4
Case Studies on Renewable Energy Technology

4.1 *Nepal Case Study Presentations*

This session was chaired by Dr. T.S. Papola, Division Head of MEI, ICIMOD. During the morning session, the first presentation was made by **Mr. Shrimat Shrestha.** Mr. Shrestha reviewed the 'Case Study on Micro-hydropower' carried out in Nepal. This was followed by the presentation of a 'Case Study on Biogas Technology' by **Mr. Ramesh Gongal** and a presentation on the 'Case Study on Improved Cooking Stoves' by **Ms. Karuna Bajracharya**. Finally, **Mr.V.B. Amatya** presented a 'Case Study on Solar Technology'. All of the speakers represented the Centre for Rural Technology, Kathmandu.

Micro-hydropower

This presentation reviewed the status of micro-hydro plants in Nepal where projects of less than 100kW were considered to be micro-hydro projects. Micro-hydro was not a new concept in Nepal. Traditional *ghatta*(s) (water mills) had been part of the rural setting in the hilly areas of Nepal for centuries and it was estimated that about 25,000 traditional *ghatta*(s) were currently in operation. There were more than 1,100 micro-hydro plants installed in Nepal, out of which the mechanical drive type numbered about 800 and turbines with electricity generators about 300 units. There were about 350 improved *ghatta*(s), MPPU, which were costly and had multipurpose uses, and there were about 250 peltric sets.

A good manufacturing base had already been developed and was primarily managed by 11 private sector manufacturers which were capable of producing turbine equipment of up to 300kW in capacity with a total production capacity of about 2MW per annum. Most of the factories manufactured turbines on demand, and they accounted for less than 25 per cent of their sales' volume. They had formed an association with the objectives of lobbying as a unified force to influence policy, providing support to its members, and becoming a focal point. These factories were located in Kathmandu and Butwal and, interestingly, most of the micro-hydro installations had been established in nearby districts. The presentation identified the key factors that had contributed to the growth of micro-hydropower. These were: low capital investment; short construction period; great potential; capabilities in indigenous technology manufacturing; simple to operate; attractive government incentives; and promotional activities had been carried out by many international agencies. At the same time, de-licensing of plants, initially those of up to 100kW and then up to 1,000kW in 1992, had further encouraged its development. Prior to 1993, the government subsidy was *ad hoc*, but now it provided subsidies through ADB/N of from 50-75 per cent on electrical components of both add-on or stand-alone electrification schemes. The main comment on the existing subsidy policy was that it did not take into account the transportation costs but provided a flat subsidy on a district basis, which according to the manufacturers was unfair.

The development of micro-hydropower was always cited as an example of technological innovation to suit the local needs and conditions of hilly areas, but the presentation identified various issues related to micro-hydropower (Box 10) which required earnest consideration by stakeholders involved in promoting this technology.

The presentation also highlighted the importance of micro-hydropower in terms of reducing drudgery for women, as it reduced the time taken in agro-processing activities and also provided opportunities for women to engage in income-generating activities and literacy classes in the evening.

Regarding legislative and regulatory issues, the presentation highlighted the following points.

- The Water Resources' Act 1996 did not specify the right of prior use of water resources for micro-hydropower projects.

Box 10: Various Issues Pertaining to Micro-hydropower Development in Nepal

- **Technological Issues**
  - Low load factor - lack of end-use diversification
  - Lack of technical back-up and monitoring
  - Long earthen canals
  - Lack of use of traditional skills: technical and management
  - Lack of emphasis on quality of civil works
- **Issues on Policies**
  - Water rights' issues
  - Lack of dissemination of smaller units
  - Increased competition with diesel mills
  - Lack of promotion of multiple-use of water resources
  - Quality control and standardisation issues
  - Gender issues
- **Institutional Issues**
  - Poor accounting system
  - Inadequate technology promotion institution and entrepreneurial development programme
- **Organizational Issues**
  - Lack of norms for project feasibility studies
  - Lack of training for operators
  - Lack of a management system
- **Financial Issues**
  - Lack of insurance
  - Warranty issue
  - Consumptive rather than productive use

- The private sector shied away from research activities because of the inadequacy of laws on patent and intellectual property rights.
- Lack of formal standardisation of procedures and guidelines had resulted in errors in flow measurements and demand estimation at the feasibility study stage of projects, as well as negligence regarding safety features in micro-hydropower plants.
- Prevailing laws and acts did not force manufacturers to provide long-term warranties or insurance.
- Entrepreneurs had to register micro-hydro plants as an industry (cottage) in order to receive industrial tax and duty exemptions.
- Entrepreneurs often found it difficult to get financial assistance from ADB/N for micro-hydro if a diesel mill or other water turbine existed within three kilometres of the vicinity. This had not only affected hydropower development but also created situation of monopolies.

The study team made presentations based on field case studies carried out on micro-hydropower. Box 11 provides the highlights of various issues that were faced at field level.

Clarifications and Discussions

During the discussions, a question was raised about the method of fixing electricity tariffs and the capacity of micro-hydropower installations. It was stated that the owner assumed that the total electricity produced would be consumed and the tariff rate was normally set as one rupee per watt per month. The rate also depended upon a particular village and its economy. The plant capacity was determined based on the number of houses willing to receive electricity for lighting, assuming three to four bulbs per household.

Regarding the case study on micro-hydro, the chairperson remarked that there was a long list of issues and preconditions for the successful operation of a five kW plant. He added that there were all kinds of internal as well as external factors that seemed to be influencing the performance or feasibility of a particular micro-hydro plant. If there were so many problems prevalent in micro-hydro, then who would really be interested in its implementation ? The chairperson requested the gathering to look at each of these technologies and also the kinds of recommendation made for policies relating to those technologies in a somewhat rational manner.

Mr. Kedia pointed out that there were 10 manufacturers working in the Eastern States of India, and they had the capability of producing turbines of different sizes up to 150MW per annum. He stated that he was very impressed by the kind of work carried out in Nepal in the capacity ranges below 20 or 40kW. In India, manufacturers would never be interested in producing turbines below 100kW, or maybe even 500kW, in capacity. It was also confirmed by another participant that India had had manufacturers for 35 years, but they were not interested in manufacturing small-sized machines. The average size of hydropower plant being installed at present was three MW.

