II

THE CURRENT STATE OF RURAL ENERGY PROGRAMMES

Energy options in the rural areas of Nepal are severely limited. As already explained in Table 1 (previous section), energy is predominantly used in the domestic sector (95.5%) and fuelwood is the most important source (78.3% or 10.8 million tons). Next to fuelwood, significant amounts of agricultural residues (2.14 million tons or 26.9 million GJ) and dried dung cakes (1.88 million tonnes or 20.5 million GJ) are consumed in the domestic sector. Together, these three sources contribute to 98.8 per cent of domestic requirements and 95.9 per cent of total energy requirements (when all sectors are considered). In contrast, the consumption of kerosene and electricity for lighting in the domestic sector is 0.9 per cent (or 45,200 tons) and 0.2 per cent (or 168 GWH) respectively. The consumption of diesel in the agricultural sector is low (0.2% or 13,000 tons). Given this structure of energy use, it is not surprising that rural energy programmes in the country are mostly concentrated on (a) relieving the pressure on fuelwood supply for domestic energy needs; and (b) promoting small, decentralised energy sources for enhancing agricultural development and rural industries. From this perspective, the programmes that are of particular significance in the Nepalese context include afforestation, dissemination of improved cooking-stoves, mini- and micro-hydro turbines, and biogas. All of these are renewable energy technologies and are implemented by various government agencies. Unfortunately, their development potentials are not fully realised because of the absence of a coordinating body that could integrate programme planning and implementation in different agencies and streamline the efforts towards meeting rural development objectives. We will return to this point again in Sections III and IV. In this section, we will review mainly the strengths and weaknesses of some important rural energy programmes.

Forestry Programme

Forests have traditionally been the most important source of fuelwood in Nepal. Recent trends in large-scale deforestation have intensified problems associated with the fuelwood and fodder supply of the increasing population. One estimate indicates that forest resources in the country have shrunk from 6.4 million hectares in 1963/64 to 3.34 million hectares in 1983 (UNDP/World Bank 1983). The rate of forest clearance is currently estimated to be equivalent to 100,000 ha a year. The problem of deforestation became worse, particularly after the enforcement of the 1957 Forest Nationalisation Act. Not only did the management of hill forests almost cease, but a substantial amount of forest land was cleared and converted to agricultural land in order to ensure private ownership before the control by the Government became effective (UNDP/World Bank 1983). Recognising the need for better protection and management of forests, a new set of rules was enforced in 1977 which delegated the responsibility for managing 2.2 million ha of forests to local communities and private individuals or agencies (Ministry of Forest 1976 and 1978). This was an important change in policy aimed at mobilising people for the protection and management of forests.

Although a large number of forestry programmes was implemented in the past by the Department of Forests, the performance has clearly been frustrating. A National Planning Commission (NPC) report states that the annual achievement of forest plantation in the Sixth Five Year Plan (1975-80) comes to around 6,000 - 7,000ha (NPC 1984). In order to improve this situation, new forestry programmes were initiated in the early 1980s. One such programme was the Community Forestry Development and Training Project in 29 hill districts under IDA/World Bank-assistance. Emphasis was placed on the protection and management of ongoing forest areas at the village *Panchayat* level,[1] establishment of nurseries for new plantations, and integration of improved cooking-stoves distribution for fuelwood conservation. During a period of five years, the project succeeded in involving 340 *Panchayats* in the establishment of 430 nurseries and plantations, and protection of 19,060 ha, and distribution of 15,760 improved cooking-stoves. The area planted was, however, much below the target of 39,000 ha. Initiatives have recently been taken at the government level to implement the second phase of the Community Forestry Project and the *Terai* Community Forestry Project with World Bank-assistance. Other programmes of a similar nature include afforestation efforts under the Small Farmers' Development Programme (SFDP) of the Agricultural Development Bank of Nepal (ADB/N), the Nepal-Australia Forestry Project, and other rural development programmes.

Despite these efforts, the current rate of forest plantation is believed to be less than 15,000ha per year against the Seventh Plan target of 35,000ha annually. The important question is whether the current level of effort and performance is significant enough to create the necessary impact in meeting energy needs and protecting the environment (Wallace 1985)? The answer is a clear "No" Forestry programmes are, unfortunately, facing a number of problems, such as:

- o difficulty in acquiring social acceptance from local communities,
- o inefficient management and use of existing forest resources, and
- o administrative hurdles to coordinate programmes in accordance with local needs and priorities.

