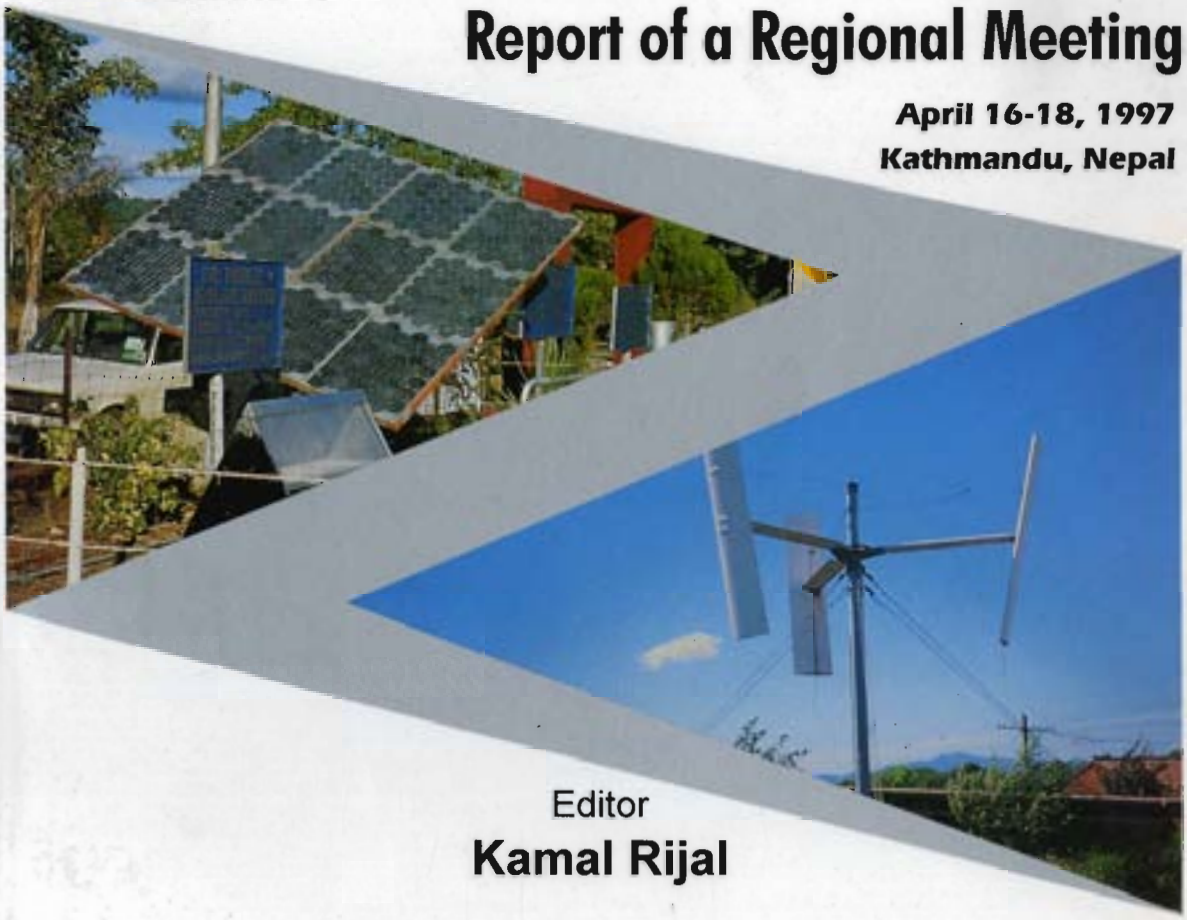
ICIMOD

Energy Use in Mountain Areas

Emerging Issues and Future Priorities

Report of a Regional Meeting

April 16-18, 1997
Kathmandu, Nepal



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Kamal Rijal

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International Centre for Integrated Mountain Development

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Cover Photo
Right: Wind generator at demonstration site in China; Kamal Rijal
Left: Solar photovoltaic system exhibited in renewable energy technology exhibition, Arunachal Pradesh, India; Kamal Rijal

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Foreword

Energy not only serves to meet the basic needs of life support systems but is a prime mover of all development endeavours. With altitude, energy requirements increase, be they for cooking, heating, or for transporting goods. In most mountain areas, a low grade of energy is required for consumptive use, thus making biomass fuels financially viable. The amount of energy required for productive purposes is low and is mainly met by animate energy in most mountain areas; and the replacement of this, in many instances, is not possible- nor even desirable given the topographical features.

Lacking alternative options, Mountain people extract virtually all their energy requirements from their environment. The price they pay is deteriorating health and a worsening ecology, decreasing soil fertility, and a rise in the level of the floodplains in the adjoining plains and an increase in area. Particularly for the poor, and specifically for women and children, deforestation can be quite costly in terms of the expenditure of human effort, which is further aggravated by the low efficiency of energy end-use devices.

Matching supply and demand to energy in mountain areas is probably more complex than anywhere else, both in terms of its problems and its opportunities. As fossil fuels are not easily available or are prohibitive in cost for daily use, mountain people have traditionally relied on biomass for cooking and heating and on animal and human power for draught and transport. Energy is also recognised increasingly as a prime mover for nearly all development endeavours, be it for the processing of agricultural products, tourism, paper-making, or any number of other activities; and the mountains are endowed with sources of hydropower and solar energy which for the most part remain untapped.

Given this situation, ICIMOD has concentrated on the issue of energy in the mountains from its inception in 1984. The energy needs of mountain farming communities and of small urban centres in the mountains have been a priority. The state-of-the art reviews on rural energy carried out in the late 80s in five countries of the Hindu Kush-Himalayan (HKH) Region provided an understanding that afforestation must receive priority as a means of overcoming the fuelwood crisis, and that programmes must be introduced to create energy options (small hydro, farm biomass, biogas, and fossil fuel options). A decentralised energy planning and management approach seemed to be a possible strategy.

With these findings, a decentralised energy planning and management programme was introduced to develop methods of rural energy planning and

management in the mountain regions; to disseminate them among district level officials; and to train trainers from selected institutions. Since then ICIMOD has shifted its focus to generating more knowledge about renewable energy technologies (RETs) and their suitability in mountain areas.

Based on the knowledge generated, the lessons learned and the need for a shift in the energy development paradigm, together with the fact that environmental sustainability has become of central importance in development thinking, the need to promote appropriate policies and investment strategies for the development of a sustainable energy system in the HKH was recognised. The primary focus of ICIMOD is to understand and to document the dynamics of energy use in mountain areas and to review state-of-the-art renewable energy technologies such as (mini-/micro-) hydropower, biomass, and solar technologies.

As a first step, ICIMOD commissioned energy-use pattern studies in the HKH region in 1996 in four member countries, namely, China, India, Nepal, and Pakistan. The meeting was organised to gain a better understanding of the issues of emerging energy patterns, policies, and programmes and to identify future priorities for energy development in the mountains. The meeting greatly benefited from the contents of the commissioned studies and the additional inputs of the authors and other participants.

This report of the meeting is not only a compilation of emerging trends in energy but also provides some useful insights into future priorities for energy development in mountain areas. It will be used to guide ICIMOD's energy programme and, it is hoped, institutions and policy-makers in the Regional Member Countries will also draw inspiration from it for their own energy programmes.

I would like to extend my sincere appreciation to the study coordinators, namely, Mr. Wang Mengjie of China, Prof. N. K. Bansal of India, Dr. Kamal Banskota of Nepal, and Prof. M. Abdullah of Pakistan for carrying out the energy-use pattern studies in the HKH region of their respective countries (which are the first of their kind) and for capturing emerging trends in the HKH region. I would also like to thank all the experts who presented papers on various themes with the objective of promoting energy development for mountain communities. I enjoyed the active participation of the experts in the meeting, especially the sharing of knowledge and experiences so freely and candidly.

Thanks are also due to Dr. Kamal Rijal who, as the coordinator of the programme, was responsible for organising the meeting and preparing this report and to other ICIMOD statt, both professional and administrative, for their contribution and support.

Egbert Pelinck
Director General

Abstract

This report summarises the discussions held and suggestions made at the Regional Meeting on Energy Use in Mountain Areas organised by ICIMOD from 16 - 18 April 1997. The purpose of the meeting was to discuss the findings of the studies commissioned by ICIMOD in four countries, namely, China, India, Nepal, and Pakistan, and to identify future priorities for energy development. Two focal areas were covered in the discussions: i) emerging issues in energy use; and ii) energy policies and programmes. With a broadened understanding of these issues, future priorities for energy development in the mountains were discussed and several suggestions were made with regard to both policies and studies to improve understanding.

The meeting addressed issues related to database and planning, energy development and its sectoral linkages, energy resources and technological options, and subsidies and incentives for renewable energy technologies. The meeting was useful in promoting understanding of emerging trends in energy use in mountain areas. These trends are: prevailing unsustainability of the energy supply and demand in the mountains; inharmonious energy transitions, on the one hand, towards non-monetised low quality energy forms and, on the other, towards non-renewable fossil fuels; wrong choice of energy resources and technologies due to lack of a quality and quantity perspective in energy programme design; ignorance of the biophysical aspects of the mountains; and the methodological dilemma of having to internalise environmental costs. On the energy policy and programme front, the meeting identified the following issues: accommodation of multiple interest groups in decision-making; lack of technology and institutional policies; lack of sectoral linkages at the policy level; lack of vision with respect to technology choice; and insufficient focus on research and development of new energy systems. The meeting suggested that the role of every stakeholder involved be recognised and that more emphasis be given to ensure the active participation of women in the design and implementation of energy programmes.

The meeting identified important areas for ICIMOD's future activities related to the energy sector. These are related to understanding and comprehending energy use variability in those economic sectors that have comparative advantages for alleviating poverty in mountain areas. Due recognition needs to be given to possible impacts on environmental conditions in fragile mountain areas and human health in opting for a particular energy mix. In this respect, factors that promote renewable energy technologies' (RETs) adaptation need to be understood and sustainable energy policies and programmes need to be

developed. The meeting emphasised that continued efforts are needed in programme advocacy, information exchange, sharing of knowledge, and increased capacities in the field of mountain energy systems.

Contents

Chapter 1
Background

Development of energy is essential in the mountains for three distinct reasons: first, to ensure the minimum level of energy services required to meet the basic needs of mountain communities for cooking and space heating; second, to maintain energy services that sustain and support economic activities (newly emerging or traditional ones); and, third, to increase the incomes of mountain communities through the development of available energy resources that are abundant and/or are renewable in nature.

In the past, the pattern of energy use has been dictated by the availability of and access to particular energy resources and technologies developed by the communities themselves, and the use of energy has been primarily to fulfill subsistence needs. Most of the time, the cost for the extraction of these fuels (primarily fuelwood) was the labour involved in their collection. Decreased availability of biomass, together with low purchasing power and increasing population, indicated unsustainable trends in energy use patterns. These trends triggered environmental hazards of different magnitudes, particularly in the Hindu Kush-Himalayas (HKH) and its adjoining plains.

Policies to promote forestry and energy development in the mountains were initially aimed at reducing the consumption of fuelwood with the intervention of providing improved cooking stoves. These interventions failed due to improper assessment of the multiple use of traditional technologies and the non-recognition of sociocultural aspects. Also, the consumption of fuelwood was considered the main cause of deforestation, while other requirements, such as fodder for livestock, land required for cultivation due to low productivity, large-scale felling of timber for commercial purposes, and so forth, were not given due attention in designing energy options. At the same time, the issues of alleviating human drudgery and deteriorating health conditions, particularly in the context of women and children, as well as decreasing soil fertility were never adequately addressed.

The appropriateness of energy resource, technology, and institutions not only requires comprehension of the quality and quantity of energy services required but also of the physical environment (i.e., mountain specificities). For example,

the quality of energy services dictates the choice of energy resources and technologies, whereas the quantity required dictates the scale of energy technologies and institutions, and these, in turn, determine the suitability of particular types of financial infrastructures. The conditions that relate to mountain specificities entail the availability of energy resources on a sustainable basis. At the same time, the choice of energy technologies and institutions is crucial in terms of their scale of operation and socioeconomic and cultural acceptability, as these factors are even more vital in mountain areas.

Given this situation, the type of energy service required and the supply available need to be understood, together with their environmental implications, so as to identify appropriate policies and investment strategies for the development of a sustainable energy system in the HKH. Recognising this, ICIMOD established a programme on Sustainable Energy Development in Mountain Areas, as indicated in the Four-year Regional Collaborative Programme, 1995-1998. Activities envisaged under the programme are to: a) analyse the present energy-use patterns in rural and urban areas of the HKH; b) prepare forecasts of the energy needs of the HKH at the household level and for industrial development; c) prepare guidelines for energy planning; and d) prepare state-of-the-art reviews on the potential use of renewable energy in the HKH.

As part of its energy programme, ICIMOD carried out a series of studies on the Analysis of Present Energy Use Patterns in Urban and Rural Areas of the HKH in order to understand the energy use patterns and supply potentials and to develop an energy database. The studies have been completed in China, India, Nepal, and Pakistan by collaborating institutions/experts and were instrumental in identifying energy sector data-gaps; reviewing energy policy and planning frameworks; reviewing energy sector manufacturing capabilities; identifying sustainable energy supply potentials; constructing energy flows for each economic activity in terms of a Reference Energy System (RES); preparing the energy balance for the HKH; and identifying socioeconomic variables that influence useful energy consumption patterns for different end-use activities.

As a follow-up, a meeting of experts from ICIMOD regional member countries was organised from April 16-18, 1997, in Kathmandu, with the objective of reviewing energy-use patterns, policies, and programmes prevalent in the HKH so as to identify priority areas for energy development.

A detailed programme of the meeting is presented in Annex 1. The study coordinators from China, India, and Nepal made summary presentations on energy use in mountain areas. Dr. A. A. Junejo made a brief presentation on behalf of the coordinator from Pakistan who could not attend the meeting. In addition, experts from China, India, Nepal, and Bangladesh made brief presentations on the energy policies and programmes of their respective countries. Extensive discussions were held on the deliberations, based on the summary presentations made by **Dr. Kamal Rijal** on the emerging issues in

energy use patterns, policies, and programmes. Priority areas for the development of the energy sector in the mountains were identified. Also, **Professor M. Nurul Islam** presented a methodology for carrying out the study on energy-use patterns in the HKH Region of Bangladesh.

The meeting was attended by energy experts from four member countries of the HKH Region and by ICIMOD professional staff members. The list of participants is presented in Annex 2. The list of studies commissioned by ICIMOD and papers presented during the meeting is presented in Annex 3.

