Inaugural Session

The Inaugural Session of the Seminar on Rural Eenergy and Related Technologies took place on March 26th, 1991. The Chief Guest on the occasion was the Prime Minister of Nepal, the Right Honourable Mr. Krishna Prasad Bhattarai. The Chairman of the Inaugural Session was the Honorable Minister for Water Resources, Mr. Mahendra Narayan Nidhi, and the Welcome Address was given by Dr. Tilak Rawal, General Manager of the Agricultural Development Bank of Nepal (ADB/N). During his address, Dr. Rawal outlined the initiation of involvement by the ADB/N in development finance. He recalled ADB/N's first joint venture with the United Mission to Nepal (UMN) that led to the installation of biogas plants. He went on to outline the collaboration on the part of the bank with micro-hydro design and application projects. To this date, there were 5,700 biogas plants and 620 micro-hydro installations, with a total of 6,500 kW of mechanical conversion capability throughout Nepal; all made possible through capital subsidy made available by His Majesty's Government of Nepal (HMG/N). Micro-hydro electricity plants, which number 91, provide a total of 920 kW of electricity generation capacity. Dr. Rawal stressed that it would be an exaggeration to say that these achievements were sufficient as existing projects were small from the point of view of total possibilities. It was for this reason that this seminar was being held. During the seminar, it was hoped that broad strategies would evolve for harnessing and sustaining rural energy and that its deliberations would produce some meaningful deliberations.

Dr. E. F. Tacke, Director of ICIMOD, then presented a brief overview of the topics to be covered by the seminar. The seminar was to be divided into four principal parts. Part I would deal with the Overall Assessment of the Energy Sector in Nepal, Part II with Alternative Rural Energy Technology Problems and Prospects, Part III would involve a Video Presentation and Exhibition of Technology - Examples, and Part IV would consist of Group Discussions. Participants would be divided into four groups which would deal with four topics.

1. Rational Approach to Rural Energy Planning.
2. Planning and Implementation of Micro-hydro Technology.
3. Planning and Implementation of Biogas Technology.
4. Planning and Implementation of Energy Conservation Measures.

He stated that it was expected that each group would then present a brief of its deliberations to a plenary session that would then come up with recommendations.

In his inaugural address, the Rt. Honourable Prime Minister, Mr. Krishna Prasad Bhattarai, stated that, although his perceptions on and knowledge about rural energy were those of a layman and not those of an energy expert, he was thankful for the opportunity to express his ideas on what he considered to be a very important topic. He emphasised the importance of energy in terms of sustainable development, especially for a poor country like Nepal. He outlined the effects of the global politics of oil and stressed the need to find alternatives to fossil fuel. Next, the Prime Minister reminded the forum of Nepal's unique dependence on forest products which provided the bulk of energy needs in rural areas. Deforestation was taking place at an alarming rate and the economic and environmental impacts of this were tremendous in terms of soil erosion, floods, landslides, and diminishing supplies of drinking water. A major effort was needed to restore the forests and make sure that they were efficiently used in future. The Prime Minister reminded the audience of the potential for abundant hydroelectricity in Nepal, but emphasised the fact that, in spite of all the years of technical experience, Nepal still had one of the highest kilowatt hour costs in the world. He stated that we had failed to manage this resource properly, and, partly because we were failing to generate electricity at low cost, less than ten per cent of Nepal's households had access to electricity. He then stressed that we would soon reach a critical threshold in our energy sector and some hard decisions would have to be taken if the price of petroleum imports was not to become a crushing burden. He also stated that collaboration involving the Agricultural Development Bank, the Water and Energy Commission Secretariat, and the International Centre for Integrated Mountain Development was very useful not only for taking stock of the problems and progress but also for identifying the concrete steps needed to improve the prospects for sustainable energy **in future.**

The Chairman for the Inaugural Session, the Honourable Minister for Water Resources, Mr. Mahendra Narayan Nidhi, stated that there was little to add to the Prime Minister's comprehensive address. It should be borne in mind, however, that 90 per cent of the people in Nepal were farmers and they depended principally upon the forests for energy - to the extent that 75 per cent of all the country's needs come from the forests and only 15 per cent from external and other inputs. We had to be careful, in this respect, that development (*bikas*) did not become destruction (*binas*). For this reason it was important to discover ways to create energy not only for domestic and farm household purposes but for income-generating activities too. He had faith that the seminar would come up with a number of useful suggestions. He asked the participants to bear in mind the fact that it was not only important to find alternative sources of energy but also important to provide for increasing supplies in the context of an ever-increasing population.