These points will be dealt with in greater detail in Section III.

The Improved Cooking-stove Programme

The dissemination of improved cooking-stoves (ICS), as opposed to traditional cooking-stoves or open hearths is potentially an effective approach to conserving fuelwood and thus reducing deforestation. The UNDP/World Bank Energy Mission assessment that, in Kathmandu Valley (population of about 100,000 households), an effective ICS dissemination programme could save up to 99,200t of fuelwood per year, and this is equivalent to the annual yield of 13,680ha of forest (UNDP/World Bank 1983). The mission had advocated the immediate initiation of the plan to disseminate 100,000 ICS in Kathmandu Valley (all homes covered) over a five year period. The belief was that the experiment would (a) develop experience in mass production, promotion, and distribution of ICS in a relatively manageable area, and (b) create a significant reduction on fuelwood consumption in the area. The programme, unfortunately, has not progressed as well as expected. The difficulty stems mainly from the absence of proper coordination in the delivery system, including technical assistance, credit support, promotion, and education of the beneficiaries.

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1. **A village *Panchayat* was the smallest political constituency and administrative unit in Nepal. Each one had nine wards. Normally, a village *Panchayat* consisted of a population between 3,000 and 7,000 in an area between 10 sq. km. There was a total of 4,000 village *Panchayats* distributed over 75 districts in the country.**

Since the early 1980s, many agencies are actively involved in the development and dissemination of ICS in Nepal. The agencies include the Community Forestry and Afforestation Division of the Forest Department, UNICEF, and the Agricultural Development Bank. So far, the total number of ICS disseminated in the country stands at about 30,000, and this is clearly inadequate (WECS 1987). Of these, only 60 to 70 per cent are estimated to be currently in use, partly due to breakage of different parts during transportation and while being used, and also due to abandonment when the stove fails to meet local requirements. Advocates claim that savings on fuelwood averages about 40 to 45 per cent or 460kg per unit per year (Shrestha 1985). Although the claim sounds impressive, the question is how many units are actually installed, used, and maintained regularly? It is difficult to find information on stove performance, monitoring, and assessment of perceived benefits by end users in the long run.

While efforts by various government and non-government agencies are continuing, the progress in stove dissemination is reported to be inhibited by socioeconomic constraints such as:

- inappropriate stove size for family use,
- inflexibility in adjusting cooking pots of various sizes (normally a standard-sized ICS is distributed),
- lack of realisation by local people about the "real" cost of fuelwood in terms of time and money (in most rural areas, fuelwood is considered to be a "free commodity"),
- heat loss through the chimney pipe (it is preferable to heat the room during winter),
- lack of interaction between stove producers and end users,
- lack of appropriate design and on-site training in the use of ICS, and
- lack of an adequate institutional set up for effective dissemination.

In spite of the current difficulties with dissemination, the fact remains that fuelwood saving through efficient stoves is an important consideration. A greater effort is needed to develop several models to suit the various socioeconomic conditions in different agro-ecological zones. A uniform model for use throughout the country is simply not a viable proposition. Emphasis has also to be placed on extension and education so that the stoves are used and maintained properly, while ensuring that repair and other support services are available on a regular basis.

Micro-hydro Systems

Micro-hydro systems have been in use in the Nepalese hills for centuries in the form of horizonal water wheels which are traditionally known as *"Pani Ghattas"*. Some 25,000 of these *ghattas* are estimated to be in operation. However, they have only limited application and produce about 1 horsepower; just sufficient for grinding maize and millet. Other crops, such as paddy and oil seed, are processed in diesel-powered mills. With the development of crossflow turbines in 1961 and multipurpose power units (MPPU) during the early 1980s, the available hydropower is increasingly used for rural applications. Because of the rapid increase in the price of fossil fuels and the problems of distribution in the hills and mountains, the efficient use of water turbines and MPPUs became the focus of attention in rural communities.

