the most comprehensive, and probably the most successful to date, has been the United Nations Development Program's (UNDP's) Rural Energy Development Program (REDP). REDP has taken a holistic approach to decentralized energy and rural development. It encompasses (i) energy development, (ii) social capital building, (iii) environmental management, and (iv) income generation.

REDP works at the national level on policy matters, at the district level for planning and managing energy activities, and at the community level to plan, implement, and maintain energy systems. At the District level, a Rural Energy Development Section (REDS) is established under each participating District Development Committee (DDC). The REDs are the authorized local bodies for energy planning, information dissemination, provision of technical assistance, and creating linkages between the DDC, NGOs, and private companies. In each district in which it is active, the REDP has also established a District Energy Fund (DEF). The DEF is made up of financial contributions from the DDC, donor funds including UNDP assistance, grants, and the returns from investments in rural energy projects.

Local NGOs are supported to provide community mobilization services, and the private sector is engaged to develop and backstop renewable energy technologies. The approach emphasizes community mobilization, human resources development, institutional development, natural resources management, and sustainable rural energy development. Each micro-hydropower scheme is owned and operated by a village level Community Organization.

Another feature of REDP at the district level is establishment of a Rural Energy Service Center (RESC). In the past, the distance from villages to competent technicians and replacement parts has been a major problem for micro-hydropower schemes. Establishment of the RESCs has reduced the downtime of micro-hydro generators. The RESCs have been in demand in adjoining districts as well.

Begun in 1996, the REDP was initially implemented in the five districts of Baitadi, Dadeldhura, Baglung, Tanahun, and Kavre. The program has now been extended to 15 districts, and a second phase, scheduled to begin in early-2003 with World Bank support, is expected to extend to an additional 10 districts. As of 31 March 2001, tangible accomplishments of the first five years of the program included[14]:

- **Regional Governance**: In all 15 program districts, the District Energy Committees have established a Rural Energy Development Section, together with a District Energy Fund and a Decentralized Energy Planning Process.

[14] REDP, Annual Report, 2001. http://www.redp.org.np/annual/annual2001.html

- **Power and Energy Generation:** 76 Micro-Hydro Demonstration Schemes and peltric-sets generating a total of 1,100 kW electricity have been commissioned, benefiting 9,494 households; 1,231 individual solar home systems are operating; 1,252 toilet-attached biogas plants are operational, and 5,700 Improved Cooking Stoves (ICS) have been put into use; each of these ICS is estimated to save 2-3 hours daily of women's time previously needed for collecting fuelwood. Also, 13 Rural Energy Service Centers have been established to provide technical support in the field.

- **Forestry/woodlots**: 92 nurseries, each able to produce 16,000 saplings annually, have been established; 1.2 million saplings have been planted on more than 750 ha of degraded land; and 181 community forests have been handed over to community control.

- **Village Capacity**: More than 27,000 women and 26,000 men from some 28,000 households have been organized in 2,626 community organizations; and more than 6,000 women have participated in various training activities.

- **Capital Mobilization**: Nearly NPR 15 million (more than $175,000) has been saved and NPR 29 million ($350,000) has been invested by women, mainly for income-generating activities.

REDP has demonstrated that holistic rural energy development is effective in establishing broad-based increases in productivity, welfare, and environmental restoration at the community level in Nepal. The success of REDP has been recognized internationally, with the program receiving several best practice awards, including a prestigious Energy Globe Award in 2000.

2.5.2 DANIDA: Energy Sector Assistance Program (ESAP)

The Danish International Development Agency (DANIDA) is providing significant technical and financial support to the Alternative Energy Promotion Center (AEPC) through its Energy Sector Assistance Program (ESAP). The ESAP is a long-term commitment, expected by DANIDA to last 10 to 15 years. There are six components:

(1) Assistance to AEPC "to create a strong national capacity for supporting and coordinating public, NGO, and commercial initiatives for making high performance and environmentally friendly sources of energy supply accessible to the rural population." The 1998-2002 budget for this component equaled $1.2 million. In addition, a full-time, resident ESAP Coordinator was provided. (His services were completed in February 2003.)

(2) General Program Support, budgeted at $0.9 million to support the ESAP Program Office and general consultancy services.

(3) Financial Assistance to Rural Energy Investments, "to reinforce the mobilization of finance for rural energy investments and programs" with initial emphasis on financing household Solar Photovoltaic (SPV) systems, micro-hydro projects, and rural grid extension. DANIDA would like to see the associated Interim Rural Energy Fund become

the main funding source for all official and NGO financing of rural energy projects. The 1998-2002 budget for this component was $15 million.

(4) Micro-Hydro Component, "to define a coherent framework and suitable concepts for a cost-effective, technically and socially appropriate development of isolated rural electrification schemes that makes use of micro-hydro plants." This component is to build on the decentralized, local involvement approach developed by REDP. The 1998-2002 component budget was $1.7 million.

(5) Solar Energy Component, "to bring the service of electricity to off-grid households and to community and other public buildings by means of environmentally benign SHS (Solar Household Systems) and to develop a commercial sustainable situation for SHS dissemination in Nepal within five years." The 1998-2002 component budget was $2 million. The target installation of SPV systems under the component was 27,000 systems over the four-year period.

(6) Improved Cooking Stoves Component with a 1998-2002 budget of $1.1 million.

ESAP has worked closely with the REDP, working in different districts and applying many of the same program components and techniques.

2.5.3 World Bank

Building on a long history of support to Nepal's power sector, in March 2003 the World Bank expects to complete negotiations with HMGN on a US$ 75 million Nepal Power Development Project.[15] The objectives of the project are to: (a) develop Nepal's hydropower potential in an environmentally and socially sustainable manner so as to meet domestic electricity demand and to export power to India, when feasible; (b) improve access in rural areas to electricity services; and (c) promote private participation in the power sector as a way to improve power sector efficiency, as well as to mobilize financing for the sector's investment requirements. The project would consist of three components:

(i) establishment of a Power Development Fund and a technical assistance package for fund administration;
(ii) support for small micro-hydro schemes for rural village electrification; and
(iii) improvements in NEA's grid transmission and distribution facilities, including technical assistance towards upgrading planning and financial management systems and preparations for restructuring.

The Power Development Fund would be administered on behalf of HMGN by a competitively selected domestic commercial bank. The micro-hydro village electrification component would build on the successes achieved under the UNDP-financed Rural Energy Development Program (REDP), allowing REDP to replicate its approach in an additional ten districts, reaching about 30,000 new consumers. Work with NEA would have several aspects: improving several key transmission lines, expanding rural electrification, and strategic

[15] World Bank Operational Summary, February 2003.

business planning and process improvements leading to restructuring.