Chapter 2
Opening Session

Dr. T. S. Papola, Head of the Mountain Enterprise and Infrastructure Division (MEI), formally welcomed the participants. In his welcome address, Dr. Papola noted that the importance given to the energy programme in the division arose with the realisation of the role of energy in increasing the incomes of mountain populations. He also spoke about the integrated approach being pursued by ICIMOD, with its identification of linkages between energy, environment, and the economy, as a sectoral approach to energy development had not been found suitable for mountain areas.

Mr. Egbert Pelinck, Director General of ICIMOD, in his opening address, pointed out the complexities of decision-making in relation to energy demand and supply, particularly in the Hindu Kush-Himalayan Region, due to poor and unreliable information. This had also hampered the development of potential renewable energy sources. Even when such development took place, it was usually from the perspective of meeting the energy needs of the urban and plains' areas. Consequently, the specificities of mountain conditions were inadequately reflected in national energy strategies, policies, plans, and programmes. And, when there was a strategy, energy was usually treated as a 'welfare package' and as a constraint to economic development. Rarely was due attention given to the sustainability of its use or its potential for generating incomes.

In light of these circumstances, Mr. Pelinck stressed the importance of making a programme on integrated energy development a part of ICIMOD's major mandate of poverty alleviation and environmental conservation. He said the energy programme was primarily guided by an overall mountain perspective for sustainable development formulated by ICIMOD for the HKH Region. First of all, the programme addressed how energy use in mountain areas could be adapted to overcome the major constraints of development such as inaccessibility and fragility. And, secondly, how the comparative advantages that mountains provided could be used for sustainable development, based on the biological, ecological, and cultural diversity of the region. For energy, these applied particularly to the mountain specificities of verticality; abundant hydropower potential and sunshine; and, in many places, a sustainable supply of biomass.

Mr. Pelinck raised a number of issues he hoped the meeting would address in depth. He emphasised the importance of energy, particularly fuel, in meeting cooking and space heating requirements in mountain areas. At the same time, he said it was necessary to find ways of reducing the drudgery in collecting fuelwood and other biomass and of making more efficient use of existing resources. Efforts in this direction would benefit women and children particularly. He pointed out that the economic considerations of providing and developing an energy supply infrastructure should be given due recognition so as to increase the productivity of mountain areas and also to sell energy as a commodity to other parts of the region.

The second important issue concerned the types of energy that were suitable from the point of view of the sociocultural characteristics of mountain communities as well of mountain specificities. In this regard, Mr. Pelinck suggested that the primary focus should be to exploit energy resources that were renewable. The mountains were fortunate in possessing these types of energy but lacked appropriate policies, technologies, institutions, and finances to exploit these resources efficiently. He emphasised the need for the right perspective in the quality and quantity of energy services required and energy resources available, as this dictated a choice of energy mix that maximised social and economic benefits in both the short- and long-term. Focussed attention would have to be paid to both the potentially harmful and positive effects on the environment, taking into account the global imperative to reduce CO_2 emissions and local imperatives to maintain sound health at the household level, besides the retention of adequate vegetative cover and the prevention of soil erosion and landslides.

Mr. Pelinck also pointed out the need to identify appropriate policies and institutional mechanisms that could ensure the development and management of the right type or mix of renewable energy resources at the household, village, and district levels. He pointed out the strong link between the institutional mechanism and the choice and scale of technology and suggested that it was essential to incorporate local views on appropriateness, need, and management before embarking on selection of a particular energy mix.

According to Mr. Pelinck, the meeting would not only be instrumental in understanding the emerging trends in energy use, policies, and programmes in the HKH Region, but would also generate ideas on the type of activities ICIMOD should engage in developing an energy sector with greater relevance to integrated mountain development within the scope of its mandatory functions of a) applied research, b) documentation, c) training, and d) advisory services.

Mr. Pelinck said,

> *"I am sure you will bear in mind that energy is not only a critical factor in integrated mountain development but also the basis*

of all life and endeavor. Ourselves and our total environment are made up of some kind of energy; without energy, nothing exists. Every spark of energy is precious because it feeds the flame that sustains life."

In conclusion, Mr. Pelinck reminded participants that the meeting was not an end in itself but rather the start of a programme on energy. He described it as a key to the well-being of the approximately 130 million inhabitants of the Hindu Kush-Himalayas and therefore of interest to ICIMOD. He expressed his belief that the results of the work of experts on energy use would not only have an impact beyond domestic and small industrial uses but also on life in these remote and marginalised areas.

Mr. Pelinck's opening address was followed by a presentation by Dr. Kamal Rijal, energy specialist from the MEI Division of ICIMOD, on the background and objectives of and the expectations from the meeting. Dr. Rijal gave a brief account of the energy programme of ICIMOD, categorising the energy sector activities before and after the implementation of the Regional Collaborative Programme (1995-1998). He highlighted the work on rural energy which began with the state-of-the art reviews in five countries and culminated in the International Workshop on District Energy Planning and Management for Integrated Mountain Development in May 1986 and the publication of a book on 'Rural Energy Planning for the Indian Himalaya'. As a follow-up to the workshop, an occasional paper 'Decentralised Energy Planning and Management for the Hindu Kush Himalaya' was published in the same year. In the same workshop, experts supported the idea of energy-centred development planning efforts at the district level which resulted in a 23-month project on 'Strengthening Rural Energy Planning and Management in the HKH' in January 1987, financially supported by the European Economic Community (EEC). The purpose of the project was to develop methods of rural energy planning and management in mountain regions; to disseminate these methods among district-level officials; and to train trainers from selected institutions within the HKH.

During the early part of 1991, ICIMOD organised a seminar on 'Rural Energy and Related Technologies' in Nepal. This was a collaborative effort of ICIMOD, ADB/N, WECS, and HMG/Nepal. In the meantime, a comprehensive study on mini- and micro-hydro plants in Nepal was initiated that resulted in the publication of an Occasional Paper by ICIMOD.

Dr. Rijal said, following the realisation of the comparative advantage of hydropower development, the mini- and micro-hydropower regional training programme was implemented during 1993 and 1994 with financial support from the Norwegian Agency for Development Cooperation (NORAD). A consultative meeting of international experts was held to review the status, achievements, policies, issues, and problems and to work out a course of

action for the future. The exercise of information collection and analysis, followed by the experts' meeting, was a useful undertaking that brought together the scattered information and experiences in the field.

While the programme on mini- and micro-hydropower technology was continuing, a new programme on solar energy had recently begun.

The main activities on mini- and micro-hydropower in 1995 included the organisation of a seminar and training programme with documentation of the same. During 1996, the main activities involved networking, building up a database, and collecting information about training needs, prevalent practices, and training materials. Five information manuals on survey and layout, installation, manufacture, operation and management, and repairs were being prepared.

A programme on 'Solar Energy in Mountain Development' commenced in mid-1996. Under this thematic programme, a modest beginning had been made in the form of an initiative to establish a network on Passive Solar Building Technologies (PSBTs), with the aim of understanding the prospects of and constraints to solar energy development in mountain areas. Institutions that could play a leading role in networking had been identified in China, India, Nepal, and Pakistan. These institutions would prepare a list of institutions involved in the field of solar energy development, organise a national seminar in each country to understand the state-of-the-art of PSBTs, and recommend appropriate policies for the development of the same by identifying areas for further study.

Dr. Rijal said that the knowledge generated on the energy sector during the 80s within ICIMOD and beyond had brought about a shift in the energy development paradigm in mountain areas and also shaped ICIMOD's energy programme. This had resulted in the need for an integrated approach to energy development for the mountains as interventions in this respect had mostly been of a sectoral nature with little recognition being given to the linkages between environment, energy, and other infrastructural services and economic activities.

With this brief review of the activities of ICIMOD's energy sector, Dr. Rijal pointed out that the meeting was a follow-up to the studies on energy-use patterns in the four countries of the HKH Region. He summed up the objectives and expected outputs of the meeting as follow.

The objectives of the meeting were as given below.

- To review energy-use patterns in urban and rural areas of the Hindu Kush-Himalayan (HKH) Region based on the studies completed in China, India, Nepal, and Pakistan

- To identify relevant issues and key areas for further studies in selected areas of the HKH
- To initiate studies on energy use patterns in Bangladesh and Myanmar
- To identify parameters for promoting energy policies and programmes suitable for the HKH

The expected outputs of the meeting were as given below.

- Improved knowledge of energy supply and demand patterns in the Hindu Kush-Himalayan Region of China, India, Nepal, and Pakistan
- Better understanding of sustainable/unsustainable trends of energy use in the HKH
- Identification of key issues and areas for further study in the energy sector of the HKH
- Development of a methodological framework for the analysis of energy supply and demand suitable for mountain areas
- Initiation of studies on Energy-use Patterns in Rural/Urban Areas of the HKH in Bangladesh and Myanmar

Chapter 3
Presentations and Discussions

Presentations were made on two thematic areas. First, coordinators of the country studies gave brief summaries of the studies on energy use in mountain areas carried out in the HKH Region of four countries, namely, China, India, Nepal, and Pakistan. Second, experts in energy planning were invited to make brief presentations on the energy policies and programmes in mountain areas. Discussions followed on these two thematic areas.

Energy Use in Mountain Areas

The morning session was chaired by **Dr. P. Venkata Ramana**, Dean, Tata Energy Research Institute, New Delhi, India, and **Mr. U Aung Kyau Myint**, Forest Resources' Specialist, ICIMOD, acted as the resource person. Summary presentations of country-specific studies commissioned by ICIMOD were made by **Dr. Kamal Banskota**, Director, Centre for Resource and Environmental Studies (CREST), Nepal, and by **Dr. A. A. Junejo**, Project Coordinator of the Mini-Micro-Hydropower Project, ICIMOD, on behalf of **Dr. M. Abdullah** of Pakistan who was absent.

The afternoon session on 'Energy Use in Mountain Areas' continued with **Mr. Zhang Mi** as the chairman and **Mr. Basanta Shrestha** facilitated the session as a resource person. The first presentation was made by **Mr. Wang Mengjie** of the Chinese Academy of Agricultural Engineering Research and Planning based on the study 'Analysis of Energy Use in Rural and Urban Areas of the HKH Region of China'. Following his presentation, **Professor N. K. Bansal**, who coordinated the study in India, made his presentation.

Following the country presentation, Professor M. N. Islam made a brief presentation on the proposed study in the Chittagong Hill Tracts. He outlined the energy policy objectives of Bangladesh and the suitability of the area-based energy planning method for the Chittagong Hill Tracts (CHT). He emphasised the importance of a database, an assessment of indigenous energy resources and technology and associated environmental impacts, and the need for a Renewable Energy Development Agency to be established under the Ministry of Energy and Mineral Resources, with appropriate institutional

arrangements for implementing area-based energy development programmes for the sustainable development of biomass fuels to meet the energy needs of specific areas like the CHT. He also stressed the importance of the participation of the private sector, NGOs, and local institutions in undertaking and implementing energy programmes. Professor M. Islam presented the methodological framework that would be used in carrying out the study on 'Analysis of Energy-use Patterns' in the CHT Region of Bangladesh to be commissioned by ICIMOD.

Fuelwood stored for rainy season, Nepal

Stored fodder, stacking straw in the hills of Nepal

Nepal

Dr. K. Banskota, in his overview of energy supply and demand patterns in Nepal, identified biomass and hydropower as the main sources of domestic energy. Biomass energy primarily included fuelwood, agricultural residue, and animal dung, whereas biomass fuels were land and labour intensive. The supply of fuelwood was mainly from accessible public forests on which there was increasing pressure due to increasing demand for fuelwood. Where shortages were acute, there was increasing reliance on crop residue and animal dung. Energy consumption patterns indicated that fuelwood was the main source of energy in the residential sector. The consumption of total biomass fuels varied across physiographic and development regions (i.e., 370 kg per capita in the eastern *terai* versus 1,700 kg per capita in the western *terai*), depending on availability, accessibility, affordability, and climatic conditions. There was a big gap between the sustainable supply from accessible forests and the demand for fuelwood (5.5 versus 11.5 million metric tonnes in 1994/95). There was no proven commercially feasible reserves of petroleum fuel, natural gas, and coal in the country. His conclusions: a) biomass energy would continue to dominate the future energy scenario; b) households would continue to be the largest energy consuming sector; and c) energy supply constraints remained as a major bottleneck to industrialisation.

There was a variation in the final energy use across the three ecological regions. Only 12 per cent of the total population had access to electricity - 4.5 per cent of the rural population and 89 per cent of the urban population. Almost 45 per

cent of the total electricity was consumed in Kathmandu Valley and system losses accounted for 25 per cent. Per capita energy consumption in Nepal ranked as one of the lowest in the Least Developing Countries (LDCs) and was estimated to grow by 2.4 per cent annually. Indigenous production of energy contributed to 92 per cent of the total final energy supply and imports accounted for nearly seven per cent and primarily included petroleum fuels and coal.

The pattern of energy consumption in terms of useful energy indicated that the residential sector had the lowest energy transformation efficiency, while it was highest in the industrial and commercial sectors. This was due to the prevalent energy mix; i.e., sectors in which the use of low-grade energy dominated the energy mix would have low energy transformation efficiency. Thus, improvement in efficiency not only required structural change in the energy mix but also improvement of energy technologies. However, population growth, poverty, low affordability, and poor social infrastructure precluded a massive shift in the energy resource and technology mix. Hence, traditional fuels would continue to dominate the energy scenario in Nepal, though programmes might be geared to improve and increase their renewability and to upgrade the quality of these energy resources.

The presentation emphasised the role that renewable energy technologies would play in reducing drudgery, health hazards, CO_2 emissions, the energy import bill and forest depletion, and, most importantly, how they could be exploited on different scales and sizes to suit local needs and locations. The development of renewable energy technologies had been highly dependent on donor support, with inadequate infrastructure for R&D, fabrication, promotion, and dissemination in place. The government policy had been inconsistent and *ad hoc*, though a serious effort had been made in the Eighth Five-Year Plan to facilitate renewable energy development. The major issues related to the development of renewable energy technologies were: non-acceptance by users; high initial investment costs; non-availability of different designs and non-utilisation of local materials; weak government commitment at the policy level; and the absence of a responsible coordinating institution. Besides these, a number of managerial and marketing aspects hampered the promotion of Renewable Energy Technologies (RETs), e.g., a variation in incentives across different energy technologies; poor research and development programmes, primarily initiated through donor interest

Traditional De-husker popular in rural mountain areas of Nepal

which lacked long-term commitment; inconsistent quality and standardisation as no institution was responsible for standardisation; serious inadequacies in terms of trained manpower to repair and maintain new technologies; poor interaction between designers and end users of the technology; poor coordination between the government, NGOs, and private sectors; and a lack of operation and maintenance support in most of the RETs.