The Vote of Thanks was given by Dr. C. K. Sharma, the Executive Secretary of WECS. He expressed his appreciation of the Prime Minister and the Minister for Water Resources for consenting to inaugurate the seminar and chair its inaugural session respectively. Dr. Sharma pointed out that energy was synonymous with vitality, hence its importance. He emphasised the need to infuse technology. He pointed out that for over a decade the ADB/N had provided the means of access to alternative energy sources for rural inhabitants. During the time there had been many successes and failures. He also pointed

out that in addition to energy policy planning, WECS also conducted studies on rural energy technologies. ICIMOD had been involved in the problems of mountain energy and risk assessment, and, on this occasion, three organisations had collaborated to provide a forum for alternative energy development. It was to be hoped that, in the coming decade, alternative sources of energy would be found and their use established. In concluding, Dr. Sharma thanked all those who had been responsible for organising the seminar.

1. An Assessment of the Energy Sector in Nepal: Implementation for the Planning and Management of Rural Energy

This paper, jointly presented by Mr. Mohan Shakya and Mr. Suresh Sharma, examines the overall energy sector in Nepal for the purpose of assessing the existing demand and supply of energy, energy policies and programmes, alternative energy technologies, and the main issues and options in the energy sector. Traditional sources are the dominant energy sources and they will continue to be so for some time in the future. It is expected that the demand for commercial sources of energy such as petroleum products, electricity, etc will grow at a higher rate than the demand for fuelwood. The supply side analysis shows that there is a mismatch between energy resource endowment and its use in Nepal; hydropower exhibits great potential, but is hardly exploited, and forests are being exploited beyond their sustainable yield. Currently, people in the rural areas have very little access to commercial energy. They almost solely depend upon forest-based biomass, agricultural residue, and animal dung to meet their domestic energy requirements. Whatever little access rural people have to commercial energy is concentrated in the *Terai* and the Kathmandu Valley.

There is lack of a strategy in energy planning and development as a result of which energy has a weak link with the other sectors of the economy. Rural energy is accorded low priority and alternative energy technologies, which can play an important role in rural energy planning and management, are treated perfunctorily. Energy sector policies and programmes are basically geared towards management of hydropower and the petroleum sub-sector. Investment policies, pricing policies, and conservation policies are seen to serve a very limited purpose and sometimes these policies are seen to transmit unintended signals to the producers as well as to the consumers. Price subsidy is seen as a major component of the government policy, but it is debatable whether the benefits of subsidy actually reach the desired groups. Energy sector planning and management show that institutional questions still remain unresolved as a result of which coordination among sectors is still weak.

Rural energy planning in Nepal needs a consolidated approach in which traditional energy, commercial energy, and alternative energy technologies each contribute to the energy sector and in the process increase the income levels and income-generating opportunities of the rural population.

The options that are available include using energy to transform the economy, promoting water resources' use also for rural energy needs, improving and providing local management for the existing forest resources, reducing dependence on the forests by promoting efficiency in the use of energy, along with other policy options such as pricing and decentralized management and ownership. Reforestation, achievement of higher end use efficiency, and conservation education are suggested. Finally, the location-specific potentials of biogas, micro-hydro, and solar and wind energy need to be exploited by following a decentralized planning and management approach.

Commentator's Observation and Floor Discussion

Binayak Bhadra commented on the paper "Assessment of the Energy Sector in Nepal". He complimented the comprehensiveness of the paper in assessing the energy sector in Nepal and noted that the old perspective of looking at energy from the point of view of economic growth alone was not enough. The implications of energy usage for the environment was an area of major concern. The big challenge, therefore, was the integration of development strategy, energy planning, and the environment. The development strategy had to be defined within the context of the strategy for environmental conservation.

Dr. Bhadra agreed with the major findings of the paper. He highlighted three particular points that it made, namely, the imbalances seen in the energy sector, the lack of focus in energy planning, and the nature of the problems and "hurdles" faced in efforts at energy planning.