2.5.4 USAID

Since 1992, USAID has worked to improve the enabling environment for private investment in Nepal's energy sector. From 1998-2001, USAID conducted a three-year, $5 million program to encourage private sector participation and investment in environmentally and socially sound hydropower development. Over $300 million in new private sector investments in hydropower projects has been attributed to this program. USAID continues to stimulate and leverage both multilateral and bilateral donor efforts to increase capacity in the hydropower sector through a follow-on project. "Increased Private Sector Participation in Environmentally and Socially Sustainable Hydropower Development." which will run through 2005.

This new project is being closely coordinated with the World Bank, other donors, and the Government of Nepal (GON) in regard the planned Power Development Fund (PDF) – as described in the section on World Bank activities above. USAID is assisting HMGN to prepare the implementation guidelines for the PDF, and is strengthening DOED's capacity to conduct survey and feasibility studies, as well as to fulfill national environmental and social assessment requirements for hydropower projects.

In addition, USAID is supporting regional efforts to collaborate on sustainable development of clean energy through the SARI/Energy Project.

Section 3 Best Practices and Promising Innovations

If progress in extending and improving rural energy services in Nepal is to be accelerated, a comprehensive strategy, commitment of resources, and persistent campaign – to last two decades or more – are all needed. Regulations need to be adjusted, investment funding must be mobilized, village-level cooperation and leadership must be developed, and technologies and institutions need to be adapted to the everyday realities of remote applications. In doing this, there are successes as well as failures from past and current efforts in Nepal to learn and build from, as well as valuable experience from neighboring SARI/Energy countries, and also from the US and other countries.

There is no single "magic pill" formula. The strategic campaign outlined in Section 4 is drawn from several general Best Practice approaches as well as several Promising Innovations. "Best Practices," as used here, are strategies, tactics, and technologies that have already proven themselves in multiple situations that are relevant to the challenges faced in Nepal. Similarly, "Promising Innovations" are strategies, tactics, and technologies that may not yet be widely practiced, but that show genuine promise based on pilot applications in Nepal itself or under similar conditions elsewhere.

Drawing from the SARI/Energy survey of Best Practices for rural electrification within the SARI/Energy member countries,[16] two programs from Bangladesh appear to provide specific experience that could be adapted usefully in Nepal. The first of these is the notable success in extending the national grid that has been achieved by local electricity distribution cooperatives under the Rural Electricity Board (REB). A second model, addressing off-grid rural energy delivery, is the Grameen Shakti's support to solar photovoltaic systems, also in Bangladesh.

These two Bangladeshi successes are described in the Best Practice summaries presented below. Also included are two Best Practice strategies drawn from US experience – the Rural Electrification Administration (REA) and national rural electric cooperative movement, and the National Co-operative Extension Service. These programs began 70-plus years ago, and are still evolving success stories. They provide basic models that have been studied and adapted throughout the world. From Nepal itself, UNDP's Rural Energy Development Program (REDP) is an internationally respected Best Practice that can serve as a rich source of experience for design of future national programs. REDP has already been described in Section 2 of this report. In addition, two Promising Innovations – both technologies that have been pioneered in Nepal – are included here. Each of the practices and innovations included here offers constructive lessons that help define the "road map" for future efforts in Nepal.

[16] Lalith Gunaratne, *Rural Energy Services Best Practices*, Nexant SARI/Energy Program, www.sari-energy.org, May 2002.

3.1 The Bangladesh Electrification Program – an Apex Agency

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

– Constitution of the People's Republic of Bangladesh, 1972

In 1976, less than 2 percent of Bangladesh's rural population had access to electricity. In that year, a national Rural Electrification Master Plan was prepared for the government by the US National Rural Electric Cooperative Association (NRECA). The next year, in 1977, the recommendations of the Master Plan were enacted in legislation that established the Bangladesh Rural Electrification Board (REB). USAID provided $75 million for initial development of the REB, with NRECA providing technical assistance

The Rural Electrification Board (REB) is not a utility itself. It is a semi-autonomous apex agency, responsible for promoting and supporting rural electrification nationwide.

Despite considerable skepticism about potential economic demand for electricity in rural areas, and whether rural people would be capable of managing their own services, REB chose to work through partnerships with local communities where people were willing to organize themselves into member-owned cooperatives. These rural electric societies, known Palli Bidyut Samities (PBS), were seen as a means to involve consumers directly in the decision-making process and creating the nationwide grassroots-level infrastructure needed to establish and maintain rural electric services. REB serves as an apex agency, facilitating, supporting, and mentoring the PBSs.

PBSs operate as not-for-profit organizations. Each PBS is organized on an area approach, covering 4 to 6 Thanas (sub-districts). The REB finds suitable local residents to serve on a voluntary board of directors; this board is the basic link between the community and the REB. The REB then invests in establishing the PBS utility with the necessary transformers and the transmission and distribution lines to link up member customers. The customer is recognized as the most important stakeholder in the process.

The first PBS was organized near Dhaka in 1978, and began providing power in June 1980. Today, two decades later, PBSs operate in more than half of Bangladesh's 68,000 villages, supplying power to nearly 4 million people,

The program is now in its fifth and final phase of the original Master Plan. More than 1,000 new connections and 25 miles of distribution lines are being added daily. However, with only about 20 percent of the people having access to electricity, it is clearly recognized that there is much still to be done.

The success of REB's approach can be judged by the fact that the PBSs have low distribution losses (13-14 percent), no reported thefts of electricity, and 98 percent billing collections. Very importantly, there is a strict system of checks and balances on procurement, and there is no apparent corruption in the system. In general, the REB has also been able to avoid political influences; it has remained non-partisan, and has been favorably recognized by all political parties.

The development of each PBS is controlled by REB. REB provides both the operating procedures and the funding to establish and operate the PBSs. Discipline is instilled into the process through comprehensive training in management, rules, and regulations. REB also hires the executive management of each PBS and has the power to terminate their employment, with PBS board approval, for non-performance. Each PBS has an annual Performance Target Agreement, based on criteria such as increasing revenue, decreasing system losses, and increasing number of connections.

Some of the key factors that continue to contribute to the Program's success.

- Engineering and construction standards are used for the development of the system.
- There are standard specifications for equipment and materials used in the Program.
- A system has been established for developing and monitoring the PBSs, providing "checks and balances" to ensure proper performance. REB negotiates performance target agreements (PTAs) with each PBS and works with the PBSs in the implementation of these agreements.
- The Cooperative model has promoted local involvement of the people who are the beneficiaries of the program. This is done through member ownership in the PBS and participation in the election of the PBS Board of Directors.
- The decisions taken at REB and the PBSs are in accordance with approved Policies and Procedures that have been established for all activities (i.e., engineering, accounting, PBS management, etc.) within the Program.
- The system is built on a priority basis and distribution lines that do not fulfill the revenue requirements are not included for construction.
- The PBSs are responsible for their day-to-day operations, but REB monitors their activities (i.e., management, system operations, commercial practices, etc.) to ensure that accepted levels of performance are maintained.
- In order to prevent unnecessary staffing at the PBSs and additional operational costs, there are established rates of growth that must be met by a PBS before any additional staff can be added to assist with a particular function.
- "System loss" is one of the primary indicators of the PBS performance. A careful watch is kept on system loss and it is maintained at reasonable levels.
- There is strong emphasis on training. The REB Training Directorate offers programs to all levels of PBS personnel.