The need to make the energy development policy a separate entity had been recognised since the Fifth Five-Year Plan (1975-80), whereas alternative energy resource development received priority in the Seventh Five-Year Plan (1985-90). The Eighth Five-Year Plan (1992-97) aimed at pursuing the approach further through the increased consumption of electricity and by supporting energy-intensive industries with the development of hydropower; developing alternative and decentralised energy resources as a substitute for imported fuel; and ensuring environmental protection. The Eighth Five-Year Plan fixed the following targets: construction of a power project with an addition of 292.7 MWe; construction of 30,000 more biogas plants; and distribution of an additional 250,000 units of improved cooking stoves. In order to improve the planning capabilities of the energy sector, the WECS carried out energy supply and demand modelling and completed models for the residential, transport, agricultural, industrial, and commercial sectors.

The factors responsible for the poor performance of the energy sector were: government interference in management; lack of trained manpower and over-staffing; lack of standardisation; limited planning; distorted pricing structures and price control (subsidies); and political pressure to supply electricity at less than long-run marginal costs. The government had taken the following steps to improve the economic and allocative efficiency of the energy sector: a) selected opening of markets and greater reliance on market forces; b) increase in the proportional allocation of resources for regional and rural development; c) administrative reforms and civil service staffing policies; d) measures for economic liberalisation; e) transparency in regulation; and f) introduction of investment credit, profit repatriation, and other incentives to mobilise funds from domestic and international sources.

The summary presentation also reviewed the manufacturing capabilities of RETs with a primary focus on micro-hydropower development. The main features highlighted were: a) manufacturers were mostly located in the western *terai* and in Kathmandu; b) local expertise in design and manufacturing capabilities existed but all the agro-processing units or electric generators were imported from India; c) poor literacy and weak management capabilities of village entrepreneurs; d) lack of well-established international markets; and e) poor organisation and management (O&M).

A review of the database for energy was included in the presentation – highlighting the following issues: a) the reliability of energy data was still

questionable; b) end-use efficiency matrices for all sectors were weak and needed to be improved through further research; c) the most recent basis for fuelwood estimates was 1979 aerial photographs and thus they might not accurately represent the current situation; d) estimates of the number of irrigation pumps were dubious and their reliability was questionable; e) data on the number of operating transport fleets posed a problem with no official data on the actual fleet in service, hence vehicles were assumed to retire in about 15 years to derive the operating fleet in road transport; and f) biomass energy balances were derived using various consumption surveys carried out in different time-frames, and this could distort the estimation of biomass fuel consumption.

Fuelwood (off-cut of fruit trees) stack ready for sale in Gilgit, Northern areas of Pakistan

Transport of Timber along the Karakoram Highway, Pakistan

The Hindu Kush-Himalayan Region of Pakistan

The presentation on Pakistan started with an overview of the general physiographic and economic situations of Pakistan and the Hindu Kush-Himalayan Region. In the overall assessment of the energy situation in Pakistan, the following were highlighted: a) forests covered 4.8 per cent of the total land area, with 1.12 million hectares of production forest and 3.15 million hectares of protection forest; b) total woodstock was nearly 210 million tonnes with an annual yield of 22 million tonnes, while the consumption estimate was 32 million tonnes, indicating a deficit of 10 million tonnes in 1991, which meant that, unless this trend was averted, Pakistan might lose all of its wood resources by the year 2011; c) crude oil reserves stood at 198 million barrels, natural gas at 21 trillion cu.ft., coal at 1,686 million tonnes, and hydroelectric potential at 30,000 MW; d) the primary commercial energy supply was 36.1 million TOE in FY 1994-95, of which the share of oil was 41.5 per cent, gas 37.2 per cent, and hydroelectricity 15 per cent, out of which 60 per cent of the supply was met by imports at a cost of nearly 1.2 billion dollars.

In the HKH Region of Pakistan, the major energy resources available were as follow: a) total wood biomass standing stock was estimated at 45.24 million tonnes and 13.82 million tonnes in the NWFP and Balochistan, which resulted in a firewood growth per annum of 2.96 and 1.79 million tonnes, respectively, in 1993; b) the NWFP was very rich in hydropower and produced nearly 3,760

Improved cooking and heating stoves fitted with a chimney in the northern areas of Pakistan

MW of electrical power, whereas Balochistan possessed 53 million tonnes of coal reserves and four trillion cu. ft. of natural gas; and c) the NWFP was a net exporter of electrical energy and imported gas and petroleum products from other provinces, while Balochistan was an importer of electricity and oil, but exported natural gas and coal.

Most households in the HKH Region used firewood, agricultural residue, dung cakes, charcoal, kerosene, and electricity. In the NWFP, 90 per cent of the households in urban areas and all the households in rural areas used traditional fuels. In the case of Balochistan, these figures were 93 and 97 per cent, respectively. Of the traditional fuels, fuelwood was used by the majority of households. The type of fuel used was influenced by the expenditure levels of user households. In urban areas, the share of traditional fuels was 77 per cent for low expenditure level users and 34 per cent among high expenditure level households. In rural areas, there was a nominal variation in the use of traditional fuels with household expenditure patterns (i.e., 96 and 92% for low and high expenditure levels, respectively).

Also highlighted were the various environmental problems being experienced in the HKH Region of Pakistan. First, pressure was increasing on the mountain environment because its population growth rate was high compared to the national average (i.e., 3.3% for the NWFP and 7.1% for Balochistan compared to 3.1% for Pakistan). Second, water and soil erosion were becoming vital concerns in the mountains. For example, 90 per cent of the soil degradation in the NWFP and 75 per cent in Balochistan resulted from water erosion, causing an increasing loss of vegetative cover. Next, the principal towns in the HKH Region, Peshawar and Quetta, were experiencing severe air and noise pollution due to vehicles on the road. Large numbers of brick kilns operating in the NWFP and Balochistan used low-grade coal as fuel which emitted substantial

amounts of pollutants into the air. Fourth, the excessive use of fuelwood had serious consequences on Pakistan's environment. It was estimated that during a period of 100 years (1880-1980), the forest area decreased to less than half. As a result of deforestation, flooding and siltation had increased. The two main reservoirs (Warsak and Tarbela) were silting up at a high rate, and it was feared that the working life of these reservoirs might be greatly reduced, and this would also have serious consequences on Pakistan's economy. In Balochistan, coal mining was carried out extensively, and this had a serious impact on the environment, e.g., land disturbance, emission of dust, acid mine drainage, and pollution of streams and rivers.

Institutional arrangements, with regard to the energy sector in Pakistan, were described briefly as follow.

- The Planning Commission of the Government was responsible for planning all socioeconomic sectors, including energy. At the provincial level, the Department of Planning and Development was responsible for planning and preparing the annual development programme for each year. In the NWFP, the Sarhad Hydel Development Organisation (SHYDO) had been established recently to carry out energy planning for mountainous areas, in particular the supply of electricity to rural areas from small/medium hydropower plants.

- Marketing and distribution of petroleum products were carried out by oil companies in the private and public sector. Gas companies were transporting and distributing natural gas all over Pakistan including the HKH areas.

- Marketing of fuelwood was carried out by the private sector. About 50,000 private businesses were engaged in marketing fuelwood. In rural areas, household members primarily collected fuelwood for their own consumption.

Plight of solar photovotiac electrification scheme at northern areas of Pakistan due to lack of maintainance.

Different types of improved biomasss stoves demonstrated at an enviromental fair in Peshawar, Pakistan

- The Water and Power Development Authority (WAPDA) was the main agency responsible for the generation, transmission and distribution of electrical energy in most parts of Pakistan, including in the HKH Region.

- The Pakistan Council of Appropriate Technology (PCAT) was engaged in the planning and implementing of decentralised micro-hydroelectric schemes in the hilly areas of the NWFP. The Aga Khan Rural Support Programme was also implementing micro-hydro schemes, mainly in the district of Chitral in the NWFP and in other parts of the northern areas.

- Development and demonstration work on renewable energy resources was being carried out mainly by the research and development organisation of the Government of Pakistan. There were no commercial manufacturers of renewable energy appliances in the HKH Region.

There was a lack of authentic data on the supply and consumption of energy in the commercial, industrial, agricultural, and transport sectors for the HKH Region. Most of the data available related to the domestic sector - that too in aggregate form.

The presentation based on the study in the HKH Region of Pakistan concluded with the following recommendations: a) a comprehensive study should be undertaken on the energy supply and consumption patterns in the selected hilly regions of Pakistan; b) since biomass was expected to remain the most important source of fuel for most households in the region, programmes should be implemented to increase the supply of biomass and its efficient utilisation as a fuel; c) electrical energy was the best option for meeting the energy requirements for lighting and motive power; therefore, decentralised power schemes could be promoted in the HKH Region; and d) local institutions, e.g., district councils, could be involved in planning and implementing energy projects.

Multi-bladed windmill at demonstration site, China

Solar cooking stove popularised in Tibet, China

The Hindu Kush-Himalayan Region of China

Mr. Wang Mengjie began his presentation by saying that the Government of China had been paying serious attention to energy development within the HKH Region and proceeded to describe the approach taken in implementing energy programmes. In China, long-term energy development plans and short-term implementation plans were formulated in line with local conditions. Institutions and management schemes were established at various levels, from the central government to the local government. The role of energy was recognised as crucial for the production sector as well as to fulfill household requirements in the HKH Region of China. The energy consumption was classified as direct or indirect consumption. The consumption of commercial energy was recorded by special agencies involved in the distribution and sale of these fuels, though non-commercial energy consumption was difficult to estimate as these fuels are normally obtained and consumed locally.

The energy resources available in the HKH Region were fuelwood, agricultural residue, animal dung, coal, and hydropower, apart from the tremendous potential for solar energy exploitation. Fuelwood accounted for 40 per cent of the total energy consumption in the HKH Region, amounting to 760 kg per capita. Although a large amount of fuelwood resources were available in relation to the small population within the region, clearly, forest resources were overexploited. This was due to inconvenience in transportation, low efficiency of stoves, and insufficient supply of fuelwood within village communities. It was observed that timber was also used as fuelwood where it was locally available. Estimates suggested that the sustainable fuelwood supply amounted to two-thirds of the demand at the local level in areas where the population pressure was acute. Most of the energy in the HKH Region of China was supplied by state-owned coal, oil, and electricity, while small hydropower, small coal mines, biomass, and solar and geothermal energy were considered ancillary inputs to the energy supply system.

The presentation also touched on the overall situation of energy technologies in the region. The importance given to developing the HKH region by the

Small-scale biomass (agriculture residue) briquetting machine manufactured and being popularised in rural areas of China

government was clear, given the establishment of the oil pipeline to Tibet (Xizang), 15 hydropower plants, 14 thermal power plants, 350 micro-hydropower plants, three solar power plants, 60,000 solar cookers, 30,000 m^2 of solar water heaters, and three geothermal power plants. Specifically, the development of solar and geothermal energy would play a crucial role in the development of Tibet (Xizang).

The following were the major findings with regard to the energy sector of the HKH Region in China.

Large-scale biogas plant with boiler suitable for cold climate, China

- Energy consumption per capita, development and utilisation of energy technologies, and energy utilisation efficiency were low. Competent management was lacking in the operation of the energy supply system. There was a shortage of energy supply and also a wastage of energy resulting in a greater imbalance in energy supply and demand.

- The costs of coal exploitation, storage, and transport were higher than the national averages, and the limited utilisation of coal was also a problem.

- The present energy development and energy consumption pattern was unsustainable in terms of the energy resource available, funding required, high transportation costs, and environmental protection.

- The government laws, regulations, and policies on energy management, resource management, and environmental protection were suitable for the region and should be implemented.

The presentation also described the goals and implementation strategies with regard to the planning and management of energy integrated construction, improving the energy efficiency of various energy technologies suitable for the region, and the development and utilisation of new energy and renewable energy technologies. The proposed goals of energy planning and management were: a) to formulate an energy development plan of the HKH Region taking the economic development plan and environmental protection into consideration; b) to strengthen energy management, improve the energy supply structure and distribution, increase the proportion of clean energy and quality energy, and carry out industrial reforms to promote the reduction of energy consumption per unit of production value; and c) to strengthen rural energy construction and rural electrification and gradually reduce the over-consumption of biomass fuels. Similarly, the proposed goals for improving energy efficiency were to establish and improve energy-saving management procedures and approval systems as well as relevant policies and regulations in the HKH Region. The goals proposed for the development and utilisation of new and renewable energy were to strengthen the development and utilisation of new and renewable energy sources, improve energy conversion efficiency, reduce the cost of electricity generation, and increase the proportion of renewable energy in the energy supply infrastructure.

Biomass products in Aruanchal Pradesh, India.

Solar home light system installed on the rooftop of a house in Khartungla, Nubra Valley, Ladakh, India.

The *Hindu Kush-Himalayan Region of India*

According to Professor N. K. Bansal, energy planning in India reflected more short-term and medium-term concerns than long-term imperatives with the regime of administered energy prices continuing. New and renewable energy sources were being implemented through the financial institution known as the Indian Renewable Energy Development Agency (IREDA), which acted as a catalyst to accelerate commercialisation of renewable energy sources. The Eighth Plan (1992-97) focussed on the area of renewable energy and mainly on improved cooking stoves and did not significantly emphasize traditional energy sources. Coal and hydro remained the main sources for power generation in the country.

Solar photovoltaic system exhibited in Renewable Energy Technology Exhibition, Arunachal Pradesh, India

The main sources of energy in the HKH Region of India were fuelwood, agricultural waste, and animal dung, since 82 per cent of its population still lived in rural areas with predominantly subsistence economies. Forest cover within the HKH Region was on the decline due to the heavy dependence of the population on forests for fuelwood, though the region's overall forest cover was still 37 per cent compared to the national average of 15 per cent. There was a wide variation of forest cover among the states. For example, the North-Eastern region had very thick forest cover (70-90%) compared to the western and central regions' forest covers of from10-41 per cent.

The low-lying areas of the North-Eastern region (most of it falling within the HKH region) contributed 20 per cent of the country's crude petroleum. No coal reserves were located in Uttarakhand and West Bengal. The total coal reserves found in Assam, Megalaya, Nagaland, and Arunachal Pradesh were estimated at 864.75 million tonnes, out of which 257 million tonnes were proven reserves. Crude oil reserves in Assam and Nagaland were estimated to be 156.5 million tonnes compared to 765 million tonnes in the rest of India. Similarly, proven and balance recoverable reserves of natural gas in Assam and Nagaland were 160.5 bm^3 compared to Indian reserves of 707 bm^3. Even though fossil fuel production in the North-Eastern region contributed significantly to the Indian economy, the region used very little fossil fuel, except for kerosene, in the domestic sector. The consumption of petroleum products in the HKH Region was primarily in the form of high-speed diesel and kerosene, accounting for about three per cent of the consumption of petroleum products in the country as a whole.