Mr. Kedia observed that most of the work was being done by manufacturers in Nepal, whereas in India manufacturers would not bother. And there was something to learn from Nepal's experience and consultancy services could take up this responsibility. He added that they had been trying to replicate financial institutions like ADB/N in India, but up to now they had not been able to convince the government. He pointed out that there was a high subsidy rate in India, whereas in Nepal it was too low. He suggested that a methodology needed to be developed so that subsidies were limited to

Box 11: Status and Issues Identified from Micro-hydropower Field Case Studies

Description	Ownership	Status	Issues
1. 85 KVA Ghandruk Micro-hydro Electrification Plan	Community	Successful community	Low load factor
2. 68kW Barpak Micro-hydro Plant	Individual/Managed like company	Achievement of local young entrepreneur sound organizational capability	Poorly designed; Risk of flood and landslide; Remote location
3. 400kW Salleri Chialsa Mini-hydropower Plant	Salleri Chialsa Electric Company/Public Limited Company	Successfully managed	Poor transportation and communication
4. 100kW Sickles Hydropower Plant	Community/Sickles Village Electrification Committee	Successfully managed community scheme	Bulb fusing; lack of motivation of women
5. Improved *ghatta* in Urthu	Community	Success due to increase in grinding capacity	Need for orientation, training and improvement in the system
6. 9kW MHP at Urthu	Community		Lack of end use; Lack of managerial and technical capabilities
7. MHP owner became a diesel mill owner	Individual	Access to information a major need in the rural areas	High maintenance cost; Long earthen canal
8. 32kW MHP at Charaundi	Individual	Failure	Water rights' problem
9. 28kW Micro-hydropower mill at Kalidaha	Individual	Failure	Flood damage
10. 1kW peltric set at Ghode Sim Community	Successful	Small peltric electrification scheme	

whatever was the requirement and a performance linked subsidy could be worked out.

Mr. Surendra Shrestha stated that the government of Nepal was trying to solve the problems of micro-hydro development. Many participants believed that most of these problems would be taken care of with the establishment of AEPC. Some of the participants commented that the resources that the government had allocated as subsidies for the micro-hydropower sector were not used effectively.

The feasibility study of the project site itself was the most vital point. The main reason for the failure of micro-hydro was location, which was mostly remote and in hilly areas. The other reason might be that all the people who wanted to implement the project did it forcefully just for the sake of the government subsidies from which they benefitted. There was also a problem associated with the availability of subsidies and, at times, ADB/N was not able to cope with the demand. But, at a later stage, with an increase in the capital cost of turbines, the subsidy allocated for the micro-hydropower sector remained unused.

One of the participants pointed out that women had done all the agro-processing (grinding, de-husking) activities at home. But, with the introduction of micro-hydro, the burden on women had been reduced though, in fact, they now had to tend to other chores, thereby not freeing them as much as had been expected. One advantage was that now they could use the time saved as they chose. In some instances, the location of the micro-hydropower mill was such that they had to spend quite some time to reach the mill.

The manufacturers played a big role in the implementation of micro-hydropower projects; especially in Nepal. The promotion of this sector seemed to be very bleak unless the capabilities of manufacturers increased.

One of the delegates pointed out that MPPU in Gauhati had been developed after seeing the progress made in Ladakh, and he added that Nepalese manufacturers had not been really outgoing enough to promote their products outside of the country. There was a good market in the hilly regions of India.
Mr. Surendra Mathema, representative of the Association of Micro-hydro Manufacturers described the problems faced by manufacturers in promotion of micro-hydro. Manufacturers had to do all the work themselves: identification of the site, design, cost estimates, installation, and so on; this had limited their capacity for growth. Mr. Mathema also pointed out that there was a scarcity of trained operators. The association had carried out training for about 60 people, and it planned to do more in future; and thus this might solve some of the problems.

The manufacturers were not very keen on site surveys because, if the site was not feasible, the manufacturers had to bear all the costs. Therefore, if there was a subsidy for site surveys, it would help. In Nepal, a subsidy of only 50 per cent on electrical parts was provided, and this was not sufficient.

Micro-hydro projects in Nepal were in decline because the banks did not accept the project itself as collateral and the interest rate was very high. A good end use had to be perceived before installation of the plant.

Mr. Bhola Shrestha, of the Intermediate Technology Development Group (ITDG), provided a good example of how the load factor had been successfully increased. In Ghandruk, the load factor had been increased up to 60 per cent with the use of various low-wattage end-use devices to heat water, cook rice, etc; primarily thermal applications. Tourists could get hot showers in both Ghandruk and Muktinath. Paper dryers and grinding of herbs were also being explored as ways of diversifying end use. A ropeway had been installed in Barpha. The most important aspect was identified as transferring and building local capacities. Mr. B. Shrestha described the training needs. Over the last three years, regular training had been conducted and the training facilities needed to be institutionalised. Mr. Bhola Shrestha emphasized project appraisal as it was very important. The first criteria would be socioeconomic and management practice. An appraisal format should be developed for socioeconomical, technical, institutional, and managerial practices.

The chairperson remarked that he wished that there were more cases of more than 60 per cent load factors. The whole question of quality depended upon the government and other institutions also. He thanked Mr. Shrestha for his positive presentation and stressed that this kind of interaction was needed to convince policy- makers.

Dr. Junejo remarked that, at this stage, private micro-hydro in Nepal was at a critical stage. Initially, plants had been more or less distributed or given a push by government agencies and people had accepted them enthusiastically. Then came discrepancies and problems with micro-hydro plants. On a positive note, the situation had improved. The number of plants was increasing.

Issues Identified and Suggestions Made

The study team made a detailed presentation of the main findings and came up with various suggestions. These suggestions were commented upon and supplemented by the participants during discussions. Most of the issues raised and suggestions made are as presented in the following passages.