- The RE Program has carefully maintained its non-political in nature. The national effort to electrify the rural areas has been supported by all political parties. Provisions within the PBS Bye-Laws keep the local political parties from becoming overly involved.

Of the 67 PBSs in the REB system, 19 are already operating with full cost recovery, and another 8-10 are nearing financial viability. As the customer base grows and additional commercial and industrial entities join the grid, more PBSs are expected to break even. Surpluses in revenue are either returned to the members, or may be used for direct benefit of the members. For example, one of the first of the PBSs to generate an operating surplus has purchased several ambulances for use of its membership.

REB manages all international donor assistance to Bangladesh for rural electrification. Over the past 24 years, REB has been able to draw upon more than $1.1 billion in financing from some 17 donors and the government. More than $200 million has been invested by USAID alone. The National Rural Electric Cooperative Association (NRECA), which prepared the initial design study that created the program, appears to have sustained a highly successful advisory partnership with REB that continues today.

3.2 Grameen Shakti (GS), Bangladesh

The Grameen Bank also began in 1976; its purpose was to provide small loans to the poor to start their own businesses. Over the years, twenty non-profit and for-profit institutions have evolved under the "Grameen Family of Companies." Many business opportunities in rural areas were hindered by lack of available energy, so Grameen Shakti (GS), or "Rural Energy," was established in 1996 as a not-for-profit company to develop and popularize locally available renewable energy resources. Its objectives are:

- to popularize and deliver renewable energy to isolated and far-from-grid rural households;
- to market solar, biogas, and wind energy on a commercial basis, focusing on rural areas, particularly on the clientele of Grameen Bank;
- to provide services that alleviate poverty and protect the environment through applied research and development of renewable energy based technologies;
- to undertake projects to progressively manufacture and market efficient and affordable household-based photovoltaic systems;
- to implement projects to generate electricity from wind in coastal areas and offshore islands; operate mini and micro hydro-plants in the hilly areas;
- to develop and implement special credit, savings, and investment programs for generation, storage, and utilization of renewable energy for benefit of rural people;
- to test new and appropriate technologies to provide more cost effective energy services at affordable price in non-electrified areas; and
- to provide capital, technology and management services to energy enterprises, including individuals, communities, businesses, non-government organizations (NGOs), and private voluntary organizations (PVOs) that promote, produce and finance enterprises based on renewable energy sources.

Grameen Shakti encourages entrepreneurs to apply PV systems for generation of income. Some of the first uses were for charging cellular phones, which had become good opportunities for village entrepreneurs. Other examples of PV systems applied for income generation include:

- lighting for rice mills, saw mills;
- lighting restaurants, bazaars, and for small shops, such as groceries and tailors;
- lighting for poultry farms; and
- power for radio/TV repairing shops, and for battery recharging.

In addition to its core program of household photovoltaic systems, GS is working with wind and biogas systems. It is also committed to promoting rural information and communication technology, including establishment of solar-powered computer education centers.

There are now more than 40 branches, many located in remote areas. Most branch offices consist of an engineer and a technician, who market and service the systems. The engineers visit the customers each month to collect payments, check the systems, and take corrective measures if needed. Each system has a "Maintenance Card" to record problems and repairs.. Technicians regularly participate in these maintenance calls. Customers are given orientation training on minor maintenance issues. Engineers and technicians also train local technicians who are expected to gradually take over the maintenance of PV systems. Some 300 local technicians have been trained to date. Customers also are trained on minor maintenance of their systems.

As of June 2002, Grameen Shakti had installed 9,118 Solar Home Systems (SHS) with installed capacity of 455,953 kWp.17 A typical solar PV system of 34 kWp costs Taka 17000 (US$ 285). More than 300 new systems are being installed month.

Two credit options are offered for those who want to buy the system on credit. Customers may choose to make a 15 percent down payment, with the remaining 85 payable within 36 months at a 12 service charge. Alternatively, they may pay 25 percent up front, with the remaining 75 percent due over 24 months with 8 percent service charge. If they choose to pay in full at time of purchase, they receive a 4 percent cash discount. The solar panels are guaranteed for 20 years, and GS provides free maintenance work for the first year.

A 25-watt solar energy system costing Tk 12,000 (US$ 220) can generate power for two six-watt bulbs to operate four hours daily. A 120-watt system at a cost of Tk 55,000 (US$ 920) generates enough power to light 10 six-watt bulbs and operate a 20 inch black and white television.

Grameen Shakti won the "Energy Globe" award for 2002.

[17] http://shakti.hypermart.net/renewables/

3.3 Solar Home Systems (SHS) and Village Hydro (VH) in Sri Lanka

The Sri Lanka Energy Services Delivery (ESD) Project began in 1997 with assistance from the World Bank and Global Environment Facility (GEF).[18] By June 2002, ESD had supported installation of:

- 18,600 solar home systems (SHS) with a total capacity of 875kW,
- 56 off-grid Village Hydro (VH) projects having an aggregate capacity of 574 kW benefiting 2,900 homes, and
- 15 grid-connected mini hydro projects generating a total of 31 MW.

Building on this success, the Renewable Energy for Rural Economic Development (RERED) Project was launched in July 2002. RERED aims to provide electricity access to an additional 100,000 remote households and 1,000 rural small and medium enterprises and public institutions, through off-grid community based and household based projects. It will also support construction of an additional 85 MW of small hydroelectric generation for the national grid.

Both projects have taken a demand-driven, market-based approach. The projects have helped to strengthen technical and marketing capacity, and have provided the funds for credit programs. An administrative unit was set up with the DFCC Bank, and funds have been disbursed through 'Participating Credit Institutions' (PCIs). These have included:

- DFCC Bank,
- National Development Bank,
- Hatton National Bank,
- Sampath Bank,
- Commercial Bank, and
- Sarvodaya Economic Enterprises Development Services (SEEDS).

In order to generate awareness, the ESD Project supported a campaign to promote SHS and VH schemes. The promotion targeted end-users, government authorities, community based organizations (CBOs), commercial funding institutions, and the general public. It educated end-users on the advantages and limitations of SHS and VH power, informed them about service and warranty arrangements and about available loan schemes. A variety of communication channels were used, including village workshops. SHS dealers were encouraged to participate in the village workshops to demonstrate their products. The project also sought to strengthen two Sri Lankan professional associations, the Solar Industries Association and the Energy Forum. These groups also provided useful feedback.

Consumer acceptance of SHS made a leap with the entry of Shell Renewables into the local market. SHS gained a second boost when a local provincial council linked its rural electrification program to the market-based ESD Project. These two events, coupled with the

[18] This section draws extensively on: Jayantha Nagendran, Sri Lanka Energy Services Delivery Project Credit Program: A Case Study. Report to Global Environment Facility, May 2001: ttp://www.gefweb.org/ResultsandImpact/ Experience_and_Lessons/GEF_Sri_Lanka_case.pdf

involvement of the local financial institutions into the ESD Credit Program, were probably the critical success factors in the take-off of SHS in Sri Lanka.