The use of renewable energy sources in the HKH Region in India was through a fully subsidised programme of the Ministry of Non-conventional Energy Sources (MNES). The principal programmes were biogas plants and improved cooking stoves, and mainly these were concentrated in low-lying areas. Almost 22 per cent of the households in Himachal Pradesh still used cow dung as fuel for cooking and space heating.

There was a huge gap in the actual demand and consumption of electricity, particularly in the two states of Himachal Pradesh and Jammu and Kashmir (J&K) for which estimated demands were 2,000 and 4,000 million kWh of electricity per annum, respectively, compared to an actual annual consumption of 300 and 400 million kWh per annum, respectively. There was also a marked difference among the states within the HKH Region; for example, in Assam and Meghalaya, the percentage of households with electricity was 19 and 30 per cent, respectively, compared to 87 per cent for Himachal Pradesh. The use of electricity for operating pumpsets to irrigate land was also observed in the HKH Region of India, while no pumpsets had been energised in Mizoram, Nagaland, and Sikkim.

In comparing the energy consumption patterns from 1981 and 1991 within the HKH Region, a distinct pattern emerged: a) the share of commercial fuels was increasing in the domestic sector; b) the share of 'other' biomass fuels was increasing among traditional fuels; and c) the availability of better infrastructural facilities increased the share of commercial fuels.

The presentation identified the following major issues with regard to the energy supply and demand patterns.

- There were constraints in supplying commercial fuels to regions such as the North-East, Lahul Spiti, and Ladakh. More than two-thirds of the total hydro potential of India was to be found in the HKH Region, of which only a fraction had been used for power generation. Part of the reason for this under-utilisation was the fact that the construction and maintenance of long transmission lines, roads, and geological conditions in the hilly regions required enormous investments and long gestation periods, aside from the capital-intensive nature of hydropower projects.

- The availability of data on energy resource availability and consumption patterns was poor. The district-level data were scanty and unpublished.

- Renewable energy sources, particularly biomass and solar, were promising alternative sources to meet the demand.

- Micro- and mini-hydropower systems might be most suitable in the hilly regions to avoid the cost of long transmission and distribution lines.

- Investment in the energy sector had been more or less exclusively reserved for the public sector, though the government had recognised the need for increasing private sector participation in development of the energy sector, particularly in electricity generation, supply, and distribution. Private sector participation was meagre so far.

- Energy policy emphasised the supply strategy to increase national power capacities and increase oil production and imports, while ignoring the demand side of the energy sector, so that the mountain energy system remained on the periphery.

- Power, coal, oil, large hydro, and nuclear sectors were the best organised and, although there was a Ministry to administer renewable energy sources, their efforts were disorganised and lacked innovation.

- There were no manufacturing capabilities for renewable energy devices within the HKH Region, although they existed for wind and solar photovoltaic manufacturing on a national scale.

- The energy supply in the HKH Region could not improve significantly unless efforts were made to harness the hydro potential and renewable energy sources. Technologies for renewable energy sources, particularly biomass, needed to be developed efficiently to utilise these resources.

Identification and Discussion of Issues

Methodological Issues: Database and Planning

Dr. T. S. Papola remarked that, while overview studies of this kind were useful, focus was required to capture the dynamics of change taking place in mountain communities with respect to the various sectors of the economy. In this context, energy-use patterns should be studied in sectors on the verge of transition. For instance, the rapid growth of tourist activities in mountain areas might require substantial and different forms and qualities of energy, thus an enquiry as to how this demand could be met and what type of energy mix was more suitable would be more meaningful. At the same time, the planning of various sectors, such as tourism or agriculture, might also provide an opportunity for energy sector development.

Dr. Papola also said that the establishment of a robust database at the macro-level alone might not convert into effective planning at the micro-level. Because the quantification and estimation of traditional fuels were both cumbersome and varied widely, depending on the technological interventions, it would be more useful to capture the general trends than to try to build a hard-core database. It was not that we did not know anything about energy use in the region, but that we knew far too little. The creation and management of a regional database in the energy supply infrastructure could be considered. However, less expensive methods of generating knowledge might be appropriate for institutions like ICIMOD whose role would be to initiate networking activities and facilitate exchange of data, while energy institutions in the respective countries of the region might consider the establishment of a database.

He also warned against the danger of using data without closer scrutiny and disaggregation. For example, a sizable part of Uttarakhand was in the plains where the use of cow dung was widespread, while there was minimal use of this fuel in the mountains. If we look at average cow-dung use in Uttarakhand, we find that dung contributes about 24 per cent of the total energy consumption, but planning on the basis of this aggregate information would have little relevance for the mountain areas of Uttarakhand. At the same time, establishing a database at the village level would also be expensive.

Mr. Zhang Mi emphasised the need for an energy database, as this would help to formulate suitable energy plans and policies at the local level. Mr. S. L. Shrestha said it was important to identify the types of database requirement that influenced the decision-making process, so that such information could be collected and collated by the national institutions, while ICIMOD could provide a common methodological framework for the countries of the region. Commenting on Dr. Banskota's presentation on Nepal, he said the 'Alternate Energy Promotion Centre (AEPC)' was created under the newly-created Ministry of Science and Technology with a mandate for channelling subsidies and promoting the development of RETs, besides coordinating and monitoring the progress. He also suggested that the development and design of a renewable energy programme in Pakistan should be based on the long-term vision for the sector, and this was missing at present.

Dr. K. Banskota questioned whether energy planning in mountain areas was essential. It was possible too many resources were being used in planning. What was important was the implementation of energy programmes that ensured the participation of beneficiaries. In this context, documenting the factors of success and failure of energy technology adaption could provide valuable insights. He quoted the case of the Barpak Micro-hydropower Project, in which a single entrepreneur proved instrumental in uplifting the economy of one area, and described the case as one in which the energy system played a key role as an entry point for the betterment of the community as a whole. The development of this scheme was based primarily on generating income rather than on consumptive use.

Professor Bansal suggested that different fuels, whether renewable or conventional, needed to be evaluated on the basis of their economic costs, also incorporating environmental costs, but that these evaluations had to be based on a systems' perspective. To this end, planning was required. He pointed out that energy planning should not be viewed as a static concept but taken from a holistic approach. With rapid changes in the availability of the types of energy resources and technologies and the increasing purchasing capacity of the mountain population, a different set of energy choices was appropriate. In this respect, local-level energy planning with dynamic sectoral links would be more suitable in mountain areas.

Dr. Rijal suggested that, while there was undoubtedly a need to create and establish an energy database, there was also a need to examine the appropriate institutions for this task and to identify the type of information required to help energy planners in the HKH Region. What was most important was to understand the dynamics of change in energy mix and energy demand. At the same time, it was necessary to understand the relationship between the types of behavioural change and of energy mix, along with the implications of these changes on the surrounding environment.

Energy Development and Sectoral Linkages

Professor Bansal observed that energy was primarily consumed in the household sector and fuelwood was the primary source in the mountains. There was a need to look at the possibility of increasing the use of energy in the productive sector so that the income of the mountain communities could be increased, thereby supplementing the energy demand of the consumptive sector. At the same time, it would help the commercialisation of fuelwood, and the resource cost of plantation would be realised gradually in rural mountain areas. Without linking energy to the productive sector, there was little scope for the judicious exploitation of mountain energy resources nor for the sustained promotion of renewable energy technologies.

Energy Resources and Technologies

Mr. S. L. Shrestha pointed out that the sustainability of biomass fuels should receive high priority in planning for the energy sector of mountain areas. Professor Nurul Islam suggested that there was a need for a national programme insofar as the suitability of renewable energy resources and technologies for mountain conditions was concerned. Professor Bansal noted that the rate of deforestation in the Indian Himalayas was aggravated by the need for forest products for construction rather than by the fuelwood needs of mountain communities. Dr. Junejo said there was a need to examine: a) what level of energy consumption was sustainable from the environmental point of view? b) what the appropriate sources of energy for mountain communities were? c) how the energy demand and supply could be made to match? d) how feasible and desirable the decentralisation of the energy sector was? and e) what type of inputs would be necessary to develop institutions at the local level?

Dr. Rijal observed that the present trend of energy use was unsustainable in both supply and demand. For example, though the HKH Region was rich in hydropower, the overexploitation of forest resources was causing rapid deforestation, not only resulting in soil erosion but in greater health hazards for the household, as well as increasing the burden on women and children who were the main parties responsible for collecting fuelwood. On the other hand, as a result of increasing population and poverty, more and more households were using 'other' biomass which was detrimental to their health as well as to

soil fertility. On the demand side, no significant change had occurred in the share of energy requirements for consumption compared to those of the productive sector. Therefore, the pertinent issue would be to ensure the increasing use of energy for productive purposes so as to facilitate greater affordability for mountain people of the type of energy forms for consumptive use preferred.

Professor Nurul Islam cited the case of the Bangladesh *Gramin* Bank which made small groups aware of technologies and provided them with credit for their installation. Mr. S. L. Shrestha noted the need for local-level institutions to promote decentralised energy systems. Professor Bansal raised the issue of unreliability and the lack of after-sales' services for alternative energy technologies prevailing in the Indian mountains. Dr. Papola suggested that sole reliance on the private sector to develop the energy sector in mountain areas might not be the solution, as the methods of energy production might not always be environmentally benign nor affordable for local communities. The private sector's interest was to maximise profit, not social benefits.

According to Dr. Junejo, biogas development might not be environmentally friendly as it contained methane and carbon dioxide, which were the main ingredients of greenhouse gas. Dr. P. V. Ramana said the issue needs to be carefully examined from the systems' perspective; i.e., from energy resource extraction to end-use application, considering the energy transformation process and the associated environmental emissions at each node of energy transformation (for example, in burning dung or biogas as a fuel). In terms of gross efficiency parameters, biogas was more efficient and released less carbon.

Dr. Rijal expressed the need for persistent efforts with regard to the development of decentralised renewable energy systems in mountain areas. He cited an example from Nepal in which the establishment of a unit to coordinate the activities of the alternative energy sector was identified in 1984 and subsequently mentioned in two plan documents but took almost 12 years to materialise, and then too only because of persistent pressure from donor agencies. Also, there is a lack of commitment to developing renewable energy resources on the part of the government. For example, most of the energy investments made in the past were often initiated by donors with no long-term commitments from recipient countries. In some cases, these were not priority areas for recipient countries. Donors were not interested in recipients' priorities.

Subsidies and Incentives

Professor Bansal said subsidy schemes in relation to the promotion of RETs had failed and would fail as long as development of the energy sector was looked at in isolation. In disagreement, Mr. Zhang Mi said subsidies were required for the development of RETs not only for equity reasons in mountain communities but also to help develop a market for these new technologies. Mr. Shrestha suggested that subsidies should be considered for the RETs only as a short-

term option to promote new and renewable technologies. Dr. Papola pointed out that the subsidy issue needed to be examined not only from the perspective of immediate and direct economic and financial aspects but also from the perspective of long-term social costs and benefits. The type of subsidy scheme would also have a bearing on the development of the energy technology or the promotion of a market for new energy technologies.

Chairperson's Remarks

Dr. Venkata Ramana, chairman of the morning session, summed up the discussions, giving his own views. He suggested that while building a reference energy system is a good exercise, the HKH Region would face numerous problems as a result of data not being available and the unreliability of the database. ICIMOD, as a regional institution, should direct its efforts towards creating and updating an energy database. The situation in the mountains was more complex because of the unpredictable dynamics, and area-specific treatment was required as the blanket approach to programme development tended to fail. Also, the sociocultural dimension needed much more careful examination in the mountains then in the plains.

Mr. Zhang Mi, chairman of the afternoon session, said aggressive promotional activities were desirable to promote the use of renewable energy technologies. At the same time, since it would be difficult to find suitable technological options to replace biomass fuels, especially in rural mountain areas, efforts needed to be directed towards planting more trees and the introduction of energy-efficient biomass technologies. In this context, the solution should be based on a consistent long-term approach rather than on unsustainable short-term solutions.

Energy Policies and Programmes in Mountain Areas

Technical Session 2 on 'Energy Policies and Programmes in Mountain Areas' was chaired by Professor M. Nurul Islam and **Ms. J. Gurung** acted as a resource person. Papers were presented by Dr. P. V. Ramana from India, Mr. V. B. Amatya from Nepal, Mr. Zhang Mi from China, and Dr. A. Junejo from ICIMOD. The essential points of each presentation follow.

Indian Mountains

Dr. Ramana began his presentation by describing the features of energy use in the context of the Indian mountains. Mountain areas had dispersed settlements and poor infrastructure, as a result of which cooking and heating demands were primarily met by biomass fuel. Biomass fuel was considered to be 'free' by the communities, though monetisation was being observed in and around urban areas. The overuse of biomass fuel had caused natural resource degradation, created health hazards, and increased the burden on women. Inadequate electrification, poor quality, and erratic supply, due to the unviable

grid extension approach, as well as the inaccessibility and unaffordability of 'other' commercial fuels had hampered the fulfillment of the lighting and motive power requirements of mountain communities. Realising this, intervention programmes with a primary focus on new and renewable energy systems such as improved cooking stoves, biogas, solar cookers and heaters, small hydropower and afforestation were initiated. The impact of these interventions remained marginal, with a minuscule effect on substitution, because of a lack of systematic planning of supply and demand, the immaturity of some technologies, and an improper institutional framework. In addition, there was no operation and maintenance infrastructure available, no mechanism for local involvement, and no match was made between electricity generation and load.

With this background, Dr. Ramana presented the key parameter for policy planning at the operational and institutional levels. At the operational level, the issues that needed to be examined with regard to dissemination were: technology choices – including research and development, establishment of micro infrastructure, and capacity-building. On the institutional front, database creation and management, sectoral integration, the suitability of financial mechanisms, and the required policy support must be carefully examined.

The options available for the dissemination of energy technologies in the context of mountain areas were centralised, decentralised, and commercial. Each of these options had certain characteristics. For example, the centralised approach tended to be target-oriented but took into account the macro issues with a low penetration rate. The decentralised approach tended to be need-oriented and took into account the area-specific dynamics with a medium penetration rate. The commercial approach tended to be market-oriented and optimise product choice based on financial costs, and this might result in high social costs due to market imperfections but might have a high penetration rate.

Currently, technological choices were limited in the mountains. This was because little attention was given to research and development: less than 0.5 per cent of the total energy budget was made available for renewable energy technology. Also, matching of energy technologies to need and end-use requirements was not considered seriously. Some of the technological options that required further evaluation but showed strong application potential in the mountains were: i) improved watermills for motive power; ii) gasifiers for water lifting; iii) PV for refrigeration; iv) biogas for tough terrain; v) biogas for low temperatures; vi) small hydropower for small-scale industries; vii) forestry for fuelwood; viii) mini-/sub-grids and distribution utilities; and ix) hybrid systems of any combination such as water, solar, and wind.