***Management Aspects*:** Most of the community-owned and managed micro-hydro plants had been more successful than individually-owned and managed plants because of frequent debates over water rights and non-participation by the community in repair and maintainance of canal damage caused by floods and landslides in the latter case, as indicated in Box 9. A strong community organization, cohesiveness of the community, democratic leadership, good technical and managerial capabilities, and strong technical back-up were indispensable for making a micro-hydro scheme successful.

***Administrative and Financial Procedures*:** Many plant owners complained about the cumbersome procedures of banks and other administrative units involved in loan sanctioning. This demotivated many from installing micro-hydropower plants. Simple and transparent procedures should be developed and institutionalised for loan sanctioning.

***Technical and Financial Feasibility*:** Optimistic assumptions of various factors, such as high electricity consumption, low costs of maintenance of long earthen canals, and inaccurate head and discharge measurements, had caused many entrepreneurs heavy financial losses. This would mean that proper evaluation of the socioeconomic setting, technical and managerial capabilities, and the adequacy of surveys and designs were essential while carrying out feasibility studies. Accountability on the part of the surveyor and manufacturer was also essential.

Choice of Smaller Units: The promotion of smaller units, such as improved *ghatta*(s) to replace traditional ones, would not only bring economic gains to marginalised *ghattera*(s) but also reduce drudgery at household level by introducing rice hullers. In many instances, micro-hydropower plants had replaced a number of traditional *ghatta*(s) from a particular locality.

***Maintenance of Earthen Canals*:** High seepage, damage by frequent landslides and floods, and blockage of the canal were the main problems. These resulted in high maintenance costs and unreliability of micro-hydro plants. Availability of construction manuals and a code and enforcement of standards while constructing canals would result in reduced maintenance costs.
Technical Back-up Service and Moni-

toring: Technical back-up service and monitoring were nobody's responsibility, as the bank was only concerned with the financial viability of the project. There should be an institution responsible for monitoring and backstopping to improve the technical and managerial capabilities of micro-hydropower entrepreneurs.

Training: Most of the micro-hydropower operators had not received training. They had become operators by learning and doing. Most of the owners did not know how to keep business records and lacked appropriate business skills.

Warranty and Insurance: There were a number of instances of damage to micro-hydropower installations caused by landslides and floods. In order to safeguard entrepreneurs from such calamities, insurance should be mandatory. Similarly, long-term warranties from manufacturers might be instrumental in cutting down on losses that might accrue to the plant owner due to manufacturing defects.

Quality Control and Standardisation: The quality of raw materials used, safety codes to be followed during installation, and rated power of turbines and generators needed standardising received from plant owners.

End Use Diversification: It was observed in almost all micro-hydro plants that the generation of electricity primarily for illumination resulted in financial losses. There was a strong need to diversify end uses into productive purposes such as agro-processing, cold storage, ice factories, power looms, carpet weaving, wood carving, and food processing.

Gender Implications: The field study revealed that the installation of micro-hydropower resulted in saving women's time because less time was required for agro-processing, in some instances, increasing their productivity in activities such as weaving and increasing their quality of life through educational programmes in other instances. Women did not participate in planning, implementation, operation, and management of micro-hydro plants, although they were instrumental in convincing the men to support the installation of micro-hydro plants.

Water Rights' Issue: The issue of water rights was critical and prevailing laws did not ensure the right of prior use for agro-processing and electricity production. Instead, water could be diverted as and when deemed necessary for irrigation. There was a need to provide appropriate compensation to the owners if such a situation arose.

Existing Policies Favour Diesel Mills: The existing subsidy on diesel fuel, low capital investment, and flexibility of diesel engines, along with the various constraints faced by micro-hydropower (as discussed), had prompted entrepreneurs to switch over to diesel mills.

Changing Cropping Patterns: The shift from cereal crop production to cash-crop farming systems had not only reduced the volume of agro-processing activities but also increased the cash income for the purchase of grain products grown in the *Terai*. This was a visible phenomenon in places like Dhading. This had decreased the economic feasibility of micro-hydropower plants.

Integrated Approach to Promoting Micro-Hydropower Plants: Case studies revealed that the repair and maintenance of canals were problematical. The benefits provided by installation of micro-hydro turbines were not sufficient to meet the cost of repairing the canal and also frequent water rights' disputes made these systems unattractive. The appropriate approach in this context would be to integrate irrigation water requirements of a particular community with the installation of a microhydropower plant. By doing so, the cost of maintaining the canal would be borne by the profits that accrued from increased productivity, and the cost of installing the turbine would be recovered through the sale of electricity and agro-processing activities.

It was also suggested that the technical and managerial aspects should be strengthened for effective implementation. In order to reduce the cost of the project, the design should not require a long earthen canal in order to reduce the cost of the project. There should be more emphasis on quality civil work. Policies that promote microhydropower, especially in the case of water rights, should be implemented. Technology promotion and entrepreneurial development programmes should be organized. Project feasibility studies should be carried out efficiently and training and orientation must be given to operators. Warranties and insurance must be granted to the projects, and projects should have more of a productive than consumptive use.

Biogas Technology

The presentation indicated that biogas in Nepal had been quite successful as a result of government subsidies and the interest and involvement of INGOs and donor agencies. Private biogas companies were introduced after 1990. The Biogas Support Programme (BSP) was set up as a joint venture between ADB/N, recognized biogas companies, and the Netherlands' Development organization (SNV). The history of biogas development dates back to 1975/76 (i.e., Agriculture Year) with the installation of 199 plants. There were 32,000 biogas plants and the target was to install 100,000 biogas plants in the third phase of the programme during the period from 1996/97-1999/2000.

Prior to 1991, the subsidy policy of the government was not consistent. With the Dutch-funded BSP programme, there was a subsidy on the total cost of Rs 7,000 in the *Terai* and Rs 10,000 in the hills, and recently an additional subsidy of Rs 2,000 was introduced for remote hill districts where the headquarters were not connected by road. The programme also provided indirect financing through training and observation tours to staff of biogas companies and other relevant agencies.

