Chapter 1
Introduction and Objectives

1.1: Introduction

Traditionally, development of rural areas, especially the more remote mountain areas, has lagged behind that of the preferred urban centres. Whereas substantial investments were made to develop adequate, sometimes even luxurious, infrastructure in the main urban centres; including the setting-up of special facilities; the rural areas did not even have basic facilities such as running water, sanitation, roads, schools, or health centres. Economic and employment opportunities, such as industries, local processing of rural produce, and transportation infrastructure, were practically non-existent in the past. The situation in mountain areas was even worse because of problems of accessibility; the relatively high cost of development activities; and, above all, the very dismal conditions of the people. It could be justifiably stated that the living conditions of people in remote mountain areas were far worse than those of the rural people in the plains.

The trend has been changing significantly during the past two decades or so, and remote mountain areas are now receiving more attention and inputs. The importance of conserving and rehabilitating of mountain ecosystems is also being realised, and governments as well as donors are increasingly providing more for the development of such areas. The level of such inputs, however, varies from area to area; and, in most cases, they do not meet the local needs.

A supply of energy in a suitable form is considered to be one of the main inputs required to raise the standards of living of the people in mountain areas and to minimise damage to the ecosystem. Per capita consumption of energy has to increase significantly in order to develop the systems and infrastructure necessary for improvement of living conditions and increase in incomes. For example, adequate irrigation systems would have to be constructed to increase agricultural productivity in many areas where rainfall is usually insufficient in some crucial months; even though the overall yearly rainfall may be high. In such cases, it may be necessary to pump water, and this would need energy. Similarly, the processing of agricultural produce needs mechanical power to run the processing equipment. At home also, more energy consumed in a suitable form would improve the quality of life and reduce drudgery as well as health hazards; e.g., for applications such as lighting, heating, cooking, washing, ironing, and for radios and television.

In many developed countries, electricity is regarded as a basic necessity. However, electricity is available to only a small percentage of the rural population in developing countries. In Nepal, for example, only ten per cent of the total population has access to electricity, and the figure for the rural areas is likely to be in the range of two to three per cent only.

At present, production, productivity, and employment opportunities in mountain areas are inferior to those in the plains. Large amounts of local produce, such as fruits and vegetables, go to waste or fetch very low prices, because of the inadequacy of transport facilities. Local processing facilities for such produce are also insufficient and rudimentary. This situation must be rectified if we hope to build a more equitable society and to counter the migration of the population from these areas to larger cities and towns.

It is known that energy is not the only input necessary for achieving development in mountain areas. Other inputs, such as comprehensive planning, investments, expertise, equipment, training, and incentives, would also have to be provided; for development of cottage industries, for example, or improvement of productivity. Nevertheless, the availability of energy, electricity for example, in a suitable form can provide modest benefits to communities, even at the outset; e.g., better lighting and replacement of kerosene (since the latter has many drawbacks related to transportation, environment, and health). Some entrepreneurs may also set up agro-processing units on their own to obtain additional benefits when electricity becomes available.

Experience has shown that the appropriateness of the source of energy for mountain areas is just about as important as the supply itself. The general tendency of government agencies in supplying electricity to mountain areas is to follow conventional practices such as grid extension or establishing diesel or larger hydropower plants. Very little attention is paid to other non-conventional resources such as mini-and micro-hydropower (MMHP), solar energy, and wind; even though many of the conventional energy systems are unsuitable and uneconomical for the more remote and inaccessible mountain areas.

MMHP is an indigenous and renewable source of energy for which potential exists in almost the whole HKH Region. Many countries, especially China, have exploited this environmentally friendly resource and benefitted significantly. However, in order to make it economically viable also, design, construction, and operation have to be low in cost; which is possible through indigenous technology and more informal operation and maintenance practices in the private sector. MMHP has many other advantages also; for example, the costs can be curtailed considerably by avoiding expensive control systems; the plants are comparatively easy to manufacture and install indigenously, thus boosting employment, economic activity, and the industrial base; organisation and management (O&M) costs are much lower than for other systems, especially in the private sector; and, above all, the adverse environmental effects are minimal. For example, even if an MMHP plant were to break down completely, damage to the surrounding areas would be minimal. An appreciable, indigenous manufacturing capability has also materialised in many countries of the Region.

Unfortunately, most of the governments in the HKH area have not recognised the advantages and true viability of MMHP plants, with the result that a very small proportion of the potential has been exploited so far. Nepal has made some novel advances in this respect and has formulated some favourable policies. Even then, the achievements are not so significant. Lately, many problems have also surfaced, particularly those concerning implementation and management aspects, and these are discussed elsewhere in this manual.