Unlike SHS, the off-grid VH industry still lacks strong commercial interests or organizational clout. The Administrative Unit of the ESD Project is working towards institutionalizing VH (and SHS) electrification options within the planning frameworks of provincial councils. In contrast, the grid-connected small power developers, who receive no financial assistance under the ESD Project, have an active association, and are already able to influence government policy effectively.

Another important aspect of the ESD Credit Program is that it ensures compliance with technical specifications for off-grid VH schemes and SHS. These standards can be reviewed occasionally, and be adjusted in accord with experience, innovations, and local market developments. But the standards ensure quality, safety and longevity and thus reduce commercial risks. GEF funds are available to financiers to verify that VH and SHS designs meet specifications. Grant funds are also available for investigating and resolving consumer complaints against vendors. No major SHS customer complaints have arisen, but one early VH scheme needed rectification work following a verification inspection. The SHS component of the ESD Credit Program was delayed for a year to allow dealers to source technically certified products. Testing of local batteries for SHS took even more time and a moratorium had to be declared on battery specifications for nearly another year. But the benefits to stakeholder confidence, as well as to quality and sustainability of the program, has been considered well worth the delays. It is generally agreed that the market for SHS in Sri Lanka is now well established, and that VH is also ready to play a significant role in rural electrification and energy services.

3.4 US Experience – Basic Strategic Approaches

In 1935 virtually 100 percent of US urban residents had electricity, while less than 11 percent of the US rural population had access. Despite numerous incentives, privately owned utilities refused to invest in rural electricity supply. By the early 1970s, however, about 98 percent of all farms in the United States were connected to the grid. This accomplishment, more than any other one factor, helped to change the face of rural life and agricultural productivity in the US, and to reduce what had been growing economic and cultural gaps between rural and urban life.

Rural electrification – and all of agricultural and rural development – in the US has evolved through a series of public-private partnerships between national and local government agencies, the private sector, and universities. Foremost among these are the funding and support partnerships established and maintained through REA/RUS.

3.4.1 The Rural Electrification Administration/Rural Utilities Service and Rural Electric Cooperatives

The Rural Electrification Administration (REA) was created as an independent federal bureau in 1935 by executive order of President Franklin D. Roosevelt. It was authorized by Congress in 1936, and in 1939 was reorganized as a division of the U.S. Department of Agriculture (USDA). The REA was established to provide farmers with inexpensive electric lighting and power. To do this, REA made long-term loans to state and local governments, to farmers' cooperatives, and to nonprofit organizations, including rural cooperatives. Rural electric cooperatives – local organizations founded, owned, and operated by their member farmers and rural communities – became the REA's largest group of clients, and the major factor in successful implementation, maintenance, and growth of rural electrification throughout the US.

In 1949 the REA was also authorized to make loans for telephone improvements, and in 1988, it was permitted to give interest-free loans for job creation and rural electric systems. In 1994, the REA was integrated into USDA's new **Rural Utilities Service (RUS)**, which continues to support improvements in rural electrification, and also for telecommunications, water supply, sewage treatment, and solid waste management. New services include distance learning and telemedicine.

The RUS Electric Program continues to make insured loans and loan guarantees to nonprofit and cooperative associations, public bodies, and utilities. Insured loans finance the construction of facilities for electric power distribution. The guaranteed loan program has been expanded and is now available to finance generation, transmission, and distribution facilities in rural areas.

Since the REA's inception, field staff have provided outreach. The RUS continues to maintain general field representatives (GFR) stationed around the country. The GFRs meet regularly with borrowers to assist in development of loan projects and provide assistance as requested. RUS field accountants also provide specialized accounting advice to borrowers as needed.

RUS also maintains close contact with industry trade associations such as the National Rural Electric Cooperative Association (NRECA). NRECA is a national organization representing the common interests of its members, which are mainly cooperative electric utilities. It was founded in 1942, to support the rural electric cooperative movement that had emerged in response to the Rural Electrification Administration's support. As a national association, NRECA was able to help local cooperatives to work together to overcome shortages of construction materials during World War II, to obtain insurance coverage, and to mitigate problems of wholesale power purchasing. Today, NRECA has nearly 1,000 members, providing electricity to 35 million people in 46 states. NRECA has been a strong advocate for consumer-owned cooperatives as well as rural community and economic development. Its members operate more miles of electric lines than the combined total of all other electric utilities in the country.

3.4.2 Cooperative Extension Services

The roots of Cooperative Extension predate the REA by nearly 70 years. The federal government began cooperating with states to promote scientifically based agricultural and rural development well over a century ago. Since 1862, each US state has had one or more leading educational institutions designated as a "land-grant" college or university, eligible for federal support to teach and research agricultural and mechanical arts as well as academic studies. In 1887, a new national program supported each state to establish an agricultural experiment station program in association with its land-grant institution.

In 1914, a third legislative act established federal-state cooperative agricultural extension services. In these partnerships, the US Department of Agriculture worked with the land-grant institutions to bring the results of scientific research and knowledge to farmers and rural residents. These programs continue today, funded under a formula based on the number of small farmers in each state, and with co-funding from the state governments. Much of the grassroots work is done at the county[19] level, with county extension agents acting as local nodes for information, expert advice, and feedback to the state and federal partners.

Cooperative extension services vary from state to state, but generally include information and advice on every aspect of farm and rural life, from improved crops and farming techniques, market information, and credit advice, to improved family nutrition and home health care.

Over the years a number of states have incorporated concentrations on energy, notably for renewable energy technologies, innovative uses, and energy efficiency information. Several states have created distinct energy branches, or energy extension services. Like agricultural extension services, these agencies work at the county level through specialists who can provide information and conduct educational programs. Increasingly, they are working with the industrial or business sectors, and applying new information and communication technologies such as the Internet.

Cooperative extension services have been replicated in the agriculture and forestry sectors in many other countries, including Nepal. They have stood the test of time and adaptability, and are widely regarded as essential public institutions. In those states, such as Florida, that have developed a strong energy extension program, these programs are playing a key role in improving energy efficiency and popularizing renewable energy technologies.

[19] A county in the US is the primary government unit below the state level, with direct responsibility for governance outside incorporated municipalities or towns, and considerable indirect authority for all local government units within their boundaries.

3.3 Recent Technological Innovations in Nepal

3.3.1 Peltric Systems

Traditional water mills (*ghatta)* have been widely used in Nepal's mountain areas for centuries, mainly for grinding grain. The traditional devices consist of a vertical shaft with a runner at the bottom made of wooden blades. Flowing water is directed at the runner, which rotates the shaft. Two round millstones, hewn locally, are fitted at the top of the shaft to act as the grinding mill. The traditional machines are made entirely of local materials, but still cost over NPR 5,000 (about $60), and need to be replaced every 2-3 years. They operate surely but slowly, with efficiencies on the order of 10-15 percent.