Turbines for agro-processing and electricity generation are cost-effective in the hills and are much in demand. Development and installation of crossflow turbines and MPPU provide examples of success when private sector initiatives are supported by public sector organisations such as the Agricultural Development Bank (ADB/N). Installations, in the range of 5 to 50kW, started during the early 1970s. The momentum picked up rapidly after 1982 when ADB/N accorded priority to the financing of decentralised energy schemes for agriculture and rural development with support from the Fourth Agricultural Credit Programme of the Asian Development Bank. A total of 190 micro-turbines were set up in rural locations within 3 years, thus surpassing the target of 160 units (Shrestha 1985). The programme was expanded in 1987 and the target was increased to 450 units under the Fifth Agricultural Credit Programme. So far, 460 turbines (out of a total of 554 units in the country), with a power output of 3,567kW of mechanical power and 166kW of electrical power, are in operation with ADB/N credit support of Rs 57.7 million (ADB/N 1987). Similarly, a number of improved *ghattas* (watermills) and a Chinese lift turbine for irrigation and other rural applications were successfully tested. These efforts have demonstrated the feasibility of using micro-hydro technologies for meeting rural energy needs in hill areas.

According to an estimate, if 3,000 such schemes are installed by 2000 A.D., an energy equivalent of about 100,000t of fuelwood will be generated (ADB/N 1986). At present, these micro-hydro plants are mostly confined to districts in the Central, Western, and some parts of the Mid-western Development regions[2]. The growth of installations has mostly centred around Kathmandu Valley and Butwal where turbine manufacturers are concentrated. The potentials in the Eastern and Far-western Development regions are yet unexplored, although vast potentials seem to exist in these areas.

It has been amply demonstrated that decentralised micro-hydro schemes could play an important role as a viable source of energy. In order to expand this programme to a significant scale, more R&D efforts are required; (a) to lower the investment required for the micro-hydro system by reducing the manufacturing cost of agro-processing equipment, (b) to integrate its use with cottage and rural industries, and (c) to improve the efficiency of traditional *ghattas* and increase the scope of their use. A number of other important issues also need to be addressed: How can its operation be expanded? How can private sector capabilities be enhanced to cope with increasing demand? Is the current institutional mechanism appropriate? How can commercial banks and government departments play a more active role?

Mini-Small Hydropower Schemes

While the private sector approach in the development of micro-hydro systems proved to be working well, the performance of the public sector in mini-hydro schemes has been disappointing. Technical difficulties have been numerous and the management of such schemes has been complex and problematic. The Small Hydroelectric Development Board (SHDB) was established in 1975 to plan and operate mini-small hydroelectric schemes and make electricity available to remote and isolated areas. According to the UNDP/World Bank Energy Sector Mission (UNDP/World Bank 1983), *"Of the 47 projects ranging in size from 45kW to 1000kW targeted for the Sixth Plan Period, 4 are in operation, 15 are under construction and 28 are in the planning stage"*. By the end of the F.Y. 1985/86, the number of mini-hydro projects in operation increased to only 12 units with a total installation capacity of 2,086kW (WECS 1986). Very low load factors and low revenue generation are common characteristics of all mini-small hydro

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2. Administratively, the country is devided into 5 Development Regions, 14 Zones, and 75 Districts. Each Development Region consists of three zones, apart from the Far-western Region which has only two.

schemes in Nepal. Revenue collection is as low as 6.6 per cent of the operation and maintenance cost for Gorkha Small Hydro Plant (WECS 1986). Load factors vary from as low as 4 per cent to a maximum of 33 per cent. The unit cost per kilowatt varies between Rs 45,000 to Rs 80,000 in contrast with the micro-turbine unit cost of Rs 10,000 to Rs 50,000 per kilowatt. Furthermore, the micro-turbines have a high load factor because of the multiple application of power in agro-processing during the day and electricity generation in the evening. Multipurpose application and linkages are often missing in publicly-sponsored mini-hydro plants.

Unlike the micro-hydro systems, which are entirely managed by private sector entrepreneurs on a profit earning basis, the government-owned mini-hydro schemes are operating at a loss. According to the Rural Electrification Task Force Report (WECS 1987), the annual subsidy provided by HMG to run ten small hydro plants is about Rs 8.0 million. The above scenario poses two very important issues: (a) should the Government continue to provide huge amounts of subsidy to micro-hydro plants or find ways to bring these schemes under private sector management to improve the operational performance? (b) how can the private sector be strengthened to own and manage new mini-micro-hydro schemes in remote areas?