Considering the environmental and other benefits of MMHP, ICIMOD formulated a project[1] to promote the use of MMHP for development of mountain areas in 1992, funded by the Norwegian Agency for Development Cooperation (NORAD). Implementation of the project started in 1993. Its main objective was to assist the countries in the HKH Region to strengthen

[1] The project was entitled 'Design and Testing of a Regional Training Programme on Mini- and Micro-Hydropower for Mountain Development in the Hindu Kush-Himalayan Region'.

their capacities for planning, design, construction, and management of MMHP schemes to meet the energy needs of remote communities by harnessing this clean source of energy. The project envisaged participation from four countries in the Region, i.e., Bhutan, India, Nepal, and Pakistan. In addition, the participation of Bangladesh, China, and Myanmar in some of the project activities was supported by ICIMOD through a special grant.

The project activities mainly concentrated on collection, review, and analysis of information from the Region, conclusions drawn, and dissemination of this information and conclusions to relevant agencies and experts in the participating countries through reports, meetings, and seminars.

An Orientation-cum-Training (O&T) Programme was also organised by this Project as the main and final activity. It was aimed at high-level decision-makers, with the main objective of apprising them of and orientating them to the suitability and role of MMHP in the development of the people of rural mountain areas; as well as the objective of addressing some environmental aspects. It was intended to highlight the role of energy in specific development aspects related to remote, underdeveloped, and sparsely populated mountain areas. A manual containing all the lecture materials was also prepared for distribution to the participants in the O&T Programme. Since the manual contained quite useful material for various groups of planners, decision-makers, and assessors of MHP/energy-related projects, it was decided to shorten and restructure it, so that it could be used for subsequent training and/or as reference material.

1.2: Energy Options for Rural Mountain Areas

Traditionally, energy in mountain areas has been used for domestic requirements (cooking, heating, lighting, and processing), for agriculture (ploughing, planting, irrigation, harvesting, threshing, etc), for cottage industries (processing heat & motive power), and so on. In almost all these cases, the predominant source of energy has been fuelwood, other biomass, and animal or manual power. Animal power is used to a much lesser extent in mountain areas than in the plains; the result being that humans have to work much harder, especially women. For example, traditionally, animal power is used for oil extraction in the plains; whereas, in many mountain areas, this hard job is also performed by the people. Similarly, most of the agricultural work (including ploughing, digging, planting, and threshing) is carried out manually. Unfortunately, the bulk of this manual work falls on women. The only modern fuel used in rural mountain areas, to any significant extent, is kerosene for lighting. However, many problems related to health, environmental damage, transportation, and availability are associated with its use. Kerosene is up to five times more expensive in some remote areas of Nepal than in Kathmandu. Consequently, the energy situation is far from satisfactory and something needs to be done to make more suitable fuel systems and allied appliances available in such areas.

Traditional sources, such as fuelwood and other biomass, are the principal fuels being used currently in many mountain areas; and their excessive use has caused considerable problems, e.g., forest depletion, depletion of organic matter, health hazards, and pollution. Although wood energy is now being promoted as a better fuel system than, e.g., coal and some petroleum products, adequate production systems have to be developed first to justify promotion of its preferred usage. At present, it is better to discourage the use of fuelwood and biomass (especially biomass) through replacement by other appropriate energy systems. Use of animal and manual power is also inadequate and undesirable, as discussed earlier. Commercial fuels, such as coal, kerosene, diesel, and petrol, have mostly to be imported and/or transported to the remote mountain areas; which is a fairly problematic task due to lack of adequate transportation facilities, the result being inconsistent and usually economically unviable supplies.

Therefore, more emphasis needs to be placed upon renewable, locally available, low cost, and environmentally friendly energy resources such as biogas, wind, solar, and MMHP; each of which definitely have specific advantages and limitations. Wind energy, for example, is very area-specific and varies with the seasons. Solar energy is fairly expensive; its availability also varies considerably with the seasons, and it is only available during the daytime. Biogas is one of the most suitable fuels for cooking and heating; however, its production volume is seriously affected by the cold weather in higher mountain areas. The different fuels or energy systems being used or considered suitable in mountain areas, including the more modern and desirable ones, have been enumerated in Table 1.1. Their level of suitability is also given by a point system (ticks). The level of suitability is based on experience, not on field studies. However, these levels can be considered as reasonable indicators for current comparison and evaluation of options.

Because of the versatility of applications and the many advantages outlined in Section 1.1, MMHP plants have been given the highest points (47 ticks), followed by electricity from other sources (45 ticks), and biogas (32 ticks) in Table 1.1. However, the number of ticks is based on suitability for a given use only, and the costs have not been taken into account. Similarly, the social and environmental benefits have not been incorporated in determining suitability. Due consideration has been given to the remoteness and inaccessibility of the areas in awarding ticks.