The subsidy scheme was channelled to manufacturers, primarily through ADB/N. The participation of other banks (NBL, RBB) was limited to two per cent in 1995/96. The percentage of subsidy in the *Terai* varied from 17-40 per cent and in the hills from 24-58 per cent depending on the size of the plants, as the subsidy decreased with increase in plant capacity. This policy resulted in reduced under-feeding of biogas plants as they were installed in smaller units. At the same time, the higher subsidy rates provided in the hills resulted in increased installation in hilly regions (i.e., 55 per cent of the total installations). Landless farmers were not able to take advantage of this subsidy scheme, as they did not possess physical assets for the bank collateral. The real price of biogas plants had decreased by about 20 per cent in the past five years if inflation can be assumed to be 10 per cent. This could be due partly to an increase in the numbers of private biogas companies (from one [up to 1991] to 36 companies) and also because of economy of scale as more plants were installed during these periods.

The presentation highlighted the various socioeconomic benefits of biogas plants, particularly for women and children. The most prominent was for saving women's labour from collecting fuelwood and managing kitchens (and children for fuelwood collection), as time for cooking and cleaning decreased substantially. This has improved the quality of indoor air and thus the health of the household as this fuel was less polluting than fuelwood. Sanitary conditions improved not only in and around the kitchen but also around the village, since the construction of toilets along with biogas plants eliminated breeding grounds for houseflies and mosquitoes.

In spite of the relatively successful implementation of biogas promotion and development programmes, there were still several technical, financial, and institutional problems in the effective promotion of this technology. These were as follow.

- Reduction in gas production during winter
- High initial cost
- Poor performance of the biogas lamp
- Sub-optimal use of biogas slurry
- No linkage between livestock development programmes and biogas promotion activities
- Lengthy procedures for obtaining information, loans, and subsidies
- Lack of follow-up action due to shortage of trained technicians for maintenance and repair of plants

The study team made a detailed presentation of findings based on the field surveys carried out. Box 12 summarizes the status and presents the main findings. The presentation highlighted various issues identified during the field survey (Box 13) which corroborated some of the issues identified in the sectoral review.

The presentation pointed out the positive aspects of biogas plant installation based on field survey results. These were: saving time spent on collection of fuelwood, reduced pressure on forests for fuel, less consumption of kerosene for lighting, improvement in health conditions, and improved health and sanitation due to construction of toilets and feeding of animal dung into biogas digesters.

Clarifications and Discussions

Dr. Papola, chairperson of the session, raised a question about ways of assessing the performance of biogas plants. The study team pointed out that the evaluation of plants was being carried out through quality control measures introduced by the BSP programme.

Box 12: Main Findings of the Biogas Case Study

Type/ Plant Location	Cost	Status	Findings
Fixed dome Mahadevsthan Kabhre (Hill)	Total cost Rs 29,000 Subsidy Rs 10,000 BSP/ABDN	Almost all plants constructed during the early eighties were abandoned and all others established after the late eighties are in use	Link biogas with livestock; Health and sanitation improvement; High cost
Deenbandhu Chitwan (*Terai*)	Total cost Rs 14,000 Subsidy Rs 10,000 KMTNC/IRVDC	All plants in use. Successful distribution of low cost biogas plant with maximum use of local resources.	Cheaper cost; sense of belonging; effective slurry use

Box 13: Various Issues Identified During Field Survey

- No linkage between livestock development and the biogas programme
- Lacks participatory/innovative biogas promotion approach
- Lacks proper use of biogas slurry
- Most of the biogas plants are owned by villagers with high incomes
- Biogas plants are costly for low income villagers
- Lack of trained (skilled) masons
- Lack of awareness campaign about slurry use and toilet-attached biogas plants
- Unwillingness of hired labours to handle slurry coming out of toilet-attached biogas plants

Mr. Baral refuted the statement that people were not using slurry because of the attachment of toilets to the biogas plant. He cited the example of Pokhara. There were 456 biogas plants and all of them used slurry and had toilets attached to the plants. The application of slurry was very beneficial for vegetable crops. He suggested that awareness among the people about the benefits of applying slurry to the fields was more important. The study team replied that the same might not apply in all places because of the varying sociocultural contexts.

A question was raised regarding the comparative productivity of a typical gas plant with respect to the use of raw materials. It was pointed out that production depended upon the total volume of raw material fed to the plant and plant capacity.
Dr. Papola stated that subsidies, up to a certain extent, would be essential for a programme like this, and they should decrease over the years. So, basically, the question was how to reduce the cost of the plant and what could the government and institutions do to bring this about.

The study team stated that the subsidy on biogas plants in the *Terai* was NRs 7,000, even though there was more potential there, whereas the subsidy for the hills amounted to NRs 10,000. This was primarily because living conditions in the hills were more vulnerable because of physical hardship and the fewer energy options available to them. It was found that biogas plants were not financially viable without subsidies, though they provided greater social profits than other forms of energy. Therefore, there should be subsidies for biogas plants, and the present rates were satisfactory. The study team also mentioned that the rates of subsidy had gone down in the last five years if inflation was taken into consideration. Also, the government was planning to gradually reduce the subsidy rates in the third phase of the biogas programme.

Mr. Baral highlighted the positive impact of biogas installation on women and children, as it saved three hours a day of women's time. Usually, small girls were sent to collect firewood instead of them going to school. Therefore, with the introduction of biogas, children now had time to go to school and fuelwood was also saved. He observed that the low cost biogas plant (i.e., Deenbandhu Model) was very efficient for use in the *Terai*. Experiments were needed with other types of low-cost model.

Issues Identified and Suggestions Made

The study team made various suggestions and these were supplemented by the participants during discussions. Most of the issues raised and suggestions made, both by the experts and the study team, were as follow.

Biogas programme for low income groups: Most plant owners surveyed were from high income groups, as they had provided land as collateral for loans. Biogas plants should be made available to low-income villagers. For this to happen, low cost biogas plants had to be promoted along with easy access to credit facilities for low income households through community loan schemes for landless and women's groups instead of the usual collateral.

Demonstration promotes adoption: Almost all plant owners interviewed had installed biogas after they had seen it working in the neighborhood. They did not believe hear-say about the advantages of biogas. A biogas promoter or developer had to find a progressive farmer willing to install the biogas plant properly to bring about a demonstration effect, as a target-driven approach had not worked in the past. Resilience was necessary.