The establishment of micro infrastructure and local-level capacity building might be instrumental in promoting suitable energy technologies in mountain areas;

for example, the establishment of operation and maintenance workshops in remote locations, the facilitation of access to spare parts, the development of local skills, and the promotion of user education and awareness campaigns. The suggested target group for capacity-building could be government functionaries, non-government organisations, and unemployed and semi-employed youths.

Database management was vital for proper planning within the energy sector and for integration with other sectors. There was a need to compile, update, process, and coordinate data and to make them available to different stakeholders at the regional level. There was a need to develop authentic and rigorous methods of estimation to aid practical planning and implementation of energy programmes. At the same time, there was a need to document the successes and failures of energy programme interventions, with the identification of causal factors, and a need for disseminating them widely. Also, it was necessary to develop methods of estimating the social and environmental costs and benefits of technology alternatives.

Energy planning should not be considered as an isolated activity but as an integral part of overall economic development. Among the examples of possible sectoral linkages were: a) developing biomass energy technologies for agricultural development; b) promoting small hydropower as part of a load development package with a focus on small-scale industries; and c) encouraging biogas development with a health and sanitation programme.

The suitability of financial mechanisms in mountain areas must be examined carefully with respect to the various options available. To do that, the form of subsidy (cash, interest, infrastructure) and its proportions needed to be designed appropriately. These varied substantially and were found to be effective in one place but not in another. Similarly, there were various forms of fiscal incentives (accelerated depreciation, tax reductions, duty exemptions) and soft credit mechanisms directed at users, manufacturers, and entrepreneurs. At the same time, the provision of risk or venture capital might be instrumental in promoting new and renewable energy technologies.

Special policy support was critical for development of the energy sector in mountain areas. These included: legislative support, inter-departmental coordination for sectoral integration, and effective monitoring of energy programme implementations. The recent policy initiatives taken in the Indian mountains included: a) acceptance of the promotion of renewable energy technologies (RETs) as part of a rural electrification programme in the North-East; b) the UNDP-sponsored five-year country programme on rural energy; c) an energy plan in preparation for Ladakh; d) plans to amend the Indian Electricity (1940) Act; and e) plans to introduce comprehensive legislation on renewable energy.

The role of ICIMOD in the region should be to act as a facilitator to promote the implementation of replicable models. ICIMOD could also take a leading role in carrying out detailed case studies to understand and capture the diversity within the region, database management, strengthening capabilities at different levels, through micro organisations, and pilot projects covering various approaches in relation to the energy sector.

Nepal

Mr. V. B. Amatya briefly described the energy sector and gave a review of energy policy in the context of Nepal. He observed that weak institutional arrangements, conflicting rules and regulations, and meagre budgetary allocations still afflicted the renewable energy sector despite the strong policy statement made in the plan document. Vagueness and generality were often encountered in policy statements, sometimes intentionally for political reasons, while, in other circumstances, it was due to a lack of relevant information. He reviewed the objectives and strategies of the energy sector as depicted in the Eighth Five-Year Plan (1992-97) and remarked that the various policies and programmes placed little emphasis on the issue of rural energy or on those issues related to forms of energy other than hydropower.

Mr. Amatya summarised various issues related to energy policies and programmes and discussed possible options. He observed that: a) fuelwood would remain the dominant source of energy for rural residential cooking and heating needs; b) fossil fuel demands would continue to rise at an accelerated rate; c) hydropower would also play an important role in the energy mix; and d) the growing energy requirements of the rural population would have to be met by renewable energy development. Given this situation, appropriate pricing policies, market arrangements, and energy quality regulations became prerequisites for ensuring sustainable energy management in line with the economic liberalisation policy adopted by Nepal. Appropriate policies on research and development and institutional strengthening to improve the very low technical and economic efficiencies of the energy sector were needed. Along with these efforts, concerns about social equity became more relevant in the Nepalese context. There was low affordability for the purchase of energy as a large section of the population lived below poverty line and market forces did not ensure that they benefited from development, and that included development of energy. But care must be taken that policy interventions encouraged rather than inhibited private sector efforts.

There was a shift in rural energy management in Nepal from a centrally-planned to people-based decentralised approach. This needed further strengthening at local level with planning and implementing energy programmes that gave adequate institutional support and incentive packages. In the interests of programme sustainability, it was necessary for energy development, especially rural energy, to be guided by a development focus. The following framework

Micro-hydro-power operated sawmill along Ghandruk trek route, Nepal

should provide broad guidelines for rural energy management.

- Development focus of rural energy systems - i.e., their ultimate impact on economic growth, human well-being, and environmental sustainability - should be the driving motivation behind all planning and programmes in rural energy through the principle of least-cost energy services.

- A long-term vision of the rural energy transition, comprising the phased technological evolution of rural energy systems, from a traditional energy base (fuelwood and other biomass) to a combination of available natural resources and technologies, including centralised and decentralised energy systems.

- Managing technology dissemination through a planning process not only focussing on commercialisation of technology but also on reducing technology dependency.

- Strategies should be pursued through the government-assisted market economy and people's participation should be supported by the government's indicative planning.

In conclusion, Mr. Amatya observed that emphasis on the market economy, without appropriate institutional mechanism, might not lead to a desirable solution on the energy front. This could be realised only with broader participation, with stakeholders (government, market, NGOs) doing what they could do best and supporting each other. The immediate efforts to promote the development of renewable energy technologies should focus on removing barriers to the operation of market forces; to give the role of financial intermediary to the NGOs, and to monitor, evaluate, and facilitate the renewable programme through AEPC.

The HKH Region of China

Mr. Zhang Mi briefly presented the factors for promoting energy policies and programmes with particular reference to the HKH Region of China. He highlighted the institutional arrangements that existed in Sichuan Province, China. There were five organisations responsible for the energy programme at the provincial level: namely, the i) Planning Committee; ii) Construction Committee; iii) Committee of Science & Technology; iv) Hydropower Bureau; and v) Village and Township Enterprises. Under the Planning Committee, there were three divisions, namely, energy, natural

resources, and the monitoring division. There was an Energy Conservation Office under the Energy Division; and a Rural Energy and Environment Office at the county level, under the Construction Committee, was responsible primarily for the extension of biogas, efficient stoves, and solar technologies. The Committee on Science and Technology carried out relevant renewable energy studies at the provincial level. The mini-hydropower development unit of the Hydropower Bureau was responsible for construction activities. Small Coal Mining Enterprises, which fell under Village and Township Enterprises, were responsible for the development of coal mining activities.

Mr. Zhang said the Autonomous Region of Tibet was suitable for developing hydropower, solar, and geothermal energies, in general, while parts of Sichuan and Yunnan had good prospects for biogas development and small-scale coal mining activities, including hydropower, solar, and geothermal energy. He said the success of an energy programme was primarily reflected in the economic progress of an area and in itself reflected the soundness of goverment energy policies. The economic development of the HKH Region of China was comparatively lower than that of other parts of China and energy development within the region was in its infancy.

The presentation provided specific examples of energy development that had occurred in some parts of the HKH Region and explained the factors that contributed towards their development. He cited examples of hydropower, small-scale coal mining, biogas, and solar. Each of these energy resources had different characteristics and would require specific policies. For example, Aba Zang Minority Prefecture in Sichuan had made great progress in hydropower development because of the following policies of the government with regard to rural electrification.

- The provincial government, autonomous prefectures, and cities should make a development plan for rural electrification and integrate it with the local power development plan as well as the national economic policy and social development plan.

- The state must give priority to rural electrification. Key support should be given to the minority regions, remote mountain areas, and poor regions.

- The state strongly supported the construction of small- and micro-hydropower stations to promote rural electrification.

Solar water heater installed on the roof-top of an apartment building, Kunming, China

- The state encouraged and supported rural areas to carry out rural electrification using solar, wind, geothermal, biomass, and other energy resources to increase the rural power supply.

- The electricity price for agriculture should be set on a non-profit or micro-profit basis.

Another example cited was biogas development in Nanjiang County of Sichuan Province. The following measures had made biogas development successful in meeting the energy needs of the communities.

- Preparation of a biogas development plan at the district level, based on local conditions. For example, a) in the south lowland areas of Sichuan where farming and animal husbandry were in a relatively developed stage, biogas was being promoted to fulfill energy and fertilizer needs; b) in the northern mountain areas where tourist activities were being promoted, the stress was on environmental protection and energy recovery with biogas technology; and c) in the middle part, which was primarily an industrial area with a large residential section, community biogas plants and biogas septic tanks were being promoted to meet energy needs and to maintain hygienic conditions.

- More attention was paid to implementing policies that strengthened biogas organisations. For example, a biogas programme was specifically mentioned in the national economic and social development plans and also featured as the main agenda of the government at all levels of the county in 1994. The number of biogas plants was also included as a criterion in selecting local leaders at the district and village levels.

- The quality of biogas construction and biogas personnel was stressed. For example, training received by personnel became a criterion for heading the biogas team at the village and district levels.

- Regular after-sales' service was ensured through a contract system. In case of poor quality, the contractor became liable for carrying out repairs or for compensating the user for his total costs.

- Incentives were provided to users. For example, biogas users got land free of cost from the government and some cash incentives were provided as labour charges for the construction of a biogas digester.

- Setting up of a demonstration unit was key for propaganda and extensions.

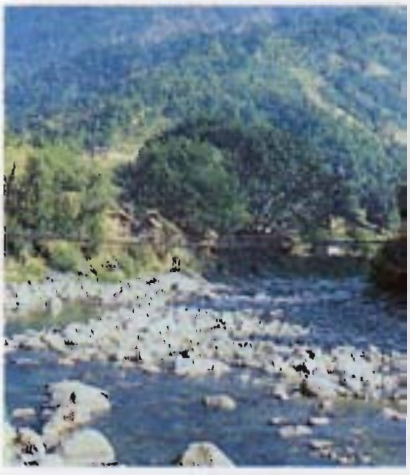
These examples suggested the following factors were instrumental in the development of small-scale energy technologies in the context of the HKH Region.

- The government's strong commitment to promoting new and renewable energy was crucial.
- Energy policies and programmes based on locally available energy resources.
- Combination of scientific knowledge with local economic, cultural, and environmental conditions to ensure technology adoption.
- Adequate attention to human resource development in terms of technical and managerial skills' formation in the field of small-scale renewable energy technologies.
- Financial viability of the programme, at the same time ensuring environmental and social benefits.
- Favourable financing, taxation, and pricing policies.

Energy Policy and Institutional Aspects: A Case Example of Private MMHP

Making a brief presentation on the policy and institutional aspects of mini-/micro-hydropower development, Dr. A. Junejo said that mini-/micro-hydropower (MMHP) was a very appropriate resource for remote and inaccessible mountain areas. It used the renewable resources available in most mountain areas; it was environmentally friendly; indigenous manufacturing facilities for the required equipment were usually available; and it could be a least-cost option in many areas. He said MMHP could become a viable option for mountain communities if the plants were: a) owned and managed in all respects by local community personnel or individuals; b) promoted and implemented by NGOs or autonomous GOs; c) indigenous equipment of reasonable quality was available; d) special funding arrangements were assured; e) appropriate policies and regulations were in place; and f) power was adequately used for productive end uses.

Dr. Junejo reviewed the status of private/decentralised MMHP in China, Nepal, and Pakistan. It was observed that costs of indigenous equipment varied from about US$ 400 to US$ 3,000 per kW; the quality and level of automation of equipment varied, but the quality was usually poor; plant factors were usually low; some progress was made in end-use development but not up to a desirable level; loans and/or subsidies were available but inadequate; and loan non-repayment was a serious issue, particularly in Nepal. He summarised the various issues related to private micro-hydropower development as high costs compared to diesel engines; design and manufacturing standards were not available or not followed; testing facilities were not available; insufficient management and operational capabilities as managers and operators were not educated or



Water stream and suspension bridge over the stream, Nepal

Mini-hydro-power plant in Leh, Ladakh, India

technically exposed and the training provided inadequate; back-stopping, monitoring, and advice were not available; funding was not adequate and also non-uniform, with inconsistent policies and procedures over subsidies, loans, and disbursement; inadequate repair facilities; and inadequate participation of beneficiaries.

He emphasised the positive aspects of some specific policies and legislation that existed in Nepal and highlighted prevalent deficiencies in the policies in other HKH areas. With the identification of these deficiencies, he suggested the following measures to promote the development of MMHP.

- Focussed attention required
- Identify suitable areas for prioritised promotion
- Increase funding level and improve fund disbursement and approval mechanism
- Determine optimum levels of subsidies
- Develop/improve technical standards/manuals and enforce them
- Strong support required to promote productive end uses
- Appropriate policies needed to overcome conflicts regarding water-use rights.

Giving an account of the current institutional arrangements that existed in Nepal with regard to micro-hydropower, Dr Junejo emphasised the need for the following.

- A central agency for policy, promotion, funding, coordination, database, technology improvement, training, repairs, end uses, and monitoring as well

- A funding approval and disbursement agency and a research and development institution
- Sufficient numbers of manufacturers, consultants, and implementers as they are key market players
- Local agencies to generate awareness and to provide information, training, and monitoring, as well as to provide repair and back-stopping facilities

The main conclusions of the presentation were as follow.

- Recipient/beneficiary participation in planning, implementation, and management is crucial.
- Local people/communities should own and manage the plants.
- Recipients must be appraised of benefits, limitations, their responsibilities and consequences of non-compliance.
- Indigenous equipment should be favoured but must be of improved quality.
- Training of various groups is necessary.
- Consistent and long-term policies and support are required.
- Repair and back-stopping facilities are needed.
- Adequate power utilisation for productive uses should be promoted.

Identification and Discussion of Issues

Dr. Papola began the discussions by saying policies could be classified into two categories: those related to the energy sector and general policies that have implications for the energy sector. At the same time, energy policies can be looked upon from the perspective of the end use of energy, productive or consumptive, and different processes and activities. The contribution that policies could make to promote a suitable energy mix (in terms of energy forms, price, affordability, quality, and quantity) to meet various energy services needed to be examined. In this context, the question was who makes these policies and to what extent do they reflect regional and local conditions and concerns – particularly those of mountain areas?

Interest Groups in Decision-making

Professor Nurul Islam said political stability was a precondition to putting forth and even to implementing new ideas such as the promotion of renewable

energy resources and technologies in the face of conventional thinking on energy development in the region. Dr. Papola argued that political changes were not so important if long-term energy issues were identified and policy elements were appropriately intertwined with the development of the renewable energy sector. Professor Bansal said political instability affected the continuity of energy policies and programmes as most decision-makers in developing countries had a tendency to scrap initiatives taken by their predecessors, not based on their merit but for political advantage. Dr. Rijal expressed the view that although policies were influenced by the political decision-making process, they were supported by a certain section of professionals within the government and non-governmental sectors who were not always fully convinced by new ideas or who might be motivated by petty personal interests. Therefore, there was a need for good wholesome interaction among professionals within the government or outside, in order to resolve the policy issues. A consensus among professionals and experts could facilitate the continuance of accepted policies even in a situation of political change.

