PART A

1 Introduction

The Hindu Kush-Himalayan (HKH) Region, with a population of about 120 million, extends across Afghanistan, Pakistan, India, Nepal, China, Bhutan, Bangladesh, and Myanmar. The people of the HKH Region, despite their belonging to different countries, live in similar conditions. They face the same types of hardship and developmental constraints. The HKH Region is characterised by a lack of adequate infrastructural development; low agricultural productivity; net deficiency in food products; poor access to health, communications, and education; and a dwindling energy base. This has led to alarming poverty in the HKH Region and, consequently, continuous outmigration.

The heavy reliance of people on fuelwood and marginal farming practices has contributed to deforestation, land degradation, and soil erosion. This has placed an additional burden on the people, especially women, in the context of procuring drinking water and ever decreasing supplies of fuelwood.

The plight of the people can be alleviated only through socioeconomic development of the region. Additional energy inputs are among the many requirements for facilitating this socioeconomic development.

Additional energy requirements can be best met through the development of Mini- and Micro-Hydropower (MMHP) for the following reasons.

- A sizeable MMHP potential exists in all the countries, and it is more or less evenly distributed throughout the region.
- In this region, fossil fuels are not competitive in remote areas because of high transportation costs.
- Grid extension is not competitive due to the remoteness and sparse nature of the settlements.
- Plants of this scale can be manufactured indigenously.
- MMHP, especially MHP (micro-hydropower), could be developed through private initiatives.
- MMHP dissemination can stimulate the national economy.
- Adverse environmental impacts are minimal.
- MMHP is suitable for decentralised development.
- MMHP can be integrated with other rural water utilisation schemes and financial viability can thereby be increased.
- Other renewable energy sources can supplement, but not replace, MMHP.
- MMHP can stimulate the local economy, provided other inputs are carefully planned and implemented.

- Rural people find MMHP attractive because it can use local resources.
- MMHP energy is suitable for agro-industrial development.

Some important breakthroughs have already been made in the HKH Region with respect to the promotion of MMHP. For example, in Nepal, about 1,000 privately-owned commercial Micro-Hydropower Plants (MHP) are operating. They provide mechanical power for agro-processing and electricity for numerous end uses, such as electric lights, agro-processing mills, sawmills, paper mills, driers, bakeries, televisions, and other domestic appliances. In some rural settlements, these plants have succeeded in bringing about modest socioeconomic changes.

At this stage, the critical question is not whether MMHP can alleviate the poverty of the people of the HKH Region but how MMHP can best contribute to this end. It was for this reason that the National Seminar on ***'Mini- and Micro-Hydropower Development in the Hindu Kush-Himalayan Region: Achievements, Problems and Prospects'*** was organised. The main focus of discussions being private or decentralised MMHP, since this sector is usually ignored by the main utilities of all the regional countries, which concentrate on bigger plants.

The seminar was organised through an ICIMOD-implemented project entitled 'Design and Testing of a `Regional Training Programme on Mini- and Micro-Hydropower for Mountain Development in the Hindu Kush-Himalayan Region'. It was funded by the Norwegian Agency for Development Cooperation (NORAD). This seminar facilitated the exchange of available information by a broad category of participants from government agencies, donors, manufacturers, installers, promoters, and consultants. The material contained in the Nepal Country Report on MMHP and the proceedings of the International Experts' Consultative Meeting on MMHP, both published by the same project, served as a basis for the deliberations of the seminar. In addition, the participants, many of whom have been associated with MMHP for a long time, were able to provide additional information.

Altogether 33 experts participated in the seminar. They represented donors, INGOs, NGOs, government and utility agencies, banks, teaching/training institutes, R&D institutes, manufacturers, entrepreneurs, contractors, consultants, and so on.

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Inaugural Session

Introduction to the Seminar by Dr. Anwar Junejo, Coordinator of the MMHP Project

Dr. Junejo welcomed the participants and outlined the purpose and background of the National Seminar. He said that the seminar was organised jointly by ICIMOD and the Agricultural Development Bank of Nepal (ADB/N) with the principal objective of exchanging information and making it available to as wide an audience as possible, an audience representing government agencies, donors, manufacturers, promoters, and consultants. He also said that the main themes of the seminar were new approaches to the promotion of MMHP in the rural mountain areas, their impact and advantages, and, most importantly, the prevalent problems and their redressal.

Dr. Junejo mentioned that similar seminars were proposed in Bhutan, India, and Pakistan as a mandatory component of the `Design and Testing of a Regional Training Programme on MMHP for Mountain Development in the Hindu Kush-Himalayan Region'; a project sponsored by the Norwegian Agency for Development Cooperation (NORAD) and implemented by ICIMOD. He also said that the seminar had been preceded by a 'Consultative Meeting of International Experts' on MMHP'. The meeting dealt in depth with the issues related to improving the viability and reliability of MMHP.

Keynote Speech by Mr. Srikrishna Upadhyay

Mr. Upadhyay's speech covered the problems and prospects of MHP development in Nepal and highlighted the present status. He said that there were 25,000 *ghatta*(s) in Nepal. Out of these, about 600 had been converted into Multipurpose Power Units (MPPU), each of which can generate up to two kW of electricity. There were over 700 water turbines, out of which about 100 generated electricity; the aggregate total was about one MW.