He noted that a number of imbalances were apparent in the energy sector and these were not limited to the imbalance between hydro-electricity and other sources. The divergence between the private cost and the social cost of energy use was a major challenge to sustainability. He agreed with the authors of the paper that the relative prices of energy items in Nepal do not properly reflect scarcity values. This may, in effect, be encouraging inappropriate use of scarce resources. The divergence between private cost and social cost of energy utilization was undermining the very basis of energy-food linkages, not only in the hills of Nepal but also in the *Terai*. Energy imbalances reflect on food scarcity and imbalance. This perspective had to be brought to bear in energy planning.

Referring to the lack of focus in energy planning in Nepal, Dr. Bhadra observed that the perceptions of donor agencies had also contributed to the lack of focus in the energy sector. Donors were more interested in commercial energy. Repayment of loans through energy sales or exports were therefore of basic interest to them. As a result, the energy problems of the non-monetised sectors of the Nepalese economy were not adequately addressed. The institutional aspect of energy production and usage also tended to be ignored. The whole issue of demand promotion (increasing demand by promoting energy-intensive industries), for example, and that of pricing was not given as much attention as it deserved. He suggested that one way of dealing with the problem of the low load factor

was to resort to a differential pricing mechanism during peak and off-peak hours. He also contended that the rural energy sector in general was ignored in energy planning in Nepal and also sectors outside, apart from hydropower, remained neglected.

Elaborating on the "hurdles" faced in efforts at energy planning in Nepal, Dr Bhadra observed that a lack of understanding of the natural resource base was a major problem. The continued debate on mega vs. small or micro-projects demonstrated a basic lack of knowledge regarding what is appropriate for Nepal. He also referred to a "technology blindness syndrome" which resulted in the lack of initiatives in coming up with novel technology solutions, for example, in the design of micro-hydro systems.

Referring to the need for the integration of energy and economy, Dr. Bhadra suggested that uses of hydropower in irrigation and energy-intensive industries (such as fertilizer production through electrolysis processes) were imperative in order to make investment in energy development sound and viable.

He indicated three basic elements or approaches that should guide energy planning in Nepal. Firstly, a decentralized approach was essential. Secondly, energy planning should help replenish the nutrient loss in the hills. Thirdly, energy development should be complemented by research into more energy-intensive usage; and probably the development of energy-intensive industrial complexes. He also noted that private sector initiatives should be encouraged, particularly in the micro-hydro area, that could allow energy-intensive end uses. Energy could be the basis for integrating a number of activities. Efforts were also needed to make private cost and social cost of energy usage convergent. He observed that agro-forestry practices had to be encouraged in managing watersheds. Conservation education, therefore, should form part of energy planning in Nepal.

A number of comments came from the floor. The relevance of the Forestry Master Plan of Nepal was highlighted by one participant in dealing with Nepal's energy problem. The aim of the Forestry Master Plan was to assure the supply of fuelwood required by households through proper management. The strategy advocated in the Master Plan was to increase the supply of fuelwood through various schemes and at the same time reduce consumption of fuelwood through the propagation of alternative technology.

It was suggested from the floor that the lack of an effective strategy and the lack of commitment by the Government were the major problems in energy planning in Nepal. The need, therefore, was for the development of a realistic and practical strategy. Such a strategy, it was suggested, also had to take into account the role of the private sector. Since no institutions for rural technology existed in Nepal, it was suggested that the government sector should actively support private manufacturers in the promotion and dissemination of rural technology.

Commenting on the analytical side of the paper, it was noted from the floor that the demand side of energy tended to be ignored in the paper. It was suggested that there was a need to look at the changes in energy demand vis-a-vis income.

Responding to the comments and queries made from the floor, the authors submitted that the Forestry Master Plan still had to be translated into practice. The need in Nepal was for the follow-up of programmes. Regarding alternative technology, it was suggested that the need was to reduce costs. The authors agreed that collaboration had to be fostered among government, private, and financial institutions to promote rural energy technology. Institutions such as the Water and Energy Commission Secretariat (WECS) could provide necessary information to private as well as to financial institutions.