Promote use of biogas slurry: Almost all biogas owners were unaware of how to use slurry efficiently and also had a problem of getting labour to apply it to their fields once it had been attached to a toilet. Demonstrations on the applicaton of slurry in development of appropriate tools/equipment (such as a trolley) for slurry handling were needed.

Structure and level of subsidy: The flat rate subsidy for biogas plant sizes had prompted farmers to install the smaller plants. This had reduced the tendency to over-size the plant capacity and later plants were subject to low gas production due to under-feeding of the plant - a common phenomenon during the 80s. This also encouraged farmers with fewer cattle to install biogas plants and integrate toilet facilities. The presentation suggested that the policies pertaining to biogas programmes should be consistent.

Quality control and standardisation: Strict enforcement of quality and standardisation by BSP helped to reduce operational failures of biogas plants. On the other hand, manufacturers claimed that it had stopped innovations to reduce costs as only one type of design was approved for construction by the BSP.

Promote low-cost biogas plants: The distribution strategy adopted and performance of the Deenbandhu biogas model were encouraging. Similar action research programmes should be carried out in other areas to cater to the needs of low income farmers. The initial costs for biogas programmes were very high, therefore, R&D should be carried out to reduce the cost.

Need for an Integrated Approach: The BSP programme should be integrated with the livestock development programme along with rural development initiatives.

Improved Cooking Stoves

The main objectives of the improved cooking stove (ICS) programme were to reduce the consumption of fuelwood and to improve hygiene in the kitchen. The ICS is convenient for women and safer for children. It reduces the time spent collecting wood, cooking, and cleaning pots/pans after cooking. It improves the general health conditions of women, as they will not be exposed to smoke.

Up to now, about 88,000 to 90,000 ICS of various types have been distributed by the government, NGOs, and private sector agencies. During the mid-80s, the community forestry programme and other programmes distributed 44,000 insert type stoves, of which 35 per cent were believed to be still in operation. ICS programmes in the past had used a target driven approach which had not worked. Users had no part in designing and planning. So most of the stoves installed were unused. Currently, this type of stove had been abandoned in favour of stoves built on site using locally available materials and skills. A number of NGOs and INGOs had included ICS programmes in their rural development efforts. Installation by trained women promoters had created employment opportunities and generated income.

Problems of ICS dissemination included their lack of diversity in use, people's social and religious beliefs absence of strong government promotional programmes, lack of proper user education and training, availability of and accessibility to free fuelwood, low rate of involvement of women in ICS programmes, and lack of financial and institutional support for local NGOs and research institutions. However, active users' participation and mobilisation of NGOs and the private sector have proven to be an effective approach to ICS distribution in recent years.

Cast iron stoves in Jumla (suitable for cold regions), the most expensive model so far distributed, received about Rs 2,000 per stove as a subsidy, whereas other clay models, costing around Rs 200 including labour, generally received a subsidy for the cost of installation through NGOs and other organizations. Considering the overall ICS programme, except for the expensive cast iron heater stoves, the cost of installations constituted a small portion of the overall cost. Most of the cost was on research and development, promotion and distribution, and training. So far, these activities had been covered by donor and HMG grant assistance. However, there was no clear-cut, integrated comprehensive programme.

The presentation highlighted the salient features of ICS distributed to some rural areas based on the field surveys and case studies available (Box 14), various issues

Box 14: Salient Feature of the ICS Programme in Villages

Place	End Use	Cost/Subsidy	Status
Pokhari Danda, Bhumkot VDC Gorkha (1 and 2 pot holes)	Cooking Animal feed	Rs 120 50% subsidy	Almost all are in use; Total of 270 ICS distributed
Mangalpur VDC Chitwan (Two pot holes)	Cooking	Rs 100 per ICS 60% subsidy	75 ICS installed of which only 60% are in use
Urthu village, Patmara VDC Jumla (Cast iron sove)	Space heating Cooking	Rs 4,500 75% subsidy	The number of installations is 60, of which all are in use; but it consumes more fuelwood than traditional stoves
Bayarban VDC Morang (Two pot holes)	Cooking	Rs 60 100% subsidy	The number of installations is 58 of which only 25% are in use; lack of technical backstopping.
Rajahar VDC Nawalparasi (Two pot holes)	Cooking	Rs 65 100% subsidy	Data on the performance are not available; use of locally available materials.
Jyamire Makawanpur (Two pot holes)	Cooking	Rs 60 100% subsidy	Tribal group; successful programme; training to ICS women motivators and installation by women technicians

were identified (Box 15), and appropriate measures suggested for the promotion of ICS in Nepal.

Clarifications and Discussions

Profesor Chalise suggested that the importance of fuelwood must not be minimised, irrespective of all the progress in the RET manufacturing sector. He said that most people in Nepal will be using fuelwood for the next 50 years. Therefore, fuelwood was and would remain a very important factor, especially for mountain people. He wondered why there was no priority for research into fuelwood and why it was not discussed. He added that talk of alternative fuels was only lip service because 80 per cent of the people were using fuelwood, but it was not reflected in government programmes and policies. People in the villages, especially housewives, had no time to go and voice their opinions. Women were busy collecting fuelwood and cooking for the family. He said that he had been involved with discussions on RETs since the early 70s and, even today, the data on energy were inadequate. Therefore, he emphasized the fact that collection of data was very expensive and difficult, and this should also be given priority during the consultation.