Mr. Upadhyay further noted that 32 Nepal Electricity Authority (NEA)-owned MHP generated about five MW of power. The total capacity of government-owned small hydropower plants was 10 MW.

Mr. Upadhyay said that most of the MHP units were individually owned. However, recently, some NGOs, such as the King Mahendra Trust for Nature Conservation, were promoting community-owned plants. The Ghandruk and Siklis MHP plants were examples of plants promoted by them.

With regard to the promotion of MHP, Mr. Upadhyay said that the Agricultural Development Bank of Nepal (ADB/N) was playing a key role through liberal financing, arranging training programmes in association with organisations such as the UNDP and

the Intermediate Technology Development Group (ITDG), and providing technical support through its Appropriate Technology Units. He further said that the government was helping to promote electrification plants by partially subsidising the cost of electrical equipment and delicensing plants of up to 1,000kW.

Mr. Upadhyay noted that decline in the ADB/N's interest, coupled with the withdrawal of government subsidies from 1989/90 to 1992/93, had had a negative impact on MHP promotion. The government subsidy on MHP was reintroduced subsequently, and it had regained priority at the ADB/N as well. Referring to the viability of MHP, Mr. Upadhyay said that privately-owned MHP gave better performances than the NEA-owned in terms of capital as well as operational costs.

With regard to the state of MHP technology, Mr. Upadhyay mentioned a number of technological achievements such as development/adaption of Pelton turbines, electronic load controllers, induction generators, and peltric units. The ITDG and Kathmandu Metal Industries (KMI) had played important roles in such achievements. The introduction of popular peltric units had had a remarkable impact on the dissemination of MHP.

Mr. Upadhyay noted that a potential for generating approximately 26MW of electricity, using the existing 25,000 *ghatta*(s) and 4,000 sprinklers, existed. The potential for electricity generation from small and MHP for the Eastern Development Region was estimated at 18MW. Thus, there was considerable potential for electricity generation from MMHP.

Mr. Upadhyay also recommended the following strategies for the promotion of MHP.

- Establishment of an Alternative Energy Promotion Centre
- Increasing the subsidy rate
- Setting up a revolving fund to support subsidies
- Expansion of a dealer network and other publicity measures
- Supporting R&D activities
- End-use development
- Strengthening the capacity of manufacturers
- Conversion of *ghatta* to MPPU and dissemination of more Peltric units

Inaugural Speech by Mr. E. Pelinck, Director General, ICIMOD

Mr. Egbert Pelinck highlighted the objectives of ICIMOD and its various programmes. He mentioned *'Rural Energy Planning and Management at District Level in Mountain Areas'* as an example of ICIMOD's earlier original energy-related programmes. This programme identified and assessed the various options that were available and recommended decentralised planning and implementation systems at the district level, including adequate training for the personnel of concerned agencies.

Mr. Pelinck appreciated the generous offer of the Norwegian Government to support the 'Design and Testing of a Regional Training Programme on Mini- and Micro-Hydropower for Mountain Development in the Hindu Kush-Himalayan Region' Project. He noted that the Consultative Meeting of MMHP experts organised previously was the first major outcome of this project. The current seminar was also an important activity in the process of implementing this project.

Mr. Pelinck further stated that the project and the seminar reflected ICIMOD's mandate very well and that is:

- addressing key issues in mountain development through the processes of environmental conservation and poverty alleviation. Mini- and micro-hydropower are particularly designed to reach disadvantaged groups as a means of improving their standards of living through the sustainable management of natural resources;
- examining the mountain-specific opportunities that mountain areas can provide; and
- bringing together experts and experiences from different countries in the region.

Mr. Pelinck said that he was aware how important an appropriate energy initiative can be for rural development. Furthermore, he emphasised the need to seriously consider the advantages and limitations of a particular alternative initiative, such as micro-hydropower, as, more often than not, it is more important to take the limitations rather than the advantages into consideration when promoting usage.

Mr. Pelinck further noted that MMHP entrepreneurs and users were interested in what MMHP could do to alleviate their problems and at what cost. This included not only monetary cost but also the work load involved, the efforts required to deal with ensuing problems, and so on.

Finally, Mr. Pelinck thanked ADB/N for co-sponsoring the seminar and wished the participants a successful outcome.

Concluding the inaugural session, Dr. Junejo thanked the Chairman of the session, Mr. Pelinck, the Guest of Honour, Mr. Upadhyay, the authors of the papers, ADB/N, ITDG, and the participants.

3
Working Sessions

Working Session 1: New Approaches and Activities

The first session of the seminar was chaired by **Dr. M. Banskota,** Deputy Director General, ICIMOD. **Mr. B. Pandey,** of ITDG was the rapporteur for this session. The highlights of the session are presented below and the summarised versions of the papers presented are given in Part B.

Dr. A.A. Junejo presented the first paper of the session: ***"Mini- and Micro-Hydropower Development in the Hindu Kush-Himalayan Region: Achievements, Impacts and Future Prospects."*** The paper reviewed MMHP development in Bhutan, China, India, Nepal, and Pakistan in great depth.