Regarding the neglect of the demand side of energy it was noted that a comprehensive study on this aspect was needed. Available information on the electricity demand showed that electricity consumption tended to increase with increases in income. It was also noted by the authors that higher energy prices had not particularly encouraged efficient use of energy by manufacturing and services' industries in Nepal. The price increase was normally passed on to consumers. The need, therefore, was to develop mechanisms that would encourage more efficient energy usage.

2. Development of Micro-Hydro Systems in Nepal: Problems and Prospects

This paper, presented by Dr. Deepak Bajracharya, observed that micro-hydro technology had the potential to contribute to the Rural Energy Sector in Nepal. He argued that the development of micro-hydro systems had been very encouraging particularly over the last sixteen years; there were about 600 units spread throughout the country. A lot of intensive and coordinated efforts are, however, needed to increase the current rate of dissemination by several orders of magnitude. Factors contributing to success included technical innovations, local manufacturing of turbines and induction generators, delicensing of units below 100 kW, provision of loans and other supporting services by ADB/N, a government subsidy policy for electrification, training in operation and maintenance, and provision of repair services by manufacturers. On the whole, successful operations showed that the systems meet locally felt needs (agroprocessing and lighting) at affordable cost; the technologies are reliable and easily understood; entrepreneurship was built up gradually; and organisational and management functions were smoothly integrated. In the future, the current strategies should be continued at the very minimum, but preferably with greater concentration on dissemination in more remote areas. Secondly, diversified end uses of electricity and mechanical power should to be promoted so as to increase the load factor through their use in productive activities. To this end, it was important to integrate the various roles of four concerned parties (viz., the Government and banks, manufacturers, research and development agencies, and local entrepreneurs and community groups). The development of micro-hydro systems could no longer be in an *ad hoc*, uncoordinated fashion if their potential was to be fully realised and put to productive use. The key to success lay ultimately with the local people who were the users and the beneficiaries. Their organisational strength and entrepreneurial pursuits had to be boosted. At the same time, complementary services and a favourable policy environment were prerequisites to enhancing the present level of success.

Commentator's Observation and Floor Discussion

Mr. Prachar Man Singh Pradhan commented on the paper "Development of Micro-hydro Systems in Nepal: Problems and Prospects". He complimented the authors for a thorough and comprehensive paper and made a number of observations dealing with the technical and other aspects of micro-hydro systems in Nepal. He noted that micro-hydro systems by their very nature had limited end use capacity. Micro-hydro systems were cost effective for the generation of 20 kW or less power because the technology used in channelizing water could essentially be the same as in traditional irrigation, and also because turbines of 20 kW or less were produced within Nepal. Above 20 kW capacity a number of problems became apparent.

Mr. Pradhan observed that identification of sites was extremely important in the installation of micro-hydro systems since many of the problems that emerged later emanated from improper site selection. He also noted that operation and maintenance was a big problem in micro-hydro systems. This necessitated proper training of operation and maintenance personnel. The availability of spare parts and location of seminar at convenient points to undertake repair works were other problem areas mentioned.

Referring to the low load factor in many micro-hydro systems, Mr. Pradhan suggested that the only way of generating more revenue was to increase the load factor. This meant the diversification of end uses. He agreed with the authors of the paper that the increased economic viability of micro-hydro systems could be assured through diversification of end uses. He also noted the substantial difference in tariff rates between the Nepal Electricity Authority and private micro-hydro systems - the latter rates being 4 to 5 times higher than the former. He suggested that there was a need for realistic pricing based on cost structure. Finally, Mr. Pradhan also expressed the need for a coordinating agency for micro-hydro development in Nepal. Such an agency could support the ADB/N, the manufacturers, and local institutions in promoting micro-hydro power systems in Nepal.

A number of observations were made from the floor regarding the role of micro-hydro systems in environmental conservation and the problems in their dissemination. It was suggested that a link had to be established between micro-hydro systems and deforestation. Specially designed 'low wattage' electric cookers could replace fuelwood and thus help in reducing deforestation. It was pointed out that even micro-hydro systems could cause damage to the environment. There was, therefore, a need to provide proper guidelines by funding and other related agencies that would help minimise environmental damage. While the high potentials of micro-hydro power remained to be exploited in Nepal, it was noted that attention also had to be focussed on improving the status of the traditional *ghattas*. There was tremendous scope for improvement in this area. Some work had been done by GTZ in this field but clearly more effort was needed. It was suggested that even a 10 per cent improvement in the efficiency of the *ghattas* would make a tremendous impact.