A number of improved designs have been introduced in recent years, developed by engineers in Nepal, India, and other countries. The new machines do not necessarily cost more than traditional units, but generally have a potential life span of 10 years or more. These machines are considerably more efficient and can do the same work in a fraction of the time. Most of these new machines can be serviced and repaired locally.

Furthermore, the increased efficiency levels of these new machines makes it possible to employ them to produce electricity in addition to mechanical grinding power. A typical cross-flow water mill can produce 3-5 kW of power, sufficient to meet the electricity needs of 25-50 households. However, the cost of a mill with accompanying power generators typically comes to NPR 150,000 (about $200).

Work in Nepal with traditional water wheels has led to the development of peltric technology. "Peltric" (Pelton + electric) systems substitute the traditional water wheel with a highly efficient Pelton turbine to generate electricity. The cost remains about NPR 150,000, depending on the size and output.

Peltric sets are small, usually weighing less than 20 kilograms. So they are relatively easy to transport to remote villages. Small-diameter plastic pipes are sufficient to carry the small quantity of headwater needed, but the head generally needs to be 60 meters or more. Several Nepalese companies have developed and introduced electromechanical turbines that can work off a very low head – 2 meters or even less. These pico-hydro plants are typically 5 W–5 kW, but units up to 10-25 kW are also being applied.

Peltric and pico-hydro technologies represent the best of integrated application of indigenous and international technological applications. They offer tremendous potential for generating power in remote areas – or anywhere electricity is used.

3.3.2 White-Light Emitting Diodes

Recent advances in electronic lighting technology are opening some exciting new possibilities for rural electrification. In 1997, the world's first White-Light Emitting Diode (WLED) was developed. Compared to incandescent or even fluorescent light, diodes are extremely energy efficient. For example, using WLEDs in a flashlight bulb allows ordinary dry cell batteries to

last seven times longer than they would with an incandescent bulb. An array of 6 or 9 WLED lamps can light up a home on a power consumption of only 1 watt! Dr. David Irvine-Halliday, of the University of Calgary, began introducing sample WLED systems to Nepal in 1999. The results have been very promising, and his initial work in Nepal led to the establishment of the Light Up the World Foundation, which is teaming with commercial producers to design and introduce advanced but appropriate lighting and mechanical generation in Nepal and to other developing countries.

Reducing significantly the amount of energy needed to light a household opens opportunities for sharing the capital costs of simple generating systems among a larger group of customers, significantly improving the economics for off-grid rural power systems. Already, Nepalese companies are working on hybrid systems that use traditional *ghatta* for milling during the daytime, and also at night to recharging batteries that can then be used to power lights or appliances.

Section 4 Rural Energy Services for All of Nepal: The Road Forward

4.1 Starting Points

Today, less than 5 percent of Nepal's rural people have access to electricity from NEA's grid system. At the current rate of expansion, over the next 30 years the central grid may reach 30 percent of them. The figures are soft, but it may be that as many as 7 percent of rural Nepalese live in villages that already people alternative sources of off-grid power production – mainly micro hydro and solar.

But the vast majority of villagers – nearly 21 million people, or 86 percent of all Nepalese – still live with chronic energy poverty. The traditional biomass fuels, kerosene, and dry cell batteries that they do use are either expensive or time-consuming to obtain and use, and damaging to their health and the environment. Decentralized hydro and other renewable energy resources are widely available, but most villagers and farmers do not have the capital, organization, or know-how to tap these resources efficiently. And – currently -- neither government nor private business has capacity to respond to more than a small fraction of the nationwide opportunities and needs.

Nepal does have strong international interest and support from donor agencies and from international renewable energy specialists, both from the business sector and NGOs. Also, there is a good base of innovative experience within Nepal, and increasing familiarity with Best Practices from neighboring South Asian countries and worldwide. This paper represents the commitment of USAID and other donors to work with HMGN to tap promising new technologies and Best Practice approaches from Nepal's own experience and that of others, and to create the capacity in Nepal to accelerate the extension of modern rural energy services.

It is important to keep in mind the ways in which Nepal is unique: landlocked, rugged terrain, dispersed population, high poverty rate, limited communications and transportation infrastructure, very limited petroleum resources, very large hydroelectric potential, good solar and wind energy potential, and very limited government funds. Physical, cultural, and institutional realities set the landscape through which the national rural energy campaign must navigate.

During this study, in meetings with HMGN officials and other rural energy supply stakeholders in Nepal, a broad consensus emerged on several issues:

Regarding rural electrification:

- NEA should be restructured to concentrate solely on becoming a commercial operation that competes with the private sector in generation and distribution. NEA should not be burdened with any rural electricity supply operations that are determined to be financially not viable; i.e., require long-term subsidies to cover operating costs. Financially non-viable electricity distribution operations -- primarily

rural electricity supply operations -- should be consolidated under a single entity that can minimize the cost of electricity supply including subsidies.

- HMGN's rural electrification targets under the Tenth Plan can only be met through a combination of national integrated grid connected and off-grid electricity supply networks.

- No national level, comprehensive plan for rural electrification currently appears to exist.

- Political interference has been a significant problem with past rural electrification programs and has disrupted the sound planning of rural electrification.

- Existing private sector and donor supported rural electrification projects, such as the Andhi Khola, Jhimruk, and Lamjung rural supply systems, and currently planned donor projects, such as the DANIDA-sponsored rural electrification in the Kanchanpur and Kailali Districts, are important initiatives, and should be supported by the new national strategy.

- It is likely that future electricity generating capacity will be sufficient to meet national demand and, therefore, load shedding will not be a problem for rural electricity consumers.

Regarding the integration of rural electrification and other rural energy services:

- The continuing dependency of the large majority of the rural population on low-efficiency and environmentally unsustainable use of traditional biomass fuels poses immediate and severe problems that equal or exceed rural electrification in priority.

- The establishment of the Alternative Energy Promotion Center (AEPC) in 1996 reflected a convergence of factors: significant foreign donor and NGO support for alternative energy, maturing of these technologies and emergence of local private businesses focused on them, as well as the serious need of the rural population for viable alternatives to grid-based electrification.

- The challenges for both rural electrification and for rural energy development generally are not technological. The technologies will continue to improve, but they are already widely known and readily available. The challenges are primarily of financing and of organization to construct and maintain the technologies at the community level.

- Alternative energy sources for meeting rural needs are becoming significant in Nepal. At some point, Alternative Energy Promotion will need to be mainstreamed into Rural Electrification. Creation of a single apex agency would begin to coordinate and merge these two efforts. Not to do so would mean that two separate energy systems continue to develop in rural areas. These two different energy systems will increasingly be

competing for the same territory, and creating distinct and largely incompatible systems.

- Because funds and resources of HMGN, donors, and civil society are limited, and skilled development workers are scarce, there is need to focus and concentrate efforts.