Referring to the achievements in the field of MMHP, Dr. Junejo said that China was in the forefront of MMHP development in terms of the number of plants installed, the development of local manufacturing capabilities, and the impact of MMHP on rural development. China began MMHP development in the early fifties. It had so far installed 45,700 MMHP plants of up to 500kW capacity, with a total installed capacity of about 6,000MW. The share of MMHP in the total hydropower harnessed is about 20 per cent.

The development of MMHP in Nepal has followed a unique course. The remarkable features of MMHP development in Nepal were the emergence of a significant number of commercial private sector MHP targetted at electrification of remote rural hill areas; the development of a large number of MHP for mechanical power; remarkable local manufacturing capabilities including R&D activities; interesting experiments in developing innovative systems of private sector MMHP management; and efforts to develop and disseminate end uses. He also said that there were 35 MMHP plants having a total capacity of nine MW, installed by the government in Nepal. There were over 700 micro-hydro units in the private sector. These represented a wide range of technologies such as stand-alone electrification units; 'milling only' plants of various degrees of sophistication from improved traditional water wheels (*ghatta*) to modern turbine units; milling units with add-on electricity generating facilities; and small portable stand-alone electricity generating units in the one kW range called peltric sets.

Dr. Junejo further mentioned that Pakistan had installed approximately two MW of MHP in the private sector, which was comparable to the figure in Nepal. The non-commercial nature of the plants and the dedication of all the plants to electricity generation were distinctive features of private sector MHP development in Pakistan. In the public sector, there were 64 MMHP plants with a total capacity of about 17MW.

Dr. Junejo said that there were 145 MMHP/SHP plants in the public sector in India with a total capacity of about 106 MW. Recently, NGOs had also started to take part in the dissemination of MHP. In Bhutan, there were 19 MMHP with a total capacity of about three MW in the public sector.

Dr. Junejo noted that Nepal had developed the most elaborate policy framework and support for private sector MHP promotion. It had also formulated policies for the promotion of hydropower in general, and these made special reference to mini-hydropower development. China had been developing MMHP under the policy of self-construction, self-management, and self-consumption. China had developed MMHP as one of the components of the rural development package and not as an isolated or independent development endeavour. Bhutan and Pakistan had not formulated policies as such for the promotion of MMHP. However, Pakistan had been supporting MHP promotion because the government was committed to rural electrification. India had announced special incentives for MMHP development in the private sector. It treated private MMHP as a supplement to the government's electrification efforts.

Furthermore, Dr. Junejo said that, generally, the principal public utilities, which were involved in the development of MMHP in the initial stages, were moving away from MMHP to larger plants because of the poor financial performance of utility-owned MMHP. However, from the perspective of the private local entrepreneur, mini- and micro-range plants had proved to be more viable. Therefore, the promotion of MMHP should be continued.

Dr. Junejo said that the cost of indigenous equipment was considerably less than that of imported equipment. But the rise in MMHP costs in Nepal, which were already higher than in Pakistan, India and China, was unsettling.

Dr. Junejo mentioned that, in all the regional countries, private or decentralised MMHP had been receiving financial and other support. Government support to MMHP should continue for some time as it should be regarded as an input to the infrastructural development of remote rural areas. Government support should also be extended to R&D, promotion, training of manpower, and so on.

Mr. Devendra Adhikari from the ADB/N presented the second paper entitled, '***ADB/N's Contribution to the Development of Micro Hydropower - Achievements, Problems and Prospects***'. The presentation gave an extensive review of the efforts of the ADB/N in promoting MHP in Nepal. He said that the ADB/N played a pivotal role in the promotion of MHP in Nepal. However, due to the fact that relatively little weightage was given to MHP programmes in terms of the ADB/N's total investment, it was not able to give this sector the full support it needed. In the context of current bank priorities, he expressed the opinion that a national-level organisation was needed to take the lead in promoting alternative energy technologies, including MMHP.

Mr. Adhikari expressed serious concern about the significant escalation of MHP costs, as they could be detrimental to the promotion of MMHP. Operation and maintenance problems were also serious. He suggested that the agencies involved in MHP should

make adequate efforts to train manpower, rehabilitate sick plants, carry out R&D and pay attention to other technical aspects.

Mr. Adhikari was of the opinion that the current level of capital subsidy on electrification plants was not enough to make them financially viable. He suggested that end-use development, as well as subsidies in productive end uses, should be considered as a means of supporting electrification plants.

Discussion. The papers led to lively discussions. Reasons for the high cost of MMHP installations in Nepal compared to the costs in Pakistan and China were sought. It was thought that, due to different hidden subsidies in the cost of raw materials in China, it would be difficult to make a comparison with the costs in Nepal. However, compared to Pakistan, Nepal was thought to have higher transportation costs (up to 40% of the total cost), more sophisticated control systems using load controllers, more expensive raw materials for penstock pipes, and no inexpensive generators, as in China. It was also pointed out that costs of MMHP have been rising over the years as has the reliability of schemes with improved civil works. However, the question was not completely resolved, and it was thought that the monopoly of manufacturers in MMHP equipment and the availability of government subsidies might be contributing to the rising cost of MMHP in Nepal.

The Government of Nepal's commitment to MMHP was questioned in light of the decreasing number of installations every year since 1985 and the uncertain and irregular annual subsidies for electrification. Confusion prevailed over the actual status of government subsidies. Of the 15 million rupees set aside in the national budget the previous year only three million rupees had been spent. However, at the same time, many entrepreneurs were not able to receive subsidies. It was not clear what the bottlenecks in the subsidy process were; this required more study.