Admittedly, there are some disadvantages associated with MMHP also; e.g., higher capital costs over diesel engine sets for example; difficulty in transportation or relocation; and problems with repairs, especially in inaccessible locations. Most of these disadvantages are discussed in more detail elsewhere in this document. Suffice it to say here that many of the constraints can be suitably addressed through inputs such as training, development of repair facilities in carefully selected locations, and so on.

MMHP plants are also well suited for connection to grids with the necessary, synchronising equipment; or to other hybrid systems such as MMHP-diesel, MMHP-solar, or MMHP-wind. In many situations, such a combination of different sources improves the reliability of supply and may bring down the costs. For example, an MHP plant combined with a small diesel-powered generating set could run for 24 hours a day at constant load, whereas the diesel set may only be operated for a few hours during the peak period. In this way, installation of a much larger MMHP plant can be avoided, thus bringing the capital costs down; at the same time, the use of diesel fuel (which is also expensive) can be curtailed considerably, thus optimising the generating costs. Similar combinations can be developed incorporating other fuel systems for specific situations.

Different terms have been used for different sizes of hydropower plants in the various countries. UNIDO has categorised the sizes in the following manner: micro-hydro (MHP) up to a 100kW capacity, mini-hydro between 101-1,000kW capacity, and small hydro between 1001-10,000kW capacity. Many countries have allocated other size ranges to each of these categories. In India, for example, plant sizes between 101-2,000kW are defined as mini-hydro, and those between 2,000-15,000kW are designated as small, whereas, in China, mini-plants have a size range of 101-500kW and small plants have a range of 501- 25,000kW. In this document, the UNIDO definitions have been followed, unless otherwise stated.

Table 1.1: Appropriate Energy Sources for Various Activities in Rural Mountain Areas

Activity	Preferred Energy Form	Suitability of Sources									
A. Domestic		Charcoal/ Fuelwood	Biomass	Manual/ Animal	Kerosene	Diesel/ Petrol	Biogas	Solar	Wind	Electricity	MMHP-SHP
Cooking	Heat	✓✓✓	✓✓	X	✓✓✓	X	✓✓✓✓	✓	X	✓✓	✓✓
Lighting	Light	✓	X	X	✓✓	X	✓✓	✓✓	✓✓✓	✓✓✓✓	✓✓✓✓
Heating	Heat	✓✓	✓	X	✓✓	X	✓✓	✓	✓	✓✓	✓✓
Washing	Heat	✓✓	✓	X	X	X	✓✓	✓✓	X	✓✓	✓✓
Ironing	Heat	✓✓	X	X	X	X	X	X	X	✓✓✓	✓✓✓
Food/grain processing	Motive power	X	X	✓	X	X	✓	X	✓✓	✓✓✓	✓✓✓
Entertainment	Electricity	X	X	X	X	X	✓	✓✓	✓✓	✓✓✓✓	✓✓✓✓
B. Agriculture											
Ploughing	Motive Power	X	X	✓✓	X	✓✓✓	X	X	X	X	X
Other land preparation	,,	X	X	✓✓	X	✓✓✓	X	X	X	X	X
Irrigation	,,	X	X	✓	X	✓✓✓	✓	✓✓	✓✓✓	✓✓✓	✓✓✓
Harvesting	,,	X	X	✓✓	X	✓✓✓	X	X	X	X	X
Threshing	,,	X	X	✓✓	X	✓✓✓	✓	X	X	✓✓	✓✓
C. Small Industries											
Agro-processing	Motive Power	X	X	✓	X	✓✓	✓✓	X	✓✓	✓✓✓	✓✓✓
Drying/heating	Heat	✓✓	✓	X	✓	X	✓✓	✓✓	X	✓	✓✓
Bricks	Heat	✓✓	✓	X	X	X	X	X	X	X	X
Woodworking	Motive Power	X	X	✓	X	✓✓	✓✓	X	✓✓	✓✓	✓✓✓
Water supply	Motive Power	X	X	✓	X	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓
D. Commercial (shops, lodges)											
Cooking/heating	Heat	✓✓	✓	X	✓✓	X	✓✓✓✓	✓	X	✓✓	✓✓
Lighting	Light	X	X	X	✓✓	X	✓✓	✓	✓✓	✓✓✓✓	✓✓✓✓
Washing/Water heating	Heat/Motive power	✓✓	✓	✓	X	X	✓✓✓	✓✓	X	✓✓	✓✓
E. Communications	Electricity	X	X	X	X	✓	✓	✓✓✓	✓✓	✓✓✓	✓✓✓

X Not applicable; ✓minor, not suitable; ✓✓ significant, acceptable; ✓✓✓ good, satisfactory; ✓✓✓✓ very good, most desirable.