- So although rural electrification is normally implemented by power utility companies such as NEA, Nepal's geographic and economic characteristics, together with its "other energy crisis" make it necessary to look "outside of the box" for an effective national solution to development of both rural electrification and other rural energy.

- Generating adequate rural energy supply, especially of electricity, will require significant long-term subsidies because of the inability of many rural consumers to pay the full costs – whether of improved cooking stoves or of electricity supply. (As far as it could be determined, no comprehensive assessment has been made of the subsidy levels needed to meet, for example the Tenth Plan's national rural electrification targets.)

- A central revolving fund for rural energy, including rural electrification, needs to be established. The Rural Energy Fund should be designed to manage both HMGN's rural energy funding (from electricity surcharges, royalties, and taxes) and official international donor funding, both grants and loans. Further, the Rural Energy Fund should be designed and managed in a manner that it is efficient, transparent, and attractive to international donors.

TABLE 4. POLICIES AND PROGRAMS FOR POVERTY ALLEVIATION: ELECTRICITY SECTOR

Source: *Concept Paper On PRSP/10th Plan,* National Planning Commission, Kathmandu, February 2002

Objective	Strategies	Activities/Programs	Targets (indicators)
To generate electricity at low cost by utilizing available water resources To extend reliable and quality electricity services all over the country at reasonable price To support development of rural economy by extending rural electrification To link electrification with economic activities To develop hydropower as an export commodity	Electricity will be developed as infrastructure that directly related to development of agriculture & industry. Electricity services will be made available to rural economy in support of social equity. Investment-friendly, clear, simple and transparent procedures will be adopted to promote private sector in electricity development. Small, medium, large and storage hydroelectric projects will be implemented. A strategy will be adopted to develop hydroelectricity with bilateral/regional cooperation. Hydroelectric development and management will be made comprehensive emphasizing development of national economy.	Encourage implementation of small and micro-hydroelectric projects at local level in remote areas. Expand rural electrification program to provide electricity services to maximum number of people. Make a suitable institutional arrangement for this purpose. Establish 'Rural Electrification Fund' for micro-hydropower development and rural electrification by apportioning some of the royalty amount. Encourage use of electricity available during low demand period for rural water supply, irrigation, industry and tourism. Encourage electrification in rural areas directly affected by electricity generation projects by exempting energy royalty on electric energy consumed in such areas for first 15 years of operation. Probe 1% of the royalty from hydroelectric projects to those Village Development Committees that are directly affected by the structures of the project for rural electrification purpose only in the project area. Provide subsidy through the Alternate Energy Promotion Center for electricity generation & distribution by construction of micro-hydroelectric stations up to 100 kW at rural level by domestic private sector. Provide facility to such stations under priority loans. Give operation and maintenance of small and micro-hydroelectric projects to local co-operatives and associate them right from the project planning and implementation stage.	• Increase in percentage of rural households with access to electricity. • Uses of electricity in non-farm small enterprises like carpentry, grain mills, etc. • Longer hours available for education for children. • Increased use of spill energy from the power generation stations. • Increase in installed capacity to 732 MW by 2005. • Increase in transmission lines length to 2,127 km by 2005. • Provision of electricity services to 23% of population by 2005.

4.2 Destinations

Ultimately, all of Nepal's people should have access to affordable, clean, and reliable electric power and fuels, just as they should have basic opportunities for shelter, livelihood, health care, and education.

Under the Tenth Plan, the objective of the electricity sector is to help reduce poverty in a sustainable manner. This is to be done by:

- generating electricity at a low cost, utilizing available resources;
- expanding reliable electric service of reasonable price;
- expanding rural electrification; and
- developing hydropower for export.

Principal national targets for Electricity Development are:[20]

- the current electricity share of 1.4 percent of total energy consumption will be increased to 3.5 percent;
- a target of 22,000 MWh of electricity will be exported from multipurpose projects including Pancheswor, Karnali, and Saptakoshi;
- in order to meet domestic demand and export targets of 400 MW, new hydropower projects totaling 2,230 capacity will be constructed; and
- the national electricity system will be made accessible to 43 percent of the people, by providing service to 2,600 Village Development Committees. (This is about two-thirds of all VDCs.)

In order to implement these objectives, the Tenth Plan provides for:

- establishment of a rural electrification trust or fund;
- restructuring of "organizations in the public sector"; and
- development of an institution for training and research regarding hydropower development.

4.3 Rules of the Road: a National Rural Energy Services Strategy

The major strategic elements of a successful national rural energy campaign are reflected in the Best Practice models presented in Chapter 3. The basic elements are fairly simple in concept, and may apply nearly universally.

First, there needs to be ***a national commitment to rural energy services***. In the US, this came about because of the desperate economic situation of the Great Depression, and the increasing disparities between rural and urban areas. President Franklin Roosevelt articulated a strong role for national government leadership in rural electrification as well as for integrated regional economic development and resource conservation, and then he obtained the endorsement of Congress to create the Rural Electrification Administration (REA). The

[20] Tenth Plan, Chapter 14.3.3. Goals

REA built upon existing national commitments to rural agricultural development through the US Department of Agriculture's Cooperative Extension Program and land grant colleges. In Bangladesh, the national commitment to rural electrification is enshrined in the constitution, but it has taken a twenty-plus year commitment of the government, donors, and technical support to make it work. These commitments have been for the long term – they are measurable in decades.

Second, ***local capacity to organize, operate, and maintain power distribution and, wherever feasible, power production, needs to be created and nurtured.*** In the US and Bangladesh, and in other countries such as the Philippines and Cost Rica, the rural electrification programs were based on creation of village cooperative associations. Both the Lamjung Electricity Association and the South Lalitpur Electric Cooperative provide promising examples of such an approach in Nepal. The Rural Energy Development Program (REDP) has demonstrated how, by starting with creation of village organizations, a range of energy production and supporting activities can be stimulated.

Third, there needs to be ***a dynamic, evolving partnership between consumers, the private sector, and the government at both national and local levels.*** In the US, two major partnerships emerged: (i) the collaboration between the Rural Electrification Administration and local electric cooperatives, and (ii) the interaction between farmers, counties, and the Cooperative Extension Service. In Bangladesh, such a partnership has been fostered by the Rural Electrification Board (REB) with its PBSs.

Key elements of these partnerships in the US and Bangladesh experience have included:

- coordination of efforts across planning, line, and local agencies;
- field extension services that support development of demand and supply – and financing for both;
- applied research and development – including monitoring of the campaign's progress and proactive searching for relevant Best Practices and Promising Innovations; and cautious willingness to undertake additional responsibilities as competence is established.

Again, in the US experience, agricultural extension services often worked effectively with the same farmers and rural communities that formed rural electric cooperatives. In recent years, as technologies and regulations have changed, these relationships have sometimes become even closer, such as in states where formal energy extension services have emerged, or where cooperative extension services have become involved in distance learning.