The viability of MMHP, the rationale for subsidising MMHP and other renewable energy sources, such as photo-voltaics, and the real cost of MMHP versus diesel were the other questions for which no definite answers could be provided and for which it was agreed that further studies were needed. It was pointed out that the new demand for MMHP was more for electrification than for milling purposes. This was true for both small Peltrics and for larger stand-alone installations.

The actual performance of MMHPs was not well documented. It was not known how many of the over 900 installations were actually still working. It was recommended that a study be conducted to find out the number of operating installations.

A proposal was made that the cost of equipment be reduced by taking advantage of standardisation and mass manufacture of equipment. It was suggested that a mass market could be created by providing lower level subsidies and by widening the support so that installation rates increased considerably.

At the end of the session, the Chairman, **Dr. Banskota**, summarised the proceedings of the session. He said that MMHP had a definite role to play in Nepal and that MMHP development should not be seen in isolation but in the context of rural development as

a whole. Further, touching upon the issue of the reduced growth rate in MMHP installations, he pointed out that there may be a need to take the risk of generating demand instead of just waiting for it to materialise. The costs, viability, and subsidies of MMHP were not absolute; it was difficult to put economic values to the savings in terms of forests and rural development. Finally, Dr. Banskota thanked the participants and those who presented papers.

Working Session 2: New Approaches and Activities (Cont'd.)

Dr. R.D. Joshi chaired this session and **Mr. D. Adhikari** was the rapporteur. The highlights of the session are presented here while the summarised versions of the papers are given in Part B.

Mr. R.S. Thapa, from the Salleri-Chialsa Electricity Company Ltd. (SCECO), presented the first paper of the session entitled '***Salleri-Chialsa Electric Company - An Experience of a New Approach for MMHP Management***'. He illustrated how an innovative management approach had helped to improve the dwindling image of MMHP in Nepal. He said that SCECO, which was a shareholder company of the Nepal Electricity Authority, the Swiss Development Corporation, and consumers (householders) as shareholders, had made a remarkable achievement in the context of making MMHP sustainable through participatory management. This had helped to win the confidence of the local community. Other measures taken had been introduction of an innovative tariff system, which helped to increase the load factor to about 44 per cent; efficient administrative and technical management, which helped to reduce system losses, maintain a high plant availability of about 99 per cent, and relatively low running costs; and allocation of about 40 per cent of the expenditure for depreciation to create a capital replacement fund.

Mr. Thapa stressed the fact that the small personnel numbers in SCECO (only 10) was remarkable in the context of the employment patterns in publicly-owned MMHP. This was achieved through training as well as giving reasonable incentives.

'The Role of the Nepal Hydro and Electric and Butwal Engineering Works' was the second paper presented by **Mr. N.R. Shrestha** from the Nepal Hydro and Electric Company (P) Ltd. (NHE). Mr. Shrestha said that Butwal Engineering Works (BEW) and NHE were two pioneering companies in the field of MMHP with a focus on development and manufacturing of electro-mechanical equipment. NHE was a joint venture company formed with the purpose of getting foreign technical support.

Mr. Shrestha highlighted the joint manufacturing capabilities of the BEW and NHE which included crossflow turbines of up to 100kW capacity, Pelton and Francis turbines of up to five MW capacity, governors, electronic load controllers, control systems, transmission towers, penstocks and accessories, and so on. The list clearly showed that these companies were the front-runners in MMHP in Nepal.

Mr. Shrestha gave a list of the principal NHE/BEW undertakings, which included, among others, the rehabilitation of the Tinau Plant (1,000kW); the rehabilitation of

turbine runners for the Sundarijal Plant (640kW); manufacturing/rehabilitation of equipment for the Andhi *Khola* Plant (5.1MW); design/ manufacturing/installation of equipment for the Darchula (250kW) and Jhimruk Plants (12MW); and site welding of the penstock during the rehabilitation of Kulekhani - I (60 MW).

Mr. Shrestha said that the low volume of demand for MMHP and insufficient government commitment to support the development of indigenous manufacturing capabilities were the main difficulties being faced by the MMHP industry.

The third paper, '***Experiences in End-Use Development and Small Industry Promotion in Salleri',*** was presented by **Mr. H.P. Shrestha** of the Salleri-Chialsa Electricity Company (SCECO). The paper highlighted the importance of institutional support to end-use promotion to make MMHP financially viable.

Mr. Shrestha noted that the Salleri-Chialsa Hydropower Plant, built with the assistance of the Swiss Government, differed from other MMHP plants because the commissioning of the plant was not perceived as the final goal. The final goal was to make maximum use of the plant by promoting appropriate end uses, thus contributing to local development as well as to sustainability of the plant. The Salleri-Chialsa Electricity Utilisation Project (SELUP) was established for this purpose.

Mr. Shrestha said that SELUP introduced a number of domestic end uses, such as rice cookers, electric kettles, mixer-grinders, irons, immersion rods, blower fans, *bijuli dekchi*(s), and so on. It organised demonstrations of end uses and provided repair and maintenance services to the users. As a result of this promotional activity, a stable market for electric appliances developed and private electric shops were opened. These shops have taken over most of the SELUP activities in this field.