Some participants questioned the reasons behind the decline in the number of installations of micro-hydro plants in recent years in spite of the availability of loans and subsidies. Others noted that micro-hydro plants had to substitute the farmers' need for fuelwood or else their significance in the village energy context in Nepal would be much less. The need to specialize in the production of turbines was also noted by participants. There was also the need to provide rural institutional support and finance to propagate the micro-hydro systems. Since one of the problems in micro-hydro power was that of higher cost per unit, it was suggested that the load factor had to be increased during the day. Encouragement was therefore needed to promote electricity use in cooking.

Responding to the comments and queries from the floor, the authors of the paper suggested a number of reasons for the decline in the installation of micro-hydro units (MHU) in recent years. Cost of MHU units had gone up, so had transportation costs. In some instances, the limited production capability of manufacturers was also to blame. It was observed that the amount of subsidy had not changed and now was much lower in relation to increased costs and this had contributed to the decline in the rate of dissemination of micro-hydro technology. In this sense, government policy was also to blame. The authors agreed that the use of electricity for cooking was still limited and had to be promoted through such efforts as the *"Bijuli Dekchi"*. However, in the village context, other end uses of electricity were equally relevant. At Karma Singh Phant, for example, lift irrigation was made possible through MHU. This made it possible to raise several crops that had a direct bearing on improvements in the standard of living of the local farmers. The major question, therefore, was to see how the productive end use of micro-hydro power (MHP) could be enhanced. In quite a few instances the end use had expanded over time. Different possibilities had to be encouraged to increase the load factor. There was obviously the need for more institutional support. Regarding specialization it was suggested that the manufacturing of turbines could be made in defined power ranges to help standardization. In this technical area also, there was clearly the need for more support from the government and the donor community.

Finally, the authors felt that the development of micro-hydro projects in Nepal had thus far been in an *ad hoc* manner. A more consistent and systematic perspective was needed. The Government had to show its commitment to the promotion of micro-hydro projects by devising favourable policies. Clearly, more research and development was called for. The manufacturers had to be involved in both relevant R & D and the propagation of micro-hydro projects by enhancing local capabilities.

3. Application of Biogas Technology in Nepal: Problems and Prospects

Mr. R. K. Pokharel, presenting the paper on behalf of the authors, made a number of pertinent points.

Biogas is one of the alternative sources of energy for cooking and lighting in rural areas. It had been estimated that the potential number of biogas digesters could be about one

million in Nepal, whereas the total number of biogas plants installed until 1989/90 was only 5,839, leaving a great deal of scope for promotion of biogas technology in Nepal.

Though some initiatives to promote biogas began in early 1970, more systematic efforts began only in 1977 with the establishment of the Biogas Company as a specialised agency under a joint investment from Agricultural Development Bank, Nepal Fuelwood Corporation , and the United Mission to Nepal.

The Biogas Company initially promoted the Floating Steel Drum type of biogas digester, a technology imported from India, but during the last decade had exclusively shifted to the promotion of the Fixed Concrete Dome type, a technology imported from China, and this was mainly because of the fact that its masonry work was underground and it principally used local material -- sandstone, bricks, and cement. It was also easier to insulate in the colder months and the maintenance was comparatively easy and inexpensive.

Almost three-fourths of the plants were installed in the *Terai* where temperature conditions are more suitable than in the hills. The most popular size of fixed dome design was $10m^3$. In recent years the attachment of latrines to the biogas plant had also been promoted and this has provided additional benefits to the farmer.

The experiences over the last two years have indicated that government capital subsidy has significantly increased the demand for biogas plants. Unfortunately in 1990/1991, the government subsidy was discontinued, thus substantially reducing the demand. If the Government continues to provide a subsidy, it has been estimated that the construction of 25,000 plants over a period of five years would bring a net benefit of about 800 million rupees by replacing fuelwood use and providing additional plant nutrients, after deducting the government subsidy of about 288 million rupees (if 50% of the capital cost of biogas installation received subsidies). At the same time it will create employment opportunities for 1.44 million mandays of unskilled and semi-skilled labour. It has also been pointed out that India has provided capital subsidies ranging from 50 to 70 per cent of the total cost. Therefore, the authors argued for the provision of subsidies in the promotion of biogas technology in Nepal.