Need for Technology & Institutional Policy

Dr. K. Banskota pointed out that technology was available, but there was lack of a suitable mechanism to ensure the dissemination of available technologies, and, even when such a mechanism existed, there was a lack of coordination among GOs, NGOs, and the private sector. Dr. Junejo noted that the dissemination of renewable technologies required the identification of entry-points, whether technologies or institutions. In the varied experience of the region, sometimes it was good technology that helped the process of technology diffusion. In other cases, it was private entrepreneurs and manufacturers, or financial institutions, voluntary organisations, government or research institutions. What was required was a combined effort by all sides as the problem was growing more complex day by day.

Role of the Government

Mr. Wang emphasised the role of the central government in providing policy directives to the provincial level based on the long-term vision of the energy sector. It was quite obvious that new and renewable energy resources and technologies would have to take a leading role in the mountain areas or else little would be left for the future generation in terms of the availability of conventional fuels that were non-renewable by nature. Such a long-term perspective was appropriately taken into account in policy making at the national rather than local levels.

Sectoral Linkages at Policy Level

Dr. K. Banskota suggested that energy development needed to be linked with the issue of poverty alleviation. How the energy sector could help to

generate more income for the mountain population was an important question that needed to be answered in energy development policies and programmes. Also, what type of energy resource development could generate more employment opportunities for them? In this context, it was important to capture the synergy of energy systems in relation to the various sectors of the economy.

Technology Choice: A Policy Issue

Mr. Zhang Mi said the basic premise for energy development should be to use natural resources in a sustainable manner. In this respect, attention should be focussed on promoting the application of solar energy in dry mountain areas like Tibet or similar areas in the region. At the same time, if there was a potential to tap hydropower on a large-scale, this should receive priority. He also emphasised the importance of local-level planning as decentralised energy systems were more suitable in mountain areas, and site-specific analysis was required prior to the commissioning of energy technology projects.

The Need for a Research and Development Policy

Mr. Shrestha called for new possibilities to be explored in the mountains. To this end, research and development were essential, for example, to promote the end use of energy as well as to capture the potential of oil seeds as a source of energy ('green energy'). The objective of the energy policy should not only consider fulfilling the existing energy demands but should also be instrumental in creating new energy demands. Dr. Ramana noted the need for assessing the application potentials of new technologies such as biogas production for decentralised electricity and fertilizer production, biogas production from agricultural residue, energy plantation for biomass gasification, and so on, in the mountains.

The Need for Knowledge Generation

Professor Bansal suggested that ICIMOD should document energy-use patterns in other sectors of the mountain economy besides households, as very little was known about the non-household sector. Dr. K. Banskota said documentation of successful cases of technology adoption in the mountains should receive priority, as these case studies would provide insight into factors that influence the adoption of a particular technology in the given socioeconomic conditions of an area. Mr. Myint proposed that biomass technologies should receive priority as biomass would dominate the energy scene of the HKH Region in the foreseeable future. Mr. Zhang Mi suggested that ICIMOD should document emerging technologies, for example, the efficient brick-making technology that had been popularised in China. This would help to promote the idea of technology transfer from one country to another.

Chairperson's Remarks

In his concluding remarks from the chair, Professor Islam said that development of renewable energy technologies should be considered within the framework of the technology dissemination process for which the four basic components were technologies, information, human resource development, and organisations. He added that modifications in the acts and legislations concerning the conventional energy sector might be required to promote renewable energy technologies. For example, there could be modifications in the Electricity Act to allow for multiple entry for power generation, introduction of a wheeling concept, financial and banking facilities, and entry of the private sector in the management of power distribution with regard to electrification in the CHT Region. He said the introduction of rational pricing policies might be an effective instrument in promoting the growth of the renewable energy sector.

Chapter 4

Emerging Issues in Energy Use Patterns, Policies and Programmes

Technical Session 3 on 'Emerging Issues in Energy Use Patterns, Policies and Programmes' was chaired by Dr. T. S. Papola, with **Dr. S. Z. Sadeque** acting as the resource person. Dr. Rijal summarised the emerging energy issues based on the output of the studies commissioned in four countries of the HKH Region as well as on discussions held during the earlier sessions.

Energy Systems' Characteristics

Dr. Rijal began by putting forward the general characteristics of mountain energy systems, classifying them into two sub-systems such as energy resources and energy demand. He pointed out, however, that the objective conditions prevailing in mountain areas, such as inaccessibility, marginality, and fragility, had implications for the energy sector. Energy resources available in the mountains were generally high in bulk density, low in calorific value, low in energy density, and low in conversion efficiency, resulting in reduced suitability, flexibility, and diversity in use, high cost of extraction, high cost of conversion, and high cost of collection. Also, energy demand characteristics depicted the major requirements for energy to be in the form of heat; a minimal amount of energy was required for motive power application; the opportunity cost of collection and conversion of energy was very low; and the energy demand density was very low because of the dispersed settlement pattern. These led to the overall characterisation of the energy system in mountain areas.

- Biomass fuels dominated the energy consumption scene
- The domestic sector was the main consumer of energy
- Fuelwood was a major supplier due to lack of access to commercial energy resources
- There was less demand for energy by the productive sector
- Energy resources available in the mountains, though dispersed in nature, were renewable.

The presentation also outlined why and how the energy needs of mountain communities were different from those in the plains. It was believed that mountain specificities, such as diversity and niche, were the main causes of distinct energy-use behaviour in the mountains. Also, the objective conditions of the mountains provided a niche for certain types of energy forms, technologies, institutions, and financing mechanisms. What was important was to identify suitable energy forms, technologies, institutions, and financing mechanisms to fulfill the economic, social, and environmental objectives.

Emerging Issues in Energy Use Patterns

Given these general characteristics of the mountain energy system, Dr. Rijal presented a summary of the major emerging issues in energy-use patterns in the mountains.

Unsustainable Trends of Energy Supply and Demand

In most of the HKH Region, the demand for fuelwood exceeded sustainable supply, not only due to rapid thinning of forests closer to settlements as a result of appropriate management practices, but also due to a lack of suitable technologies to meet cooking and heating demands, increasing demands for fuelwood to meet the needs of incoming tourists and emerging cottage industry activities, and the increasing demand for high-grade energy. (Selected examples are provided in Box 1.)

Inharmonious Energy Transitions

There were two distinct phenomena in mountain areas. First, there was a movement towards non-monetised, low-quality energy forms. This was due to the fact that the purchasing power of the mountain population and their willingness to pay were low, and therefore, if fuelwood was scarce, most of the population started consuming 'other' biomass fuels for which the cost associated was only that of labour for collection. Second, there was a movement towards non-renewable fossil fuels. This was because the mountain population that could afford to pay for energy services tended to buy commercial fuels such as kerosene and LPG as reliable renewable energy technologies were unavailable. The main factors aggravating these movements were as follow.

- Existing price distortions, as the price of fuelwood, even when marketed, did not reflect the real resource cost. The cost reflected was the collection cost and varied widely from location to location, depending on the opportunity cost of labour.

- Subsidies on commercial fuels, such as kerosene, diesel, and electricity, not only in the mountains but also in the plains, led to a wrong choice of energy mix.

Box 1
Examples of Unsustainable Trends in Energy Supply and Demand

- In Nepal, only about two-thirds of the fuelwood demands are met by a sustainable supply of fuelwood at the national level. The fuelwood balance at the district level shows varying patterns. Fuelwood is in surplus in some of the districts in Western Nepal and in short supply in the central hills.

- In Pakistan, the total sustainable supply of fuelwood is less than 40 per cent of the total demand, of which more than 90 per cent is available in the Northern Mountains (i.e., NWFP, FATA, AJK, Northern Areas). In the fuelwood supply and demand balance for the Northern Mountains, supply exceeds demand 1.6 times. However, fuelwood is extracted to meet the demands of the plains as it fetches a good price.

- Traditional stoves, though effective as heating devices, are less efficient for cooking. The direct smoke emission causes health hazards. The improved stoves disseminated in Nepal, though efficient with regard to pot utilisation efficiency, are not suitable for the room heating requirements of mountain households.

- There are several locations in Nepal, India, and Pakistan where tourism is being promoted. The energy demand of the tourist is high compared to that of local residents. Most of these demands are in the form of heat energy which is being met by fuelwood in the absence of appropriate information and due to the prohibitive cost of RETs.

- Increased agricultural and cottage industry activities demand higher quantities of heat energy. These increased activities not only demand heat energy but also motive power for which high-grade energy in the form of mechanical and electrical energy is required. The energy options available for the provision of high-grade energy are limited.

- No technological innovations occurred as choices were made on an *ad hoc* basis, as illustrated in Box 2.

Lack of Energy Quality and Quantity Perspective

The lack of understanding of the quality and quantity of energy required not only led to a wrong choice of energy resources and technologies but also to a wrong scale of energy technologies and institutions. Generally, no distinction was made between the availability of fuelwood and hydropower, forgetting the quality of energy supply, and it was considered that one could substitute for the other in all circumstances, primarily on the basis of their fiscal cost. In most

Box 2
Making the Wrong Choice

The decreasing availability of fuelwood is being felt in many mountain areas, and this is demonstrated by the uprooting of vegetative cover, increasing time for the collection of fuelwood, increasing use of 'other' biomass fuels, etc. There is no visible impact of technological innovation even though the crisis is being felt. This is primarily due to three reasons: a) women are responsible for cooking as well as managing the fuel supply but are not involved in household decision-making; b) resource cost of fuelwood is not reflected in making choices of fuel; and c) the opportunity cost of collecting fuelwood is never realised and thus fuelwood is treated as a 'free' gift of nature.

cases, commercial fuels were subsidised and no appropriate incentives were available for renewable energy resources and technologies. In such circumstances, the use of commercial fuels increased even though they were environmentally unsustainable.

No initiative was being taken by the demand-side institutions regarding the choice of energy mix. Planning the provision of energy was seen as the responsibility of energy institutions and thus lacked a demand-side perspective in most cases. The comparative advantages of energy synergism were not at all understood. Energy resources and technologies were selected without a proper understanding of the social and cultural implications, as very little was known about these factors which might affect the level and type of energy services demanded. The social and cultural factors that would have implications on energy demand were not given adequate attention in designing the energy supply infrastructure.

Ignorance of the Biophysical Aspects of Mountain Areas

The ignorance of biophysical aspects led to the application of inappropriate energy technologies and also of institutional and financing mechanisms. For example, the quantity of energy services required in the mountains was quite low due to the scattered settlement pattern and lack of infrastructural development. Also, no distinction was made between centralised and decentralised energy systems. For example, the extension of grid electricity into the mountains was given priority instead of promoting decentralised energy systems. Further, the suitability of decentralised energy systems entailed that community-based participatory institutions were more sustainable.

Methodological Dilemma to Internalising Environmental Costs

Several valid environmental concerns were raised by the experts with regard to mountain areas. The most prominent of these were: a) increasing rate of deforestation; b) indoor air pollution caused by inefficient burning of biomass fuels, causing significant health hazards-particularly to women and children; c) increasing outdoor air pollution in specific urban areas in the mountains due to inefficient burning of biomass, coal, and petroleum fuels in brick kilns and bakeries as well as in the transportation sector; d) decreasing soil fertility due to an increasing diversion of agricultural residue and animal dung from the farm to stoves as well as increasing soil erosion; and e) increasing concern over global warming, even if the mountains are not a significant contributor currently, they could become so if unchecked. There was a lack of methodology to internalise environmental costs imposed as a result of production and use of different energy resources. At best, a mitigative approach to project development was being adopted, and this was inadequate for capturing the environmental concerns in a holistic manner.

Energy Policy and Programme Options

In conclusion, Dr. Rijal summarised the issues related to energy policies, programmes, and institutions, as well as the options in promoting sustainable development of mountain energy systems emerging from the presentations and discussions as follow.

- Develop a mountain perspective that integrates not only energy development but also other sectors such as agriculture and tourism
- Develop a long-term vision for the promotion of renewable energy systems in the mountains;
- Identify the role that the energy sector plays in fulfilling economic, social, and environmental goals of mountain communities
- Develop energy policies and programmes that are mountain-biased
- Adopt an integrated approach to planning to ensure greater sectoral linkages
- Remove cost, financing, and investment barriers typical to mountain areas
- Remove institutional bottlenecks
- Reduce the prominence of supply-side institutions, for example, by transferring the ownership of the forest from the government to the communities, etc

- Arrive at a better understanding of the demand-side issues of the energy sector so as to increase use efficiency

- Integrate gender concerns in implementing and planning energy systems in the mountains as women are the stakeholders in terms of household energy demands

- Develop a methodological framework for evaluating energy systems, integrating environmental issues, choosing the appropriate energy mix, and identifying mechanisms for technology adoption; this should include appropriateness of financing and institutional mechanisms

Suggestions Made

Vigorous discussions were held following Dr. Rijal's presentation. The suggestions made are presented under four broad themes below.

Gender, Participation, and Sociocultural Issues

The role of every stakeholder involved in the development and use of energy must be recognised, with more emphasis given to ensure the active participation of women in the design and implementation of energy programmes. Energy technologies being promoted should have sociocultural relevance and acceptance in the mountains. Priority must be given to the specific needs of users and communities through the development of small-scale decentralised systems, whereby indigenous knowledge and local institutions are used in the management and mobilisation of local resources to reduce dependency on outside knowledge and resources. The development of energy technologies should not be based on needs as perceived by experts and planners but on needs identified by local residents, the direct beneficiaries. Special care must be taken to ensure that women are not left out as they are the managers of household energy systems.

Technology Choice and Technical Issues

One major concern in the mountains is to make the production of fuelwood renewable rather than to restrict its use, as the energy substitution is limited by mountain-specific conditions. In this context, suitable modes of afforestation, such as community forestry, social forestry, leasehold, and private forestry, should be promoted by designing appropriate institutional mechanisms that suit local conditions by addressing ownership issues as well. There was a general tendency of users to shift towards employing high-grade energy forms as their living conditions improved. It was thus desirable that the development of technologies which could improve the quality of biomass fuels receive high priority besides augmenting fuelwood supplies and increasing the efficiency of energy conversion devices. The possibility of developing and producing green energy, such as the

extraction of oil (Jatropa, 'Chiuri' butter) and alcohol fuels should receive the prior attention of research and development. There were other options which might be more suitable, given the resources available in the mountains. For example, hydropower, solar, wind, and geothermal energy possessed comparative advantages in the mountains but their selection should be based on area-specific factors. The development of micro-hydropower needed to be linked to the productive sector to improve the plant utilisation factor, thereby ameliorating the economics of power production. Some traditional technologies, for example, Ladakh space heating devices, were efficient and could be popularised in similar mountain conditions.