Dr. Papola, chairperson of the session, stressed the importance of fuelwood. Deforestation and environmental degradation in mountain areas were primarily caused because it was difficult for poor mountain households to meet their daily needs. This factor should be examined very critically. There were other causes for deforestation

Box 15: Issues Identified from Case Studies on ICS

Technological Issues

- Lack of alternative, various appropriate designs matching the needs of users
- Suitable for multi-fuel use
- Stoves capable of fulfilling cooking and heating requirements as desired by users
- Stove should match with housing structure and climatic conditions
- Stoves to cater for space heating needs
- Lack of technical backstopping
- Repair and maintenance problems

Financial and Economical Issues

- Free access to fuelwood

Institutional Aspects

- Sporadic promotional programme
- Intermittent promotion and lack of continual effort
- Lack of monitoring agency
- Lack of research agency for continual efforts to improve designs

Social Issues

- Lack of local-level women technicians
- Incompatibility of stoves with social and religious practices
- Weak participation of women in ICS programme
- No housing and kitchen improvement programme to link up with the ICS programme

and environmental degradation also, so mountain people alone could not be blamed. He pointed out that, while looking for alternative sources of energy for mountain areas, somehow the focus always seemed to be on saving fuelwood. Much more importance had to be given to saving fuelwood by providing a higher grade, more efficient, and more versatile form of energy, because fuelwood, even when available, was not a versatile source of energy. **Mrs. D.D. Shakya** stated that RECAST was still involved in the *chulha* programme by promoting household cooking stoves and institutional cooking stoves. RECAST was also looking at how to minimise fuelwood use by looking for fuelwood alternatives.

Dr. Rijal said that open fire type traditional stoves were more efficient than improved cooking stoves if space heating requirements were also taken into consideration. Therefore, the important issue was to identify household needs and comparison of technologies should be based on the types of tasks performed. It was wrong to say that improved cooking stoves were more efficient than traditional ones without properly understanding the role that traditional *chulha* had played in mountain households. This statement might be true for the plains where space heating requirements were minimal. The improved cooking stove programme in the past had clearly had a bias towards the plains. Although the smokelessness of improved cooking stoves must be recognised fully, as they reduced health and environmental problems, most of the ICS programmes were designed to reduce the increasing rate of deforestation rather than to minimise negative health impacts. It was, therefore, suggested that the ICS programme should be considered a component of the kitchen improvement programme in the hills and mountains of Nepal; and this would mean better health and hygiene, eventually reducing pressure on the forests as well as the burden on women and children who collected the fuelwood. To add to this, it was pointed out that, in India, less than five per cent was saved in fuel from cooking stoves and biogas, and it was suggested that there was a need to re-orient the ICS programme to make it suitable for the hills and mountains.

Issues Identified and Suggestions Made

Various suggestions were made concerning policies, institutions, technical and financial aspects, research and development, and gender issues based on the observations made by the study team. These were commented on during deliberations. Most of the issues raised and suggestions were as follow.

Develop long-term vision: Long-term vision was essential for a healthy kitchen environment and reduction in fuelwood consumption. The programme needed to be conceived from the kitchen improvement perspective.

Technical back-up and monitoring: An institution with the responsibility for providing technical back-up and monitoring the programme should be created so that technical problems encountered by users could be resolved without them abandoning improved cooking stoves.

Matching technology with user needs: The type of stove required varied from place to place because of the fact that different needs were being met by traditional stoves. At the same time, cooking habits and needs differed among various ethnic groups. Different models were needed for different locations and ethnic groups. It was found that promotion of a fixed/one-type design of ICS had not been successful.

Use of local materials and indigenous skills: It was found that by using local materials and training local women to construct ICS, successful promotion of ICS was realised. This aspect must be considered in designing ICS programmes.

Need for intensive research and development: Development of various types of stoves suitable for different rural communities was essential. This would require continuous R&D activities with good financial support. The type of research activities that could be considered were: low-cost ICS for space heating with smoke removal devices; versatile ICS that could be operated with different types of biomass fuel; easy to install and clean chimneys; ICS for big families, hostels, and police/army barracks, *rakshi* (alcohol) preparation, animal feed preparation, and ICS that reduce cooking time. Efforts must be made to commercialise these developments.

Building Capabilities at Village Level: It was found that ICS technicians played a vital role in successful ICS programmes. The criteria for selection of the trainee should be that he/she be unemployed, local, innovative, with good motivational skill, and preferably a woman. Users should also be oriented, so that they understood the importance of each component of the ICS and were involved during the placement and construction of the same. Users should have a say in choosing the location for installation.

Subsidy needed for promotional activities: The sum of money involved was not great, except for stoves to be distributed in cold regions. The cost incurred during the distribution of ICS (for cooking) was primarily for training ICS technicians and promotional materials. It was suggested that the promotional activities related to ICS distribution should be subsidised.

Solar Photovoltaic Technology

The presentation reviewed the status of solar energy technologies, in general, but primarily focussed on the development of solar photovoltaics (SPVs). The development and promotion of SPV home lighting systems (roughly, 400 households with 30-35Wp for lighting) were recent in Nepal. This was being promoted by private entrepreneurs and NGOs. There were three companies who assembled and supplied these systems. Accordingly, SPV for small-scale irrigation and drinking water supplies was only in the experimental and demonstrative stages. Nepal Electricity Authority had pioneered the installation of a 30-50kW SPV for rural electrification in remote areas such as Simikot in Humla, Gamgadi in Mugu, and Tatopani in Sindhupalchowk, but frequent breakdowns had occurred. There were more than 6,000 units of 50W module SPV systems installed in different parts of the country for communication purposes; these were mostly installed by the Nepal Telecommunication Corporation and the Civil Aviation Department and military barracks in remote locations.

The presentation highlighted the government subsidy scheme. In FY 1996/97, the government provided 50 per cent and 75 per cent capital subsidies on the total cost for SPV home systems and irrigation, respectively, and ADB/N was still doing so. SPV companies enjoyed tax and duty exemptions for importing solar cells and other accessories. There was no subsidy on solar dryers and cookers. The interest rate for entrepreneurs was 16 per cent, and this was being channelled through ADB/N.

The presentation highlighted the salient features of SPV systems distributed in parts of the country based on the field survey and case studies (Box 16) and various issues were identified (Box 17).