The authors also emphasised that there was a need for systematic research into and the development of biogas technology, in order to reduce the cost of installation and increase the efficiency in the production of biogas throughout the year, particularly for hilly regions of the country. At the same time, the need to establish a specific department in the Government for the development of renewable energy resources, including biogas, was pointed out.

Commentator's Observation and Floor Discussion

Mr. Dhruba Joshi commented on the paper "Application of Biogas Technology in Nepal: Problems and Prospects". He said that biogas was not as simple and as straightforward

a technology as it was sometimes made out to be. It was in some senses a controversial technology with attendant hopes and disappointments. Therefore, he suggested that there was a need to create greater awareness regarding biogas technology among users.

Biogas clearly had enormous potential in economic production and sanitation-related areas. Its dissemination had, however, not been widespread and it had not always been an unqualified success even in a country like China where it had been very well promoted. He noted that biogas technology was not merely a technology but a whole system in the sense that it fitted certain types of farming systems better than others. While the technology itself might be desirable in the rural setting, it also needed to make financial sense to the farmer. Biogas, therefore, must be an economic and financial proposition in order to be acceptable. Finally, there was a whole gamut of issues related to institutions, infrastructure, and government policy which also had to be adequately addressed in order to bring about a wider dissemination of biogas technology. The commentator agreed with the principal issues identified in the paper, namely, the need for a clear government policy regarding subsidy; the need for a coordinating institution; the need for appropriate research and development; and the need to bring down costs. A sound government policy was called for and the Government needed to strongly support the dissemination of biogas technology. Mr. Joshi noted that the cost of biogas could not be reduced as long as the current designs were prevalent. He suggested that there were other areas where cost reductions would be feasible. Reduction in the size of digesters without reducing current production levels was one possibility. The need for more R and D and the need to bring the micro-biologist into the research arena was therefore important. Another possibility was to look at new inputs to digesters. Dung, for example, could be replaced by water hyacinths. More research in these areas was clearly called for. Mr Joshi also raised the issue of subsidy and wondered how long it could continue and whether it could be justified.

The paper and the comments elicited a number of suggestions from the floor. Problems of a technical as well as of an institutional nature were raised. The problem of slurry disposal in urban areas was highlighted by one participant to elucidate the problem of coordination. Questions were raised regarding the type of institutional changes that were required for better dissemination of biogas technology. Competition and, by implication, privatization was suggested as a mechanism to reduce the cost of biogas plants by some participants. The question of subsidy was raised again and again and the Government's role in the propagation and dissemination of biogas plants was scrutinised by the participants.

Responding to the queries and comments from the floor, the authors of the paper made a number of points. On the institutional aspect, the need for a "multi-model", "multi-design" approach was emphasized. The need for research and development in assessing other low-cost designs of digester was clearly felt. It was suggested that the R and D as well as extension work carried out, by the Biogas Company, for example, had to be subsidised by the Government or else the burden would be passed on to the farmers. This was one clear way of cutting costs. The authors also remarked that private sector involvement was

already underway and that construction of small biogas plants had been given over to private contractors by the Biogas Company. Training was regarded as a matter of priority and to this end the training and extension capacity of different institutions dealing with biogas had to be strengthened.

Subsidy, the authors remarked, was a major issue in all alternative energy. The idea of subsidy raised a number of questions. Could the Government sustain subsidies? What was the link between subsidy and environmental sustainability? Were different types of subsidies comparable? Several things had to be looked at simultaneously before making a judgement on the issue of subsidy. The cost-benefit calculations made in the paper showed that biogas is economically (from the national perspective) viable. This directly contradicted the argument for reduction or removal of subsidy. The need for subsidy was really related to promoting biogas plants on a priority basis in rural energy planning. Subsidies were essential for the rapid promotion of biogas. Subsidies in this sense should really be viewed as incentives.