All successful public-private partnerships for rural energy development have had to establish strong outreach to consumers and other beneficiaries at the community level. The US experience with cooperative extension services has probably been the most wide-reaching of these efforts, reaching rural communities in every state, and evolving to address almost every imaginable aspect of rural life. The rural extension service in the US has always been a major source of objective information about agricultural technology and rural industries, helping farmers and small businesses to identify production-enhancing appliances and machinery, and assisting in rural residents in gaining access to credit and financing.

Most of the scientific research and engineering development for improved energy services in the US came from the private sector, in the course of conventional electrification development. Government-funded research has also been significant, notably for renewable energy technologies.

One of the attributes of the US research and information system that is generally taken for granted is the considerable effort that goes into documenting and communicating successful research and applications of both technologies and management systems. Every county, state, and national project is likely to be carefully accounted for and reported on as part of normal budgeting and programming processes – usually on an annual basis. In addition, trade journals, local newspapers, and national media give attention to both successes and failures, ensuring widespread dissemination of experience and results. And professional associations hold periodic meetings at regional, and national levels, facilitating first-hand exchange of ideas and practices, both within and across sectors.

Finally, it should be noted that these US agencies have gone through considerable evolution themselves. The Rural Electrification Administration has become the Rural Utility Services. And the Cooperative Extension Services now frequently play a direct role in energy conservation and renewable energy technologies. Having reached their initial objectives, they have added or moved on to other needed services.

4.5 The Vehicle: an Apex Agency for Nepal's Rural Energy Campaign

Following from the above design parameters, and what we have learned of Nepal's unique situation, experience, failures, and accomplishments to date, ***we recommend that HMGN establish a Nepal Rural Energy Services Authority, or RESA***.

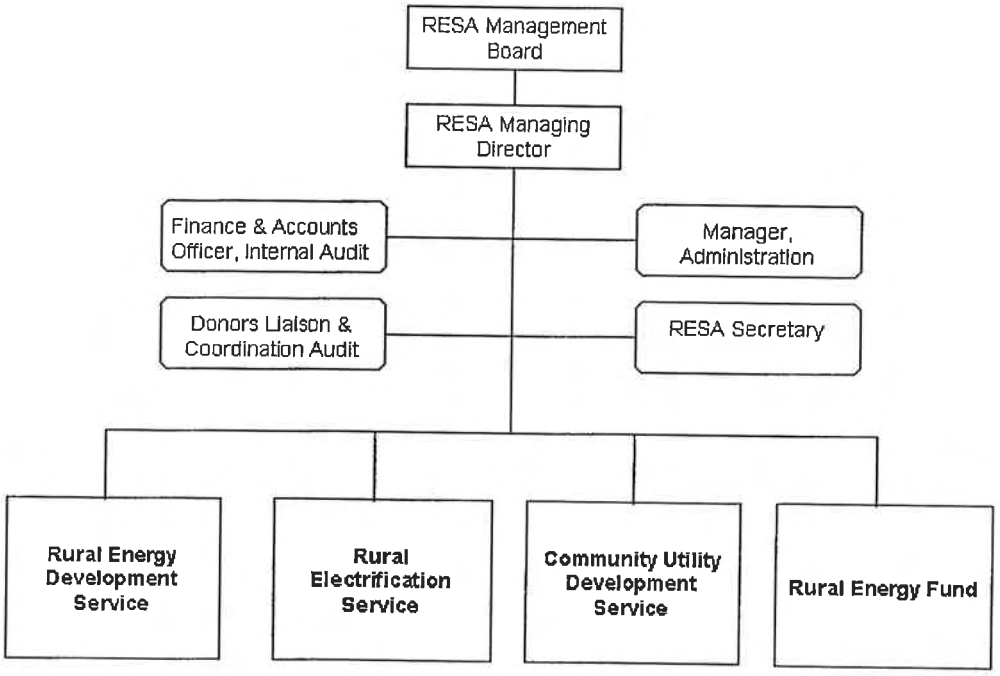
The proposed RESA would be an apex entity. Its primary mission would be to help local community associations, including cooperatives, to develop consumer-owned-and-managed rural electric services. It would also work actively to catalyze private sector investment in production and distribution of rural energy services – private investment should be welcomed, and there is room for more than one model of consumer-driven management.

RESA would build on NEA's past efforts to develop isolated and off-grid service, and also on the successful pilot activities of both the UNDP REDP and DANIDA ESAP programs. It would take an area focus, working with districts and villages. In each district, RESA would work closely with both the District Development Committee and the District Energy Committees, establishing and strengthening Rural Energy Development Sections of the Energy Committees, and assisting in preparation of District Rural Energy Plans.

Field-based energy extension workers, linked closely to the district offices and in parallel to agricultural and forestry extension workers would assist in establishing local associations, and be charged with working to stimulate local demand for energy as well as to facilitate the introduction of appropriate generating, distribution, and storage technologies.

While electrification would be the primary focus, RESA would be concerned with *all* energy resources, technologies, and use. Traditional fuels and cooking technologies would be an important concern, as would use of kerosene. Dry cell batteries would also be of interest, since they can play a significant factor in lighting and in storage of electricity. Batteries are of concern for an additional reason: without supervision and broad public education, the increasing use of dry cell batteries threatens to become a hazard to health and the environment. By operating nationwide at the grass roots, RESA can help to reduce or avoid this problem.

Figure 1 Initial RESA Conceptual Design Organization



This comprehensive approach to rural energy services reflects the linkages and cross-substitution of electricity with other energy sources, such as kerosene lighting and woodfuel cooking. It also recognizes the reality that improved cooking stoves (ICS) can be as important as electric light bulbs in improving rural life, especially when health and environmental aspects are factored in.

Like NEA, the proposed RESA would be an autonomous utility corporation, wholly owned, at least initially, by HMGN. Unlike NEA, RESA would not be expected to turn a profit, or even to break even financially. Its performance should be linked to careful economic assessment of the total economic costs – health and environmental, as well as financial – of its services in rural areas.

The Rural Electrification Service would be drawn from the sections of NEA that presently work with off-grid rural electrification. Similarly, the Rural Energy Development Service would absorb most of AEPC – virtually all but AEPC's current research and development functions. The REDP would provide a core for the Community Utility Development Service. And the Interim Rural Energy Fund, augmented in accord with the Tenth Plan, would provide the basis for the Rural Energy Fund. But there are additional loan and investment funds of relevance, such as those currently administered by the Agricultural Development Bank. These need to be carefully considered, and their operations coordinated to assure optimal impact and avoid overlap and confusion.

Creation of a new apex entity that will function as an autonomous utility will eventually require specific enabling legislation. A Rural Energy Services Act would affirm the national commitment to rural energy development, as well as define the entity charged with achieving it. But interim steps are possible, as discussed in the Milestones section, below.

Overall RESA management would be the responsibility of the RESA Management Board. This Board would consist of HMGN Nepal appointees, the RESA Managing Director, and the Executive Directors of each of the four RESA Departments. (See Table 6.)