Clarifications and Discussions

Prof. J.N. Shrestha stated that one insurance company had begun to insure the PV

Box 16: Salient Features of SPV Technology in Nepal

Place	Cost/Subsidy	Status
Timilsina Gaun Kabhre (35W stand alone)	Rs 30,000 50 per cent subsidy	Installed in 13 houses. All are in use
Pullimerang Tanahu (35 stand alone)	Rs 23,000 50 per cent subsidy	Installed in 80 houses – almost all are in use – installed by higher economic class villagers Villagers attempting to link it with the socioeconomic development of their village
Simikot, Humla (50kW central SPV)	Monthly average charge of Rs 76	Irregular supply due to frequent breakdown of inverter; high installation costs
Sundarighat Water pumping Bode, Kathmandu (I phase - 4kW and II phase - 40kW)	US$ 482,000 (I Phase) US$1538,000 (II Phase)	Operating well; high cost research project
Rural/Remote Communication	Not available	Operating well and replaces 1.2kW generator set; successful application of SPV for remote/ rural communications

Model System and 75 systems were established in Dhading at the cost of just Rs five per month. He outlined the revolving fund system of Pullimarang that had facilitated the installation of SPV home systems and said that it had been very beneficial to the community. He added that some of the data presented by the study team were misleading, therefore real data had to be worked out. He stressed the need for subsidies for the PV system.

Dr. Junejo was of the opinion that the cost of PV was higher than the cost of micro-hydro. He added that there should be demarcation of areas for SPV promotion, so that energy would be available to communities at the cheapest possible rates.

It was pointed out by Ms. Soma Dutta that, in India, the PV system was used for back-up in some areas. PV was used to operate pumps and for various other uses in India. The only problem with PV was that it needed a lot of space.

Mr. K.C. Dhimole stressed the importance of creating a database on radiation, sunshine hours, topography, hydrology, and so on. He requested ICIMOD to create a database in consultation with various other agencies working within the HKH region. He suggested that the cost of solar photovoltaic modules should be reduced in order to reduce the cost of the whole system. Systems should be designed taking into consideration the climatic conditions of the location. A research centre could be established in one of the countries of the HKH region in order to study different climatic conditions. He stated that the policies that had been discussed would help create awareness and foster development. They would also help to assimilate the commercialisation of RETs in trying to create an effective institutional infrastructure.

Mr. Navin Dhungel suggested that a better mechanism should be adopted and he stressed the urgent need for R&D for the promotion of private enterprises. He added

Box 17: Issues Identified from Case Studies Pertaining to SPV Technology

Policy Issues
- No policy-level emphasis on equity issues
- Need for demarcation for SPV electrification

Financial and Economic Aspects
- Poor people cannot afford it
- No linkages with income-generating activities, but has potential
- High up-front costs
- More suitable for low load applications such as communication
- Low maintenance costs

Technical Aspects
- Frequent fusing of bulbs
- Centralized system suffers from frequent invertor break-down
- No over charge controller
- No research activities

Social Issues
- SPV home system is a household status symbol and creates tension in rural areas
- Increased communications by installation of TV in remote locations, but only rich people can afford it
- Increased social interaction among villagers
- Technical skill improvements at village level

that subsidies should be given to PV Solar Systems, even though it distorted the market.

Issues Identified and Suggestions Made

The study team made various suggestions with regard to SPV development in Nepal. These were commented upon by the participants. Most of the issues raised and suggestions made were as follow.

Area identification for SPV home systems: SPV systems were found to be appropriate for low power applications and where no other options were available because of their high cost perkWp. For example, it was found that, if the demand was very low, less than 300 W, SPV systems were cheaper than diesel generators. Also, the SPV system was cheaper than grid electricity when demand centres were located further than 40km from the grid. It was, therefore, important that areas where such possibilities did not exist were places to be considered for SPV home system promotion. Contrary to this, it was observed in Kabhre that these systems were promoted in places where it was planned to extend the national grid.

Subsidy - mechanism for demonstration: It was observed that, as a result of the 50 per cent subsidy on the capital cost of the SPV system, it was becoming popular among high-income families. The question of social equity had become crucial, as in most cases subsidies were received by the rich, and the prime motive for such an installation was to demonstrate their status, contrary to the objective behind providing a subsidy. However, in the initial phase, it could be justified in terms of creating a demonstration effect in remote areas to popularise the technology.

Minimise technical constraints: The system faced various technical constraints such as: low power conversion efficiency, storage problems, and climatic uncertainties. These constraints needed to be resolved for smooth functioning of SPV systems.

Stand-alone versus centralized systems: The comparison between centralized systems in Mugu and Humla and stand-alone systems in Kabhre and Pullimarang in Nepal showed that the latter were more appropriate in remote areas due to conversion, transmission, and managerial problems. Stand-alone SPV systems should be promoted rather than centralized systems.

Promote institutional linkages and coordination: There was a lack of coordination and monitoring of the various institutions involved in the development and promotion of SPV. A newly established organization, AEPC, should play the lead role in facilitating the efforts of various organizations to promote SPV technology.

Need to design an innovation funding mechanism: At present, rich families had enjoyed the benefits of subsidies as bank loans were available for those who could provide land as collateral. It was important to create access to capital resources for poor and marginal farmers to purchase technologies for labour saving and to improve the living conditions of poor families through income-generating activities. In this respect, formation of village-level cooperatives could be an important beginning, for which the government might have to provide seed money. This approach needed to be tested prior to its replication.

Integration with income-generating activities: The subsidy that was being provided could only be justified if it was linked properly to income-generating and social development activities. An attempt to promote a bag-making enterprise in Pullimarang was a remarkable example of productive end-use of an SPV system. Similarly, conduction of literacy classes in the evening, educational programmes through TV, and provision of light to the Health Post were a few positive development activities initiated in Pullimarang.

Increase Opportunities for Women's Participation: The impact of SPV systems was positive on women and children, as they provided opportunities for women to perform their activities in a more relaxed manner, whether tending their babies or spending time in income-generating activities or participating in development activities such as literacy classes and awareness programmes, forestry users' groups, and so on.

4.2 Technology Dissemination and Adoption Approach: A Case Example of Passive Solar Housing in Himachal Pradesh

Dr. S.S. Chandel highlighted the importance of the Passive Solar Housing Programme in Himachal Pradesh. The majority of buildings constructed in recent years ignored energy-saving opportunities such as orientation towards the sun during winter, proper ventilation during summer, landscaping, breezes and other natural elements of the site, and opportunities in the structure and materials of the house itself which, with thoughtful design, could be used to collect and use free energy. A climatically responsive building reduces adverse impacts on the natural environment while improving the quality of life. It was possible to reduce energy consumption by 50-70 per cent by using well-tested concepts of passive solar and climatically adapted building designs.