Small industry promotion received importance in SELUP, said Mr. Shrestha. SELUP supported entrepreneurs through technical information dissemination, coordination of business ventures, advisory services, feasibility studies, and training on management and book-keeping.

Mr. Shrestha also said that the achievements of SELUP were impressive. Twenty-six small-scale industries had been established. About 35 per cent of the households had started to use electricity for cooking and about 11 per cent for heating. Concluding, Mr. Shrestha said that the Agricultural Development Bank should take responsibility for providing technical and financial services to local entrepreneurs.

Mr. Ajoy Karki from the Butwal Power Company presented the last paper of the session entitled, '***Development of Mini-Hydropower in Remote Areas - Some Experiences and Challenges'***. Mr. Karki said that mini-hydropower development required more rigorous financial, technological, and socioeconomic analyses than micro-hydro.

Citing the example of the 500kW Jhankre Mini-hydro plant, designed to supply power, together with a diesel plant, during the construction of the 60MW Khimti Hydropower Plant, Mr. Karki said that it resolved the water rights' issue by guaranteeing the existing mode of water withdrawal for irrigation. The reasonably detailed financial analysis of

the project helped to select the best water availability for the plant, considering its inclusion in the grid after the commissioning of the Khimti Project. He also said that the concerns of the local people were addressed while developing the national-scale Khimti Project by making provisions for electrification of the surrounding area and providing job opportunities to local people.

Mr. Karki listed a few innovative technical decisions adopted in Jhankre with the aim of reducing costs. These included the use of plum concrete in anchor and thrust blocks, the use of high-grade steel for penstocks, and the use of a desilting basin cum forebay concept. In conclusion, he remarked that preliminary geotechnical investigations might be justifiable in the case of mini-hydro schemes.

Discussion. Regarding the paper presented by **Mr. R.S. Thapa**, the participants unanimously agreed that improved management can improve the sustainability of MMHP to a significant degree. They also appreciated the progress made by SCECO in managing the Salleri-Chialsa Mini-Hydro Plant. However, some participants said that the hidden cost of Swiss support in the management of the plant should be considered before drawing inferences about the sustainability of the plant.

The participants lauded the role of NHE and BEW in MMHP development. They also suggested that these companies should play a greater role in helping other private manufacturers to develop their capabilities. The participants agreed with the conclusion that MMHP could be sustainable only if adequate efforts were made to promote end uses. The reported improvements in the financial situation of the Barpak MHP, due to enhanced end uses, was cited as an example of the positive impact of end uses on the financial viability of MMHP.

The innovative approaches adopted in the Jhankre Mini-hydro Plant sparked the interest of the participants. Some participants expressed doubts about the appropriateness of the low-water availability selected for the plant in view of the lack of adequate water storage facilities.

Working Session 3: Problems and Redressal

Mr. Gerry Kent chaired the session. **Mr. S. Sharma** was the rapporteur. The highlights of the papers presented in the session are outlined below, and the summarised versions of these papers are presented in Part B.

Dr. A.A. Junejo started the session by presenting the paper entitled ***'Problems Associated with the Private/Decentralised MMHP Plants and Some Possible Redressals'***. Dr. Junejo said that the MMHP funding system was most developed in Nepal. However, low and inconsistent funding had discouraged entrepreneurs as well as manufacturers. The poor repayment of loans had further aggravated the situation by discouraging the bank as well.

Dr. Junejo said that poor implementation of some of the existing policies and the lack of policies in other areas had made MMHP investment risky. He emphasised the

alarming increase in prices of indigenous equipment. This could not be explained by inflation alone and should be investigated seriously. He mentioned that the economic returns of electrification through MMHP were still poor. Dr. Junejo expressed the opinion that, both in Pakistan and Nepal, frequent plant failures had been reported. The administrative and technical management capabilities of owners/managers and operators were, as a rule, poor. The remoteness of private MHP in Nepal had made these difficulties more serious.

In conclusion, Dr. Junejo recommended some redressals, such as extensive manpower training on MHP, support to R&D activities, development and promotion of end uses, better coordination between agencies involved in MHP, establishment/designation of a suitable institution with the overall responsibility for MMHP promotion, preparation of guidelines for surveys, feasibility studies, design, installation and commissioning, and so on.

Mr. S. Devkota from the Balaju Yantra Shala (BYS) presented the second paper of the session entitled, ***'Balaju Yantra Shala Experiences in MHP Technology Development.'*** He said that BYS was the first industry in Nepal to manufacture MMHP equipment, notably turbines. It started by manufacturing propeller turbines. After a few trials of propeller turbines, this venture was abandoned as it did not meet the local requirements. Subsequently, BYS manufactured cross-flow turbines, which was gradually established as the predominant turbine used in MHP in Nepal. BYS had achieved a great deal in cross-flow turbine type manufacture, developing 13 models altogether. In addition, BYS had been carrying out site surveys and installing and commissioning MHP plants.

Highlighting the difficulties faced by manufacturers, he said that high customs' duties on raw materials and low customs' duties on imported turbines were discouraging local manufacturers. The lack of a hydrological database for MHP sites and the lack of trained mechanics were also mentioned by him as serious constraints to MHP development.