The main RESA administrative and financial control units are proposed to be located directly under the Managing Director. Also reporting to the Managing Director would be a unit for Donors Liaison and Coordination. This unit would be the focal point for development of a central, national-level rural electrification financing component of RESA or, possibly, in the future a separate entity. It would also be responsible for coordinating Pilot activities with other Nepal rural electrification and energy supply projects outside of the Strategy.

RESA personnel administration would be the responsibility of the Joint Manager, Administration and associated professional staff. This includes development, implementation, and management of a human resources management program. The unit will also be responsible for recruiting RESA's employees.

4.6 Milestones/Schedule

Assuming that consensus with the Ministries of Water Resources and Science and Technology, together with the National Planning Commission, can be reached quickly – say by April 2003, definitional studies and some initial training activities could be completed within 3-4 months – by the end of August. This would be an incubation period for the new organization.

Normally, in the creation of a new organization such as RESA, the first major milestone would be the passage of enabling legislation. In the current political situation, enacting a Rural Energy Services Act may not be feasible in the near future. A second priority action is to prepare a budget for inclusion in HMGN's budget. Since the 2003/2004 fiscal year begins in July 2003, there is little lead time for doing so.

Table 5. Illustrative List of Responsibilities for RESA

- To recommend short-term and long-term policies to His Majesty's Government of Nepal (HMG/N) on matters relating to electricity supply.
- To formulate plans and programs for electricity generation, transmission and distribution system and other related activities, and construct, operate, protect and maintain electricity generation stations, sub-stations, distribution centres, transmission and distribution lines and related facilities in order to implement its plans and programs.
- To make arrangements for electricity generation, transmission and distribution for industrial and agricultural development as well as for the general public on the basis of techno-economic viability of power generation and other energy projects for the rural population.
- To fix electricity tariff and other charges relating to electricity and energy supply services for rural areas.
- To make arrangements for the development of skilled human resources development in the areas of electricity generation, transmission and distribution through advanced-level training and education programs.
- To provide technical guidance and consultancy in matters related to electricity and for "alternative" forms of energy generation, transmission and distribution in rural areas.
- To perform other functions in order to accomplish the objectives of the RESA's mandate.
- To borrow from national agencies, banks or individuals.
- To borrow from foreign governments or foreign and international agencies, after taking prior approval from HMG/N.
- To collect revenue from the sale of electricity, or other energy technologies and related service charges from the consumers,
- To invest the RESA funds.
- To buy electricity generated by the private sector; and
- To perform all required functions in order to fulfill RESA's duties and responsibilities.

Some interim arrangements may be appropriate. For example, it may be possible to establish RESA under the Development Committee Act. Similarly, if the organizational basis can be worked out, budgets planned designated for rural energy/electrification activities in the coming fiscal year could be merged. These issues would, along with details of the partial mergers of existing parts of agencies, and specification of responsibilities, work plans, and initial training, be determined plans during the incubation period.

A rough schedule for detailed design and establishment of the strategy is presented in Table 7, followed by explanatory notes in Table 8. This schedule covers the nine-month period from the present, March 2003, through November 2003. During this period, technical support from SARI/Energy is available to support HMGN to establish the proposed RESA.

Consultation with key donors, including USAID, the Asian Development Bank, and the World Bank, UNDP, and DANIDA would continue throughout the detailed design work. There would also be time to complete several initial training seminars and to prepare a master plan for training and staff development before the SARI/Energy project comes to a close toward the end of 2003.

Table 6. Illustrative Composition of the Board of Directors

The Minister/State Minister of Water Resources or Person appointed by HMG	:Chairman
Secretary, National Planning Commission	: Member
Secretary, Ministry of Water Resources	: Member
Secretary, Ministry of Finance	: Member
Secretary, Ministry of Science and Technology	: Member
Secretary, Ministry of Local Development	: Member
Secretary, Ministry of Population and Environment	: Member
Director, Water and Energy Commission	: Member
One prominent person from commerce, industry, or financial sector	: Member
One person from consumers group	: Member
Two prominent persons with experience in rural energy/electrification sector from outside government	: Members
Managing Director, NEA	: Member
Managing Director, RESA	: Member Secretary
Four Directors, RESA Service Departments	: Members

Table 7 Schedule for Detailed Design and Establishment of the Strategy

	2003 Mar Apr May Jun Jul Aug Sep Oct Nov
STRATEGY Draft for Review Formal & Informal Review Meetings Revised, Working Strategy	🕮 //////// ///🕮
APEX ORGANIZATION (RESA) Detailed Design Study Review and Approval Appointment of Senior Management Recruitment of Staff Beginning of Operations	////////////////////////🕮 //////////////O ////O ////////////— ///////////////
ENABLING LEGISLATION Drafting Team Appointed Drafting Team – Study Presentation of Draft	O? ////////////////////////? 🕮?
BUDGET Preparation Submission Approval	/////////? 🕮? O?
TRAINING PLAN Visit to Bangladesh REB Design of RESA Training Plan First Staff Orientation Seminars	/// --------//////////////// ---------////////////////

🕮 = report
//// = period of intensive effort
O = target date
– = period of less intensive effort
? = tentative

Table 8 Explanatory Notes on Schedule for Detailed Design and Establishment of the Strategy

STRATEGY ▪ Draft for Review ▪ Formal & Informal Review ▪ Revised, Working Strategy	This report constitutes the draft strategy. It needs thorough discussion with key stakeholders, including the several donor agencies that have actively contributed to Nepal's rural energy programs in the past. Review meetings can be conducted in Kathmandu in March 2003.
APEX ORGANIZATION (RESA) ▪ Detailed Design Study ▪ Review and Approval ▪ Appointment of Senior Management ▪ Recruitment of Staff ▪ Operations	Assuming concurrence from key HMGN agencies, the meetings for review of the draft strategy would also provide input to the detailed design study. SARI/Energy can provide appropriate expertise to collaborate with a select HMGN work group to complete the detailed design work. Following formal HMGN approval of the RESA, this workgroup could serve as an interim advisory group until the board of directors and senior management are in place and begin operations.
ENABLING LEGISLATION ▪ Drafting Team Appointed ▪ Drafting Team – Study ▪ Presentation of Draft	Drafting of enabling legislation or alternative rules, would be provided in parallel to the detailed design work for RESA.
BUDGET ▪ Preparation ▪ Submission ▪ Approval	Ideally, as indicated here, establishment of RESA would coincide with the start of the Tenth Plan, in July.
TRAINING PLAN ▪ Visit to Bangladesh REB ▪ Design of RESA Training Plan ▪ Staff Orientation Seminars	While the detailed design is underway, staff from NEA and other key stakeholder representatives, could visit the REB in Bangladesh and/or the ESD/RERED program in Sri Lanka.. SARI/Energy can provide consultant support to design of RESA's initial manpower development strategy, and also prepare and assist in presentation of the first orientation seminars for new staff.