The presentation described site, shape, and orientation of building; reflectivity of ground and building surfaces; vegetative cover around the building; size and orientation of window and door openings; and planning of interior space to play a significant role in terms of increasing the effectiveness of building for energy saving.

The presentation highlighted the main features of the Solar House Action Plan for Himachal Pradesh, India (Box 18). The State Council for Science, Technology, and Environment (SCSTE), HP, is the nodal agency for coordinating this activity. Under the programme, designs incorporating the solar concept were prepared for 20 buildings to be constructed by the State, of which three buildings had already been constructed. At the same time, the Ministry of Non-Conventional Energy Sources (MNES) had formulated a passive solar programme with the following objectives: a) to create awareness of passive solar technology through training and education of the masses for large-scale application and b) to provide comfortable conditions in the living and working spaces of buildings by optimum use of available solar energy in buildings, energy management to reduce the consumption of commercial energy in buildings through preparation of a detailed project report (DPR), and construction with the same. In order to meet these objectives, MNES had provided various incentives. For example, MNES had provided 50 per cent of the costs of the DPR of a building using passive solar architecture up to a maximum of ICRs 50,000 or 2.5 per cent of the estimated cost of the building for each project. These facilities were available to state nodal agencies also.

Dr. Chandel's presentation also highlighted various projects being undertaken by the SCSTE. These were: a) establishing a network of institution/experts within the HKH region of India - funded by ICIMOD; b) reviving traditional hill architecture; initiatives in the cold desert of Spiti Valley; c) tra-

Box 18: Main Features of the Solar House Action Plan for Himachal Pradesh

- Design and construction of buildings as per the norms of solar passive concepts
- Organization of specialised training courses in passive solar housing techniques
- Constitution of an expert group from the State/National/International R&D institutes to coordinate and catalyse the Solar Housing Programme in the state
- Establishing a Technical Project Management Cell in the SCSTE to create in-house facilities for technology dissemination
- Retrofitting old government and private buildings with passive solar systems
- Modification in building bye-laws to make passive solar features compulsory in buildings
- Incentives to the public for solar construction in urban and rural areas
- Construction of demonstration houses in four major climatic zones
- Research and development/evaluation studies related to solar houses for cold climates, encouraging R&D activities in State Universities/Institutions
- Conduct energy audit of government buildings to suggest measures for reducing energy consumption
- Compilation of data on solar radiation, weather pattern, and climate
- Identification of passive solar features of traditional hill architecture
- Establishment of a Solar Energy Research Centre for Mountain Regions

ditional architecture of HP; d) compilation of meteorological data of HP; d) passive solar design of houses to be constructed under the *Gandhi Kuteer Yojna*; and e) organization of specialised training programmes.

The presentation recommended guidelines for passive solar technology adoption (Box 19) based on experiences gained in implementing these programmes in HP as well as guidelines prepared for other hilly states of India.

Clarifications

Answering a query on Passive Solar Heating, Dr. Chandel replied that there should be a proper mix of various options. Designs were made suitable to lower costs. He stated that, while designing the building, a panel of experts (architects) worked along with the solar scientist.

4.3 Chairperson's Remarks

Dr. T.S. Papola, Chairperson of the session, remarked that some proportion of the initial or intermediary costs should be given. A lot of work had been done, but the most crucial and most important issues needed to be identified so that they could be tackled first. All the issues related to mini- and micro-hydel plants were not going to be resolved in this session of the meeting.

Dr. Papola added that, as far as the meeting was concerned, the recommendations for the promotion of these appropriate technologies which had come forth had been eagerly awaited. He said that certain points had to be kept in mind. What was the government doing that was discouraging a particular sector ? What should the government do in order to encourage it ? The fact that this sector needed more subsidies meant that it could not be run profitably, why should the private sector be interested in it ? Some basic issues needed to be tackled. Micro-hydro technology was considered the most appropriate form of energy supply in mountain areas in spite of all the issues raised.

The chairperson pointed out that, from the perspective of economics, subsidies could not be justified if they could not meet the basic objectives of development and poverty alleviation in the long run. He added that

Box 19: Guidelines for Passive Solar Technology Adoption

- Government housing agencies in the hilly regions need to incorporate provision for passive solar technology in building estimates
- Housing agencies should make systematic efforts to orient/train their architectural and engineering wings to adopt this technology
- Housing agencies should also study the feasibility of suitable changes in the existing buildings for incorporating passive solar technology
- Suitable modifications in building bye-laws need to be carried out
- Suitable incentives should be identified for its adoption
- The buildings requiring central heating systems should install systems that work in conjunction with solar passive heating systems to reduce the cost
- The use of natural daylight features in buildings should be incorporated so as to reduce electrical consumption in daytime lighting
- The features of traditional hill architecture need to be retained to promote eco-friendly housing technologies

he was not totally against subsidies as long as they were justified. The issue of private sector participation on the one hand and subsidies on the other needed to be discussed in more detail and resolved.

Regarding private and public sector issues, he thought that plants could not be run successfully by either the public sector or the private sector. They could best be run by the community. Big industries would not be interested in installing small plants in the remote parts of Nepal because they would not get anything out of them. In most cases in which these plants had been run successfully, viably, and had benefitted people, they had been successful because of local community participation. Subsidy and assistance were provided not for the profit of an individual but for the upliftment of a community.

Dr. Papola stated that ICIMOD was not in the business of promoting manufacturers or a particular group. It was in the business of trying to exchange information and, if possible, facilitate or transfer appropriate technology for the alleviation of poverty of mountain people. He added that he believed that the development of micro-hydropower was very crucial for the alleviation of poverty in the mountains. This was the reason why ICIMOD was interested in the promotion of micro-hydropower.

Low-cost Solar - Timber Kiln Installed at Energy Park, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, H.P., India

Paddy De-husker Operated by Micro-hydropower Plant Multipurpose Power Unit at Gajuri, Dhading District, Nepal