The third paper of the session entitled, ***'State-of-the-Art — Technologies Appropriate for MMHP',*** was presented by **Mr. B. Pandey** from the Intermediate Technology Development Group (ITDG). The paper provided guidelines for selection of MMHP technology. It emphasised that the appropriate choice of technology was crucial for the success of an MMHP. Reliability, local/national manufacturing capabilities, and correspondence with the needs and capabilities of the community for whom it was designed were the parameters determining the appropriateness of a particular technology in a given situation.

Mr. Pandey's presentation covered the following technologies: improved *ghatta*, turbines for milling, add-on schemes, peltric sets, and stand-alone schemes. He said that despite reasonably-matured MHP technology, some bottlenecks still remained in certain areas: civil works, pelton turbines, induction generator controllers, and current cut-outs.

Discussing the example of the Yangar MHP in remote Humla District, Mr. Pandey said that its failure was clearly due to the selection of inappropriate technologies. Further, he

recommended the following measures for MHP promotion in remote areas: (a) the role of organising and motivating communities may be better served by NGOs than by ADB/N; (b) MHPs were unlikely to succeed without outside technical support; (c) the current level of financial support to electrification MHPs should be increased; (d) stand-alone electrification schemes were seldom sustainable; and (e) agroprocessing, especially oil expelling powered by MHPs, was most rewarding economically.

The fourth paper of the session entitled ***'Viability and Desirability of Mini- and Micro-Hydropower'*** was presented by **Dr. R.D. Joshi** from the Tribhuvan University. He said that both private and public sector efforts in the electrification of rural hill areas started in the mid-seventies. Private sector efforts had been directed towards the sparsely-populated rural hills, whereas the public sector had been towards the district headquarters. Though the success of private sector electrification in Nepal was encouraging, its growth rate had not been high enough to meet the Eighth Five Year Plan target.

Dr. Joshi was of the opinion that MHP technology, although already workable, was still evolving. Further research and development (R&D) efforts were necessary for a fully matured technology. He also said that add-on MHP might be financially viable, but stand-alone plants became financially viable only when end uses were adequately developed. Popular one kW peltric sets of the stand-alone type were an exception to the above rule.

Dr. Joshi mentioned that community-owned, non-commercial MHP was also emerging in Nepal. This type of plant could be divided into formally-managed and non-formally managed plants. Experiments were being carried out to evolve financially-sustainable models of formally-managed plants. Dr. Joshi said that rural electrification efforts in Nepal, through private MHP, were encouraging from the rural development standpoint, because it was a common practice for MHP entrepreneurs to integrate agro-industrial end uses with MHP.

Concluding the presentation, Dr. Joshi suggested the following measures for MHP promotion: (a) entrepreneur-owned MHP should be the focus for MHP promotion; (b) end-use promotion should receive high priority; (c) stand-alone plants, which could make relatively higher contributions to rural development, should receive higher subsidies than add-on plants; (d) an agency responsible for the overall promotion of MHP should be established or designated; and (e) the subsidy level should be differentiated according to the economic development indicators of the areas being considered.

Mr. G.P. Devkota presented the last paper of the session entitled '***Development and Dissemination of Mini- and Micro-Hydropower in Nepal: The DCS Experience.'*** He mentioned that the Development and Consulting Services entered the MHP field with the manufacturing and installation of the first turbine — a cross-flow turbine, in Jhare *Khola* in 1976. Since then it had been involved in survey, design, installation, and commissioning of MMHP. Its notable R&D activities were related to automatic voltage

regulators, electronic current cut-outs, positive thermal coefficient thermistors, and electronic load controllers.

Mr. Devkota said that 260 MMHP plants, out of the 918 installed by 1993 in Nepal, were installed by DCS alone. Out of the DCS-installed MMHP plants, 54 were electrification schemes. By 1993, it was estimated that the total power generation from DCS installations was 730kW, and approximately 50,000 people benefitted from DCS electrification programmes.

The lack of good testing facilities, the lack of MMHP standards, uncertainty in the provision of subsidies, high initial costs, inadequate users' knowledge, and limited availability of spare parts were mentioned by Mr. Devkota as the main problems facing MMHP promotion. He said that the possible solutions to these problems might be: (a) organising repair and maintenance training for operators; (b) opening local sales' depots; (c) organising consumer education and mobile training programmes; and (d) rewarding the successful owners/promoters/operators.

Concluding the presentation, Mr. Devkota made the following recommendations: (a) standardised equipment should be developed; (b) simpler funding mechanisms should be developed; (c) manufacturers should organise follow-up visits; (d) plant operation manuals should be prepared; (e) R&D activities should be undertaken to develop end uses; and (f) MMHP awareness-raising programmes should be organised.

Discussion. Responding to the question from a participant about the possible ways of dealing with non-repayment of loans, it was suggested that judicial measures to approve as well as recover loans might be helpful. The issue of escalating MMHP costs in Nepal was widely discussed. One of the participants, commenting on this issue, said that the old micro-hydro schemes were cheaper but unreliable, and the new ones were more expensive but reliable.

During the discussions, concerns were raised about the difficulties involved in returning poor quality imported Indian goods. No satisfactory solution was found to that problem. A number of questions was raised about the price and quality of various cross-flow turbine models manufactured by BYS.

One of the participants asked whether the appointment of dealers could help promote MHP. It was agreed that such an approach was feasible only for standardised equipment, such as peltric sets, but not for larger sets that were site-specific.