The Biogas Programme

The history of biogas development in Nepal began with the fabrication of one prototype unit in 1955 using an old 200 litre oil drum and a gas holder made of mild steel sheeting. Thereafter, one or two private owners built biogas units in Kathmandu. However, there was no real interest shown in biogas until the energy crisis of 1973. When the Government designated the fiscal year of 1975/76 as the "Agricultural Year" to boost agricultural production, a special plan for biogas promotion was developed and 199 plants were built that year by various contractors using interest free loans from ADB/N (Gorkhali 1985).

Gobar Gas Tatha Krishi Yantra Vikas Ltd.

Popularly known as the Biogas Company, this organisation was established in 1977 for the organised promotion of biogas plants. This was undertaken as a joint venture investment of the ADB/N, the United Mission to Nepal, and the Fuel Corporation of Nepal. The Biogas Company is backed up by a Research and Fabrication Unit in Butwal and sales and services' centres at strategic locations in the *Terai* and inner *Terai* regions[3]. The company had installed 3,719 units by March 1989, of which about 50 are community-sized plants. Out of the total number of plants installed, more than two-thirds are dome-type digesters, originally developed in India. The community biogas plants are used mostly to run agro-processing and other small-scale industries, while family type plants are used for household cooking and lighting. Efforts to use the slurry in fish ponds and the gas for lift irrigation have remained limited.

Biogas has been looked upon as a potential substitute for fuelwood and kerosene. Operation of biogas plants in the warmer climate of the *Terai* has been relatively free of problems. However, in the hills, where the winter temperature falls below 10° C, year round production of biogas has not been possible. In this respect, research on biogas production in a colder climate and also on the possible use of agricultural residue and other biomass ,along with animal dung are of relevance.

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3. The *Terai* and Inner *Terai* are lowland belt in the south of Nepal. They are about 50-80km wide and 800km long. Together, they amount to about 25 per cent of the total area of the country.

The biogas programme with its current installation capacity of 600 units per year has still a long way to go in order to make a significant impact on the national energy scene. With the commitment of the Government, in 1988/89, to provide Rs 3.45 million in annual subsidies i.e., a (25% subsidy on the investment cost of each plant), the rate of installation is expected to increase to 1,000 units a year. At this rate, the programme will be able to substitute 37 million kg/year of fuelwood, assuming the operational efficiency of 75 per cent (Chalise 1983).

The increasing cost of installation is one of the main constraints in biogas dissemination. This is in part due to (a) the increasing overhead expenditure of the company and (b) the increasing cost of raw materials. The company has, in addition, a weak base in research as well as in technology development. The limited number of field offices is another factor that hinders widespread dissemination. In addition, very little support was forthcoming from agencies other than the ADB/N. Government support to biogas development in the past has been nominal and related policies have been inconsistent (e.g., irregularities in the provision of subsidies have created confusion and negative effects). These issues and constraints warrant urgent attention before embarking on an extended scheme of biogas development in Nepal.

Solar and Wind Energy

The solar radiation in Nepal, considering its entire surface area, is estimated to be 26.6 million MW (WECS 1988). However, the use of solar power in the country is at an early stage of development. Solar energy is used mostly for water heating with passive solar collector systems. Solar heaters are currently manufactured in local workshops, such as Balaju Yantrashala, Butwal Engineering Works, and many other smaller enterprises. They are becoming very popular for residential use in Kathmandu and other cities. Also, their use has been gradually extended to hospitals, schools, and tourist hotels/lodges. In addition to water heaters, about 600 units of solar crop driers and solar cookers have been installed on a trial basis. A few units of photovoltaic cells are being experimented with for use in water lifting and communication purposes. The basic problem has been the high cost of imported solar panels. Their viable use on a sustained basis is, therefore, questionable.

Small-scale windmills can be used for lift irrigation. The main problem in Nepal is the absence of reliable data for proper assessment of wind energy. Also lacking are R&D efforts to modify imported prototype designs to suit local conditions. Practical applications will be limited in the future unless these problems are overcome.

As is apparent from the above background, the significance of contributions made by rural energy projects is not very great. The degree of success and reliability varies from project to project. Some projects, such as micro-hydro and biogas installations, have certainly contributed towards meeting a small part of rural energy needs at the household and village level. Afforestation, management of forestry by local communities, and dissemination of ICS have been slow. Projects related to solar and wind energy are still in the experimental stage and need further evaluation.