Energy technologies should be perfected before their dissemination as mountain people had limited access to capital resources and could not afford to take risks. The role of the government was crucial in minimising the risk to consumers and to developers.

Economic and Financial Issues

Energy development should be viewed in relation to development and poverty alleviation. It should be seen as an input to improving productivity, incomes and the diversification of the economy. There was much to suggest that energy transition was closely linked to economic development. Therefore, the economic linkages of energy transition should be clearly worked out and planned.

Economic and financial assessments and calculations were needed in making technology choices, linkages, and sustainability. Economic costs of alternative energy options should be rigorously examined. A mix of private and public sector was preferable for creating energy demand in mountain areas, whereas private sector and NGO involvement might be suitable for perfecting and disseminating energy technologies.

Environmental Issues

There was a need to estimate the environmental costs of energy development and to internalise them while evaluating the energy mix suitable for mountain areas. At the same time, development of one form of energy might not create environmental hazards at the users' level but might have implications at the production level. For example, the installation of solar photovoltaics in the mountains might not pollute the air but could generate pollution at the production level.

Some energy resources, such as micro-hydropower, solar, wind, and specific biogas options, were more environmentally friendly than others, e.g., the combustion of fossil and biomass fuels. But the increase in forest area and crown density through afforestation and forest enrichment had carbon sink advantage to offset global warming.

Chairperson's Remarks

In his concluding remarks, Dr. T. S. Papola highlighted the points of the discussion. First, there were gaps in our knowledge and information on mountain-specific energy options. It was important to identify data gaps and efforts should be geared to filling these gaps rather than to starting afresh. Second, it was also clear that fuelwood would remain the main source of energy at the household level as a primary requirement was heat energy. Among the options discussed by Dr. Rijal, the augmentation of fuelwood supply through afforestation and upgrading the quality of biomass fuels deserved special emphasis. Third, the energy needs of the productive sector were in the form of motive power. Thus, renewable energy technologies, such as hydropower and solar, would be of more use as imported non-renewable fossil fuels were costly. Fourth, it was important to understand why certain types of energy systems were not sustainable in the mountains and why certain emerging energy transitions were not harmonious and whether policies could be evolved so that these transitions become harmonious. The need for measures to check certain trends emerging in the energy situation of the mountains was obvious. But before that, it was essential to capture these trends and to identify appropriate interventions in technology, policy, institutions, and financial mechanisms on an area-specific basis, keeping the specific mountain context in mind.

Chapter 5

Future Priorities for Energy Development

Technical Session 4 on 'Identification of Key Areas for Further Studies' was chaired by Dr. M. Banskota, Deputy Director General, ICIMOD, with Dr. A. A. Junejo acting as a resource person. Dr. K. Rijal made a brief presentation of the areas for further study in relation to the energy sector in mountain areas. This was based on suggestions made by the country review studies and also on the discussions held in earlier sessions.

Prior to suggesting further studies in the energy sector that would be relevant to ICIMOD, Dr. Rijal discussed the need for a shift in the energy development paradigm in the context of mountain areas, as the energy development approaches that were suitable in the developed and plains' areas were not viable in mountain areas. Further, the issue of environmental sustainability was also gaining impetus in current-day development thinking.

Shift in the Energy Development Paradigm

Traditionally, energy had been treated as a constraint to development, with the approach for planning energy development always from the supply side. Gradually, the development of energy in the mountains was not only seen as fulfilling social and economic objectives but as also having environmental impacts. Dr. Rijal suggested that the social objectives should include: a) providing the minimum level of energy to sustain the basic needs of the population; and b) reducing human drudgery, particularly that of women and children. The economic objectives that needed to be considered were: a) sustaining and supporting economic growth; b) increasing economic productivity; and c) treating energy as an economic commodity to increase incomes. Environmental considerations were required to ensure that: a) the natural resource base was used for the betterment of the present generation without compromising its availability for the needs of the future generation; and b) the exploitation of particular resources did not result in general discomfort to the society. The suitability and relevance of a particular energy form needed to be examined not only from the perspective of energy demand structures and their associated environmental impacts but also from the perspective of their implications for income redistribution and for the income from producing energy.

The development process in the mountains should thus be accompanied by energy technology interventions that included but were not limited to: i) increased availability of renewable energy and energy-technology supply infrastructures; ii) introduction and/or increased use of energy conversion devices to alleviate human drudgery and boost productivity; iii) productivity increases that facilitated off-farm employment; iv) improved efficiency of use; v) better value use of energy forms; and vi) increased use of efficient devices.

At the same time, the development of energy systems should be based on financial and institutional sustainability, meaning that the choice of energy mix and scale of energy technologies and institutions were important in the mountains. In this context, choices had to be made in terms of; a) types of energy and their availability (renewable and non-renewable); b) types of energy institutions (decentralised and centralised); and c) types of financing mechanism. The choice or mix of energy resources and technologies and institutions should be based on prevailing mountain-specific conditions (such as inaccessibility, fragility, marginality, diversity, and niche) as these led to opportunities and constraints in the development of energy.

Renewable energy resources (including biomass) had to play a dominant role in the mountains as the energy services required were primarily of low quality, i.e., heat energy. It was also important to realise that biomass energy was not a non-renewable fuel if used and exploited judiciously. This meant the rate of extraction of biomass fuel should not exceed the rate of replenishment, so that a sustainable yield of biomass fuel was consumed rather than exploited rampantly.

Further, the quantity of energy services required in the mountains was also quite low due to the scattered settlement pattern and lack of infrastructural development. This, together with the fact that mountains were extremely scale-sensitive due to their fragile nature, made decentralised energy systems more viable in the mountains. Small-scale interventions in mountain communities were also less risky than large-scale interventions. Decentralised renewable energy systems also had implications for the choice of institutions in terms of both scale and operations. Community-based participatory institutions were more suitable for the promotion and development of forestry and decentralised renewable energy systems.

Energy Programme Objectives and Components

Given the desired shift in the energy development paradigm, the objectives of an energy programme in the mountains should be as follow.

- Develop economically and environmentally sustainable energy strategies that emphasise the intervention of a broad range of technology packages (institutions/ prices/ products/ suitability) to meet the economic needs of the mountain people

- Identify a policy package to reduce the emission of greenhouse gases and various other environmental hazards (physical, biological, social, and economic) caused by energy technology interventions
- Relieve energy constraints by promoting the use of efficient energy technologies
- Establish a dynamic database linkage among economies, the environment, and energy sectors that will be instrumental in formulating sustainable energy options
- Develop a better understanding of the existing energy use variability and explore the possibilities of energy synergism
- Establish a framework for information sharing and programme advocacy

The various components of an energy programme that will meet these objectives are given below.

Decentralised Energy Planning Activities

Energy planning activities should include the following: i) centralised planning for bulk energy supplies must be accompanied by indicative planning for decentralised energy supplies; ii) energy demand-side agencies must adopt an energy perspective of their sectoral plans and programmes; iii) at the intermediate and lower levels, participation of the private sector, NGOs, and local institutions should be seen as essential for developing and implementing programmes and projects; iv) planning should be viewed as a continuing process which need not always lead to a 'Master Plan'; and v) integrated planning must be accompanied by the integration of implementation efforts.

Decentralised energy planning activities should result in the identification of technology packages (inclusive of resource, technology, and institutional framework) suitable for a specific area because of the decentralised nature of energy supply and demand.

Identification of Technology Packages for Intervention

The programme needed to be designed to ensure the improvement of energy system efficiency and supply levels by a reduction in the emission of greenhouse gases and an increase in the rate of carbon sequestration. Inclusion of management and maintenance aspects in technology dissemination would increase the rate of technology adoption which, in turn, would help to make energy transformation systems sustainable. For example, the people of the HKH Region relying on the forests for their susbistence needed an alternative

livelihood for themselves and for their children. It was becoming clear that the destruction of the HKH region's forest resources would be eased by technology interventions.

The most effective approach was to identify different sets of technology packages for intervention in selected, diverse rural communities having diverse socio-cultural and economic statuses. These packages should be efficient, acceptable to private sectors, environmentally attractive, and should reduce the drudgery of women. This would help to promote economical and environmentally-sound development of energy resources, particularly biomass. For example, the efficient burning of wood and combustible residues would reduce the emission of greenhouse gases and energy requirements which, in turn, would alleviate mounting pressure on energy, agriculture, and the environment.

Implementation of Action Research Programmes

The implementation of action programmes meant intervention of identified technology packages in local communities. For example, these interventions might involve planting trees integrated with other agricultural activities; adoption of cooking stoves that reduce fuelwood consumption while not compromising the household need for light and heat; improvement of the 'F-5 System' of food, fuel, fodder, fertilizer, and fibre to identify shrub and tree species that maximise a household's utility from the same biomass source while reducing pressure on forest resources; solar dryers to reduce post-harvest agricultural losses as well as to create opportunities to add value to cash crops such as fruits and vegetables; and technologies to make traditional brick kilns more efficient and less polluting by introducing models with improved combustion which have been pioneered in one area of the region and transferred to other areas.

Improving the Knowledge-base on Sectoral Linkages

Conventional energy strategies invariably tended to treat the various energy-using sectors as independent of each other, since little was understood about the existing relationships between them. Thus, energy planning for each sector was usually carried out in isolation. Consequently, the interdependence of energy-consuming sectors was rarely exploited. In fact, proper understanding of the interdependence could become the basis of what had been termed 'synergism' whereby the combined and cooperative effects of approaches in two or more sectors were greater than the sum of the separate effects left uncoordinated.

Developing a Methodological Framework for Energy Planning and Database Management

Though energy planning activities had been carried out in the countries of the region for more than a decade, lack of comprehensive methodologies as well

as the scarcity of available information made the task complicated. In most cases, demand-side information was almost non-existent and issues relating to decentralised energy systems were not fully understood. Understanding in these areas was imperative, prior to formulating sustainable energy strategies.

The integrated approach of database management and the identification of a number of link parameters between sectors would help to arrive at a holistic approach to preparing guidelines for energy resource management. In this regard, extensive use of GIS, remote-sensing techniques for database management, and the establishment of a regional network needed to be initiated. Also, a database on energy, environment, and economy for the HKH Region should be developed.

Programme Advocacy, Information Exchange, Sharing of Knowledge, and Improvement of Capabilities

Workshops, seminars, study tours, and regional consultative meetings would be instrumental in meeting the multiple objectives of programme advocacy, information exchange, and sharing of information. The active involvement of national institutions in programme and research activities would improve capabilities as well as confidence in the application of research findings on the methodological approaches and processes involved.

Training packages were effective tools for improving capabilities and needed to be developed primarily for the following target groups: a) manufacturers; b) development workers; and c) semi-skilled labourers. These programmes should consider producing a training kit for trainers as well.

Standardisation and Quality Control for Renewable Energy Technologies

Currently, though a number of renewable technologies were being employed in the HKH Region, most of these were not functioning mainly due to their substandard quality. It cannot be denied, however, that there were other reasons for the malfunctioning. Quality control measures should be introduced and appropriate mechanisms designed to suit the local conditions of the countries.

Key Areas for Energy Studies by ICIMOD

Identification of key areas for energy studies would have to be based on the understanding developed so far about the role that the energy sector played in fulfilling the economic, social, and environmental objectives of mountain communities with an overall framework of the objectives and mandated activities of the centre. The objective of ICIMOD was *"to help promote the development of an economically sound mountain ecosystem and to improve the living standards of the mountain populations"* through documentation and information exchange, research, capacity-building, networking, demonstration and advisory services.

ICIMOD's energy programmes needed to be designed primarily to understand the energy-use pattern and behaviour, to develop sustainable energy policies and programmes, and to identify factors that promoted renewable energy technology adaptation. The centre's efforts, in most cases, should also focus on creating a knowledge-base and developing innovative approaches as well as their documentation. Continued efforts needed to be made in terms of programme advocacy, information exchange, sharing of knowledge, and improving capabilities. The following thematic areas were considered important for investigation and study.

Understanding Energy Use Variability

The major energy-consuming sectors in the mountains were households, agriculture, and cottage industries. Sufficient knowledge existed in terms of factors affecting the household energy sectors. However, very little knowledge was available with respect to energy-use patterns and the factors that affected energy-use levels in cottage industries and in agricultural activities in mountain areas. Thus, priority should be given to understanding the energy-use variability of various types of cottage industry activities and farming systems.

A series of case studies should to be carried out by identifying the major cottage industries and agricultural activities of the HKH Region in order to capture factors that influence the energy-use level and the choice of energy mix. Selection of the prevailing types of cottage industry activities and farming systems was essential prior to examining the energy-use variability of a particular activity. Detailed surveys of energy resource and technology mix should be carried out by classifying these activities a) in terms of product; b) in terms of fuel use and energy technology employed; c) in terms of location, etc. It was also important to understand the quality and quantity of energy demanded for these activities and the factors that affect the level and type of energy demanded. The following factors that might affect the level of energy consumption as well as the choice of a particular energy mix should to be examined.

- Energy resource availability patterns (type, nature, quantity, quality) and energy supply infrastructures and their scale (management, operation, institution)
- Access to various energy technologies
- Price of various forms for energy and technologies
- Affordability of users/consumers
- Quality and quantity of energy services demanded

- Climatic conditions
- Awareness of the application potential of various energy technologies and their associated environmental and social implications
- Level and type of economic activities
- Availability of physical and social infrastructures
- Homogeneity or heterogeneity of the communities
- Sociocultural norms and values

Developing Sustainable Energy Policies and Programmes

It was essential to examine the suitability of energy mix to support and sustain different types of agricultural activities and cottage industry in a sustainable manner. The findings of the study on energy use variability and the examination of various issues discussed below would eventually lead towards the identification of suitable energy policies and programmes for the mountain population.

The issue of sustainability should be examined not only from the perspective of resource and technology but also from that of environmental and social sustainability. At the same time, the financial sustainability of a particular energy mix should be examined along with the institutional sustainability of the supply infrastructure. The availability of and access to the energy supply infrastructure warranted careful examination. Questions as to the type of environmental impacts and the implications on gender as a result of selecting a particular energy mix should be examined. The examination of these issues would not only lead to the identification of an appropriate energy mix but also help to design suitable policies to support and sustain these activities in the mountains. (Some factors that might affect the promotion of energy policies and programmes in mountain communities are listed below.)