Regarding the decline of MHP business, it was noted that the MHP turnover had remained more or less stable in BYS, though its share in the company's turnover had always remained below 10 per cent. BYS had been exporting equipment. However, it had not been able to make a profit out of MHP.

Discussions about the of demand for MHP were not conclusive. Some participants felt that the demand for MHP was not sufficient, while others opined that there was too much demand for it and stressed that MHP should be promoted carefully. The scope for introducing Francis turbines in Nepal was also discussed. Participants were of the

opinion that it would not be wise to introduce Francis turbines because of the low level of MHP demand.

In the course of discussions on the reliability of load controllers, it was noted that electronic load controllers were fairly reliable, whereas induction generator controllers still had reliability problems. The possibility of introducing subsidies on energy as an alternative to the subsidies on capital costs was discussed. It was agreed that in the current circumstances this was practically impossible.

One of the participants asked if DCS was making a profit from MHP, and it was explained that DCS, a non-profit organisation, had been operating at break-even point. Referring to the low priority accorded to milling type MHP by DCS, it was clarified that DCS was withdrawing from that area because private manufacturers had already developed adequate capabilities in that field.

One of the participants asked whether it would be appropriate for DCS to promote milling MHP in the Mid and Far-Western Development Regions, given the slow dissemination of such MHP in those regions. It was explained that there was not much demand for milling MHP in these regions.

Working Session 4: Direction for the Future

The fourth session was chaired by **Mr. B. Pandey** and **Mr. S. Sharma** was the rapporteur. The highlights of the session are given below. The summaries of the papers presented are given in Part B.

Mr. V.B. Amatya presented the first paper entitled **'Institutional Requirements for MMHP Development in Nepal'**. In the context of dwindling biomass resources and high transportation costs of fossil fuels, Mr. Amatya said that alternative energy sources should be seriously considered for remote rural hills. Among the alternative energy sources, micro-hydro had proven to be capable of being commercialised.

Mr. Amatya also gave a brief review of the institutions involved in the MMHP sector. In the course of the review, he said that the ADB/N played a key role in the successful dissemination of MMHP. He also said that NGOs and INGOs had played important roles in this endeavour. Mr. Amatya said that the Eighth Five Year Plan included policies and programmes for Alternative Energy Technology (AET) promotion, including the institutional set-up.

Referring to the problems faced by MMHP, Mr. Amatya said that most of the problems could be directly linked to the lack of a dedicated institution for MMHP promotion. He suggested that a Central Micro-Hydropower Promotion Centre, which could be a wing of the Alternative Energy Promotion Centre proposed in the Eighth Plan, be formed within the government framework but that it should be made as autonomous as possible. The main responsibilities of such a centre should include: (a) coordination and facilitation of R&D activities; (b) preparation of guidelines and manuals on MHP-related

work; (c) quality control; (d) facilitation and coordination of training programmes; and (e) facilitation of financing.

Dr. K. Rijal presented the last paper of the session entitled ***'Perspective on Mini- and Micro-Hydropower Development'.*** He noted that the scattered settlement pattern in the hills and mountains of Nepal had made micro-hydro a preferable option for rural energy supply. The other intangible benefits of MMHP were its potential to: (a) substitute fuelwood for cooking and heating applications in residential, agro-based cottage industries and commercial activities; (b) reduce human drudgery, especially of women; (c) increase income-generating activities and help move towards a modern economy; and (d) reduce carbon emissions and deforestation. With regard to the international experience in rural electrification, he said that rural development could only be achieved if a broader-based development package was designed with energy as the prime mover of rural development. Dr. Rijal also listed the factors impeding the growth of MMHP, which were: (a) market and price distortion; (b) lack of capital resources; (c) low load factor; (d) lack of policies to guide R&D activities; and (e) lack of a coordinating agency. He proposed the following means to promote MMHP: (a) improve the economics of MMHP through end-use diversification; (b) link it to the development of mega-projects; and (c) conduct economic analyses taking market distortion into consideration.

Discussion. One of the participants wondered if the Alternative Energy Promotion Centre (AEPC) was necessary as MMHP was already being subsidised. It was mentioned that many inputs, other than funding, were necessary to promote MMHP. Another participant enquired why alternative energy resources were discussed only during power crises. It was noted that the drive to promote MHP was not associated with the current power crisis because the MHP target area was generally beyond the reach of the grid.

The concept of linking MMHP to mega-projects sparked the interest of the participants. They agreed that MMHP could be used to supply electricity to the areas surrounding the mega-projects.

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Concluding Session

The Concluding Session was chaired by **Dr. M. Banskota**, Director of Programmes, ICIMOD, and **Mr. S.L. Vaidya** was the rapporteur.

Dr. R.D. Joshi presented the seminar conclusions prepared by a small committee. Members of the committee were Dr. A. Junejo, Mr. B. Pandey, Mr. D. Adhikary, and Dr. R.D. Joshi.

The proposed conclusions, the discussions which followed them, and the conclusions adopted subsequently are presented below.

Conclusions and Discussions

1. Appropriate standards of technological reliability need to be developed and implemented.

The participants made an effort to identify appropriate agencies for the preparation of MMHP standards. However, the participants could not agree on that issue. A conclusion was adopted with the following modification:

> *"Appropriate standards or guidelines for design and manufacture of MMHP need to be developed to improve the performance and reliability of plants."*

2. R&D and allied facilities need to be developed and adequately supported.

The participants felt that the conclusion should be spelt out more precisely, elaborating on the purpose of R&D activities. Some participants were of the opinion that *quasi*-governmental organisations or NGOs might be suitable for developing such facilities. The conclusion was adopted in the following form.

> *"R&D and allied facilities need to be established or incorporated in the existing manufacturing systems to improve performance and quality and also to reduce costs. Additionally, development of more standard equipment, such as peltric sets, would also be helpful in this regard.*

3. End uses need R&D as well as financial support in the same way as MMHP plants.

This issue generated considerable interest among the participants. They stressed the importance of rigorous technical and financial feasibility analyses before the introduction of end uses. As there is a great deal of risk involved in starting end uses before MMHP becomes viable, there is a case for providing financial support to end

uses. The conclusion was adopted after the following modifications for clarity were incorporated.

> *"More R&D also needs to be carried out to identify and develop the additional end uses as well as the allied appliances. Financial inputs would also be necessary."*

4. Novel electricity tariffs and adequate management systems are proving to be useful tools for increasing plant use. This work needs to be continued.

The conclusion was adopted in the following form:

> *"Novel electricity tariffs and management systems for the formal electrification plants have contributed significantly towards enhancing the plant factors. These ideas may be pursued further and promoted."*

5. Training of surveyors, installers, owners, managers and operators is very important and has not received adequate attention.

Various agencies that could contribute to the training were identified, but the participants could not recommend a particular organisation that would take care of the training activities. The conclusion was adopted unchanged.

6. The question of soft loans and subsidies needs to be studied in depth, in terms of level and various other parameters as well as implementation aspects.

There was general consensus on the issue that the subsidies were not adequate to achieve the desired dissemination MMHP. However, recommendations on the level of subsidies and their mode of implementation could not be made because the issue required rigorous study. The conclusion was adopted in the following form.

> *"The situation regarding the loans and subsidies, including the amounts and percentages and other parameters as well as implementation aspects needs to be studied in depth and a more effective system may be developed."*

7. Customs' and sales' taxes need to be reduced on and consistently applied for raw materials for MMHP.

The participants, especially those representing the manufacturers, stressed that high customs' duties on raw materials and low custom duties on imported finished MMHP products had weakened the MMHP industry in Nepal and raised the MMHP costs. Some participants were of the opinion that providing rebates on the customs duties to MMHP manufacturers might serve the purpose better. The conclusion was adopted after the following modification.

> *"Customs' duties and sales' tax for raw materials and other components needed for indigenous manufacture of MMHP equipment, may be reduced or rebate be provided, whichever can be implemented more judiciously and transparently."*

8. There is a need for an independent institution to oversee the promotion of MMHP and to organise inputs.

The need for an organisation with the overall responsibility for MMHP promotion was recognised by the participants. Some participants felt that it might be better to designate an existing agency for this purpose rather than create a new one. The conclusion was adopted with the following revision.

> *"An independent institution may be established or a coordinating agency may be organised from the existing institutions to oversee the promotion of private MMHP and organise inputs for its proper development and implementation."*

9. The current rates of MMHP growth are not adequate for the sustainable growth of MMHP.

Some participants were of the opinion that the current growth rate was not sufficient to meet the Eighth Five-Year Plan target and, therefore, the National Planning Commission (NPC) should review the situation. Others were worried that the present rate could not sustain the manufacturers and, hence, NPC intervention, in terms of increased support, was needed. After a lively discussion, the conclusion was adopted in the following form.

> *"The current rate of installation of private MMHP is neither sufficient to meet the projected government targets nor to lead to eventual sustainable growth. Consistent and enhanced financial supports may be provided for agro-processing and electrification MMHP plants."*

10. The establishment of more extension centres in locations where MMHP has not made adequate inroads is also required.

There was general consensus on this issue. Many participants felt that urgent action was necessary in this area. The mode of establishment of such centres was also discussed. The conclusion was adopted in the following form.

> *"More extension/promotion centres may be established in remote areas to promote the technology."*

The seminar also recommended that the following studies be undertaken.

1. An assessment of the reasons behind rising MMHP costs so as to identify ways to curb them to the maximum possible extent
2. Identification of bottlenecks in MMHP-financing procedures in order to make them simple and effective
3. An assessment of the operational status of private MMHP
4. A study of the competitiveness of MMHP with diesel plants, with special reference to the repair and maintenance aspects of MMHP

Chairman's Remarks

Dr. M. Banskota, the Chairman of the session, thanked the participants and the co-sponsor of the seminar, ADB/N. He also congratulated Dr. A. Junejo, the Coordinator of the MMHP Programme, and the participants for the very useful outputs of the seminar.

He said that development intervention in the Hindu Kush-Himalayan Region should be based on need assessment. While the need for strengthening the energy base of the region was generally accepted, the need for MMHP and its scope needed to be carefully studied. The parameters/linkages which influenced the performance of MMHP should be studied in depth.

Dr. Banskota also stressed the fact that the development of local entrepreneurship was one of the crucial factors in the success of MMHP. Lastly, he thanked the participants once again for attending the seminar.