- Integration of different components of a mountain development perspective and energy development strategies at the operational level
- Integration of sectoral policies with the energy development programme
- Possibility of capturing energy synergism
- Consistency among various sectoral and intra-sectoral policies in relation to the economic, social, and environmental objectives

- Existence and suitability of institutional and organisational structures to ensure and establish linkages between policies and programmes

- Suitability of legislation and regulations to promote the desired energy mix in the mountains

- Existence and suitability of the financing mechanism

Identifying Factors to Promote Renewable Energy Technology Adaptation

The choice of energy technology and institutions depended on technical parameters such as the availability of energy resources, prices, and life and efficiency of the device, though the final basis for selection should be its social and cultural acceptability by mountain communities. Most of these factors were location-specific and required close scrutiny with regard to the mountain-specific situation. This meant location-specific analysis must be considered in identifying factors for the promotion of RETs. Factors, such as the stage of technology, policies and programmes, institutional and financing mechanisms with regard to a particular technology, and the possibility of ensuring social and environmental objectives, would be vital. Therefore, it was essential to examine the factors given below in relation to a particular technology prior to identifying strategic elements for their promotion.

- Suitability of a particular technology to meet the energy services demanded in terms of their quality and quantity

- Implications of national policies (fiscal, trade, import, energy pricing, etc) and sectoral policies (energy, forestry, industry, environment, etc) on the development of RETs

- Identification of gaps in the prevailing legislation and regulations relating to forestry, water, renewable energy resources, etc

- Review of economic incentives provided for the promotion of RETs, if any, and their economic, environmental, and social implications

- Review of direct public investment programmes with regard to rural electrification, afforestation programmes, and RETs and their impact on mountain communities

- Review of institutional arrangements with regard to RETs' development to identify institutional bottlenecks

- Analysis of the gender implications of RETs

- Review and analysis of the traditional skills and management practices with regard to energy resource use

Suggestions Made

Detailed discussions were held on Dr. Rijal's presentation and the following suggestions were made.

- Objectives should be translated into activities and appropriate indicators should also be identified and assigned to assist in developing suitable programmes.

- Studies should have specific objectives such as providing feed-back to decision-makers to improve the policies and programmes. A time-frame should also be formulated for such studies and suggested programmes.

- More successful and promising technologies should be studied for their dissemination in specific areas where they were considered to be an effective option. Otherwise, studies only were unlikely to bring about the intended objectives of poverty alleviation or economic growth.

- Many mountain areas differed from each other; suitable technologies should be specifically identified for different areas. Indigenous and local renewable sources should be given priority.

- Some specific in-depth studies should be undertaken to determine why some technologies were successful in one location/area while they failed in others.

- For international/regional organisations, carrying out studies, data gathering, or promoting favourable policies, it might be necessary to identify and designate a coordinator in each country. This coordinator would assist in data collection and the exchange of information, experts, and technicians.

- Due attention should also be given to identifying, evaluating, and promoting suitable energy-saving/energy-efficient technologies/devices.

- Some programme outlines or guidelines should also be put forward as a logical follow-up to studies and data gathering to address problems in the field, such as poverty alleviation and income/employment generation, and to avoid failures.

- Studies were a necessary prerequisite for everything, but they should be authentic and well-focussed. Studies should provide feedback to decision-makers and implementers to improve the programmes and their benefits/

impact. For example, this meeting had made it clear that current patterns of energy use were not sustainable and transitory changes were also not appropriate. Studies should be undertaken to suggest options and methodologies to correct this situation.

- Data gathering was problematic and the projections and assumptions that followed in terms of quantifying non-commercial energy were usually not accurate. It was, therefore, necessary to fill the data gaps and to develop/test/improve the quantifying assumptions and projections.

- It was important to determine which technologies/systems were suitable for a given area and how to disseminate them.

- Some other (non-energy) issues also affected the energy situation. The interest and anticipated gains of the stakeholders, such as investors, developers, and users, also needed to be studied and understood to bring about a harmonious balance and desired results.

- Other factors such as the dynamics of economy, urbanisation, and changing attitudes and expectations must also be given due consideration in the studies.

Chairperson's Remarks

The chairman, **Dr. Mahesh Banskota**, Deputy Director General, ICIMOD, observed that discussions primarily focussed on energy issues but in many instances non-energy issues influenced the energy sector and, at times, dictated the choice of energy mix. These might not be considered sustainable by energy experts but might be optimal from the point of view of resource allocation. For example, in some mountainous areas, the availability of LPG, which is a non-renewable and imported energy source, could reduce pressure on the forests significantly, even though this choice might be considered unsustainable. There was a need to devise a mechanism to share benefits, with some associated costs, that would accrue to the population outside the mountains due to activities initiated in the mountains.

In the past, a number of issues had been examined with regard to the environmental, social, and economic implications of energy production and usage. *"Are there other issues that should receive greater attention in the context of the mountains?"* Dr. Banskota asked.

Given that societal development was a dynamic process and the rate of urbanisation was increasing rapidly, it was possible the suitability of energy mix might differ significantly. Similarly, the commercialisation of farming systems and newly-emerging service sectors in the mountains might demand different

forms of energy of which little or nothing was known. So there was a need to tackle these issues not only by looking at the energy sector in isolation but also in relation to other sectors.

It was vital to identify the most appropriate forms of energy resources and technologies that were sustainable and that supported and augmented the present global trend of economic liberalisation and growth. What was more important, however, was to have the right policy in place and to provide more information to the mountain people with regard to choices available in the energy sector.

It was also important to analyse and understand the role of stakeholders involved in developing energy systems. The role of stakeholders became pronounced in the context of mountain areas. The decision-making process was more complex because of a larger number of interest groups, and the risk associated with decisions taken was high because of the fact that there were less options available to the stakeholders.

Given that a number of plans and master plans had failed in the past, it might be appropriate to consider developing an indicative plan in the energy sector and to allow the players involved to take their own initiative to make the programme successful. Instead of the government playing the lead role, it should act as a facilitator, and it might be appropriate to quickly move into developing projects aimed at creating options in the mountains.

Chapter 6
CLOSING

In the closing session, chaired by **Mr. Egbert Pelinck**, Director General, ICIMOD, the resource persons from technical Sessions 3 and 4 made presentations (as presented earlier) of the highlights and conclusions, followed by closing remarks by Mr. Pelinck.

Mr. Pelinck said it was clear from the presentations that the emerging trends in the mountain energy system were not encouraging, be they in terms of heavy dependence on biomass fuels and overcutting of forest resources or in terms of the transition from fuelwood to inferior quality biomass fuels or to non-renewable fuels. We should not lose sight of our goal of poverty alleviation and environmental sustainability and we should remember that poverty tends to further degrade the surrounding environment due to the search for food and income. The energy system should provide an opportunity to increase the productivity and incomes of the mountain population besides providing sufficient energy for them to cook their daily meals. It was important to make the right choice of energy mix to meet the energy demand of the mountain population. It was equally important to ask ourselves what the energy sector could offer to the mountain population to alleviate poverty.

The adoption of appropriate energy policies not only at the national level but also at the operational level might be instrumental in the sustainability of these trends. Suitability of technological options played an important role. Given the mountain specificities and the fact that mountains were scale-sensitive, it was obvious that decentralised energy systems were more viable. At the same time, the development of large-scale hydropower might be considered for generating more income and employment for the mountain population. However, the environmental implications of these large-scale interventions should be properly addressed. The choice of decentralised energy systems favoured participatory institutions rather than bureaucratic institutions. In this context, the role of NGOs could not be overemphasised for implementing small-scale energy technologies as well as for being a watch-dog for internalising environmental and gender concerns. The mountain population was averse to taking risks because of poverty, so all renewable energy technology intervention programmes should be accompanied with

appropriate financing schemes whereby credit institutions would play an important role.

Looking at ICIMOD's mandatory functions, the core area of concern would be to fill the gaps in knowledge of mountain-specific energy issues and to document and disseminate these at wider levels. At the same time, there was a need to raise awareness and build capabilities at policy-making levels.

Proposing a vote of thanks, Dr. Rijal voiced the general opinion of the participants about the need to understand, comprehend, and assess technologies that were or would be suitable in different areas of the HKH Region in terms of: a) policy issues and desired interventions, b) suitability of scale of technologies and their reliability; c) scale of institutions, d) economic acceptability, and e) social and cultural acceptability. It was hoped that ICIMOD, with the cooperation and collaboration of those present and others, would facilitate the understanding of these issues.

Annexes

Annex 1

Programme

APRIL 15, 1997
Arrival of Participants

APRIL 16, 1997

9:30 - 10:30 Opening session
Welcome by Head, MEI Division
Opening address by the DG
Introduction by participants
Introduction to the meeting by the Coordinator
(Group photograph)

10:30 - 10:45 *Tea/Coffee Break*

10:45 - 13:00 **TECHNICAL SESSION 1**: Energy Use in Mountain Areas

Chairperson: Dr. P. Venkata Ramana
Resource Person: Mr. U Aung Kyaw Myint

Country presentations and discussion

- Nepal
- Pakistan

13:00 - 14:00 *Lunch hosted by the DDG at the ICIMOD Guest House*

14:00 - 17:00 **TECHNICAL SESSION 1** (Continue)

Chairperson: Mr. Zhang Mi
Resource Person: Mr. Basanta Shrestha

Country presentations and discussion

- China
- India

15:30 - 15:45 *Tea/Coffee Break*

Presentation of Study Proposal on Energy Use Patterns - Bangladesh

19:00 - 21:00 *Welcome dinner hosted by the DG, ICIMOD, at Hotel Annapurna*

APRIL 17, 1997

09:30 - 13:00 **TECHNICAL SESSION 2**: Energy Policies and Programmes in Mountain Areas

Chairperson: Prof. M. Nurul Islam
Resource Person: Ms. J. D. Gurung

Presentations and discussion by experts

- Mr. Zhang Mi
- Dr. P. Venkata Ramana
- Mr. V. B. Amatya
- Dr. A. A. Junejo

10:30 - 10:45 *Tea/Coffee Break*

13:00 - 14:00 *Lunch hosted by the Head, MEI, at the ICIMOD Guest House*

14:00 - 16:30 **TECHNICAL SESSION 3**: Emerging Issues in Energy Use Patterns, Policies, & Programmes

Chairperson: Dr. T. S. Papola
Resource Person: Dr. S. Z. Sadeque

Presentation by Dr. K. Rijal, Programme Coordinator
Discussion/suggestions

15:45 - 16:00 *Tea/Coffee Break*

APRIL 18,1997

09:30 - 11:15 **TECHNICAL SESSION 4**: Identification of Key Areas for Further Studies

Chairperson: Dr. M. Banskota, DDG
Resource Person: Dr. A. A. Junejo

Presentation by Dr. K. Rijal, Programme Coordinator
Discussion/suggestions

11:15 - 11:30 *Tea/Coffee Break*

11:30 - 13:00 Closing Session

Presentation of Technical Session 3: Dr. S. Z. Sadeque
Presentation of Technical Session 4: Dr. A. A. Junejo
Concluding Remarks by the DG
Vote of thanks by Dr. K. Rijal

13:00 - 14:00 *Closing lunch hosted by the DG at the ICIMOD Guest House*

Annex 2

List of Participants

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8. Mr. V. B. Amatya, Energy Engineer
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9. Mr. Shyam Lal Vaidya, Executive Director
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ICIMOD

1. Mr. Egbert Pelinck, Director General
2. Dr. M. Banskota, Deputy Director General
3. Dr. T.S. Papola, Head, MEI
4. Dr. Tej Partap, Head, MFS
5. Mr. Pramod Pradhan, Head, MENRIS
6. Mr. Aung Kyaw Myint, Forest Resource Specialist, MNR
7. Ms. J. Gurung, Gender and Development Specialist, MFS
8. Mr. Basanta Shrestha, MENRIS
9. Dr. Pitamber Sharma, MEI
10. Dr. A. A. Junejo, MEI
11. Dr. S. Z. Sadeque, MEI
12. Dr. K. Rijal, MEI

Annex 3

List of Studies Commissioned by ICIMOD and Papers Presented at the Meeting

Studies Commissioned by ICIMOD

1. *Analysis of Energy Use Pattern in Urban and Rural Areas in the HKH Region of China*
   Mr. Wang Mengjie, Mr. Wang Gehua, Mr. Xiao Mingsing, and Mr. Ding Yi, Chinese Academy of Agricultural Engineering Research and Planning (CAAERP), Beijing, China

2. *Energy Consumption and Use in the Hindu Kush Regions of India*
   Prof. (Dr.) N. K. Bansal, Centre of Energy Studies, Indian Institute of Technology, New Delhi, India

3. *Overview of the Nepalese Energy Sector*
   Dr. Kamal Banskota and Bikash Sharma, Centre for Resource and Environmental Studies (CREST), Kathmandu, Nepal

4. *Analysis of Present Energy Use Patterns in Rural and Urban Areas of the HKH in Pakistan*
   Prof. M. Abdullah, Peshawar, Pakistan

Papers Presented

1. *Main Factor for Promoting Energy Policies and Programmes in the HKH Region: China Case Study*
   Mr. Zhang Mi, Deputy General Manager, Chengdu Energy - Environment International Cooperation (CEEIC), Chengdu, China

2. *Energy Use in the HKH Region: A Policy Perspective*
   Dr. P. Venkata Ramana, Dean, Rural Energy and Environment Division, Tata Energy Research Institute, New Delhi, India

3. *Energy Policies and Programmes: Issues and Challenges for Nepal*
   Mr. V. B. Amatya, Energy Engineer, Water and Energy Commission Secretariat, Ministry of Water Resources, Singha Durbar, Kathmandu, Nepal

4. *Energy Sector of Nepal: Status and Development Plan - Policy*
   Mr. S. L. Shrestha, National Planning Commission Secretariat, Singha Durbar, Kathmandu, Nepal

5. *Private Mini-/Micro-Hydropower for Less Developed Mountain Areas: Policy and Institutional Aspects*
   Dr. A. A. Junejo, Project Coordinator MMHP Project, ICIMOD, Kathmandu, Nepal

6. *Proposed Methodology to Study the Energy Use Pattern in Chittagong Hill Tracts Region of Bangladesh*
   Prof. M. Nurul Islam, Institute of Appropriate Technology, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

ICIMOD

Founded out of widespread recognition of degradation of mountain environments and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or parts of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

ICIMOD WORKSHOPS

ICIMOD Workshops are attended by experts from the countries of the Region, in addition to concerned professionals and representatives of international agencies. Professional papers and research studies are presented and discussed in detail.

Workshop Reports are intended to represent the discussions and conclusions reached at the Workshop and do not necessarily reflect the views of ICIMOD or other participating institutions. Copies of the reports, as well as a Catalogue of all of ICIMOD's Publications, are available upon request from:

Documentation, Information, and Training Service (DITS)
International Centre for Integrated Mountain Development
G.P.O. Box 3226
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Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bhutan
- India
- Nepal
- Bangladesh
- China
- Myanmar
- Pakistan

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