It was often argued that subsidies only helped rich farmers because biogas plants are out of the reach of small farmers even at the present rates of subsidy. The authors suggested that while this was generally true, the subsidy to the rich had at least one merit: it reduced the effect the rich farmer would otherwise have on the environment ! The issue of subsidy had therefore to be seen from the perspective of linkages.

Finally, the authors argued that large-scale dissemination of biogas was imperative to deal with the rural environment and energy crisis in Nepal. The private sector, the biogas company, and the Government had to combine their efforts to make biogas a successful alternative energy source in Nepal.

Chairman's Conclusion

In his concluding remarks from the Chair Dr. C. K. Sharma noted that the three papers in the first session were in a way devoted to the explanation of one or another aspect of Nepal's "energy dilemma". The dilemma was reflected in the fact that fossil fuel could not be the basis for Nepal's energy needs mainly because of the lack of verified deposits in the country as well as the limitations imposed by foreign exchange constraints on its importation. Hydropower clearly seemed to be an alternative but even in this area there was a dilemma. Should Nepal go in for mega- projects, should more attention be devoted to micro-hydropower systems, or should there be a balance between the two? Micro-hydro plants were also relatively expensive with per kW costs at around NR 35,000. Further there was the problem of load factor and of diversifying the end use of electricity.

The Chairman noted that in Nepal's case the reliance ultimately would have to be on renewable resources such as water, forest, and solar power. The regional dimension of energy opportunities within Nepal should also be appreciated. Micro-hydro systems had clear possibilities and prospects in the hill regions whereas biogas had potential in the

Terai. Such decentralized systems fit well with Nepal's mountain conditions. The government strategy should therefore be to encourage private institutions in the development of micro-hydro systems. He noted that WECS was preparing an inventory of feasible micro-hydro sites in Nepal. In the *Terai* and middle hill regions of Nepal biogas clearly had prospects, but the problem was one of high costs. There was, therefore, the need for R and D to examine cost reduction possibilities. These alternative energy technologies did not, however, preclude the importance of forests in Nepal's energy sector. Afforestation should remain the primary area of attention in Nepal's energy planning. Also demand management measures such as increasing end use efficiency, inter-fuel substitutions, and other conservation practices were important.

On the question of subsidy, Dr. Sharma remarked that the Government could not subsidise everywhere. Subsidies had to be decided judiciously by taking into account the fact that energy had to be regarded as one of the basic components of a strategy for sustainable development.

4. Biomass and the Conservation of Energy through Improved Cooking-stoves in Nepal: Problems and Prospects

The speaker Mr. K. M. Sulpya made the following points in his presentation. Exploitation of the forests for fuelwood, fodder, and timber by the growing population had placed heavy pressure on the forests, resulting in fuelwood scarcity. This had forced rural people to burn lower quality fuel such as twigs, branches, crop residue, animal dung, and even weeds or grasses. The situation was further compounded by the use of inefficient cooking stoves. Technologies that could lead to better conversion of biomass into energy were available but adoption in the rural context and the dissemination of information to rural consumers was very limited. Thus, fuel conservation was the only option for the rural poor.

So far more than 60,000 ICS had been distributed but the actual use varied considerably. Because of target-oriented distribution programmes, the improved cooking stove (ICS) programme had not been promoted in a holistic manner and programmes had failed to meet their targets. The reasons are many and are related to the programme management, material choice, and social and technical considerations across different ecological regions.

Despite low achievements, the technology in itself had the potential to save fuelwood use in the domestic sector. Also carbon monoxide amd smoke emission in the kitchen were reduced by use of this equipment resulting in health benefits. Estimates showed that, if the ICS programme fulfilled its potential, it could result in savings of as much as six per cent of the fuelwood used in the middle mountains, Siwaliks, and the *Terai* by 2010. But this would require improvement in the existing arrangements for research and development, programme management, and also in the institutional capabilities of the programme.

Commentator's Observation and Floor Discussion

The commentator Mr. B. P. Kayastha complimented the writer for a comprehensive paper that touched on a number of relevant issues and brought out problems associated with biomass consumption. Mr. Kayastha traced the sources of pressure on the forest and identified them as those caused by the increased energy needs of the population as well as the population increase itself. It was therefore apparent that the solution lay in producing more biomass for fuel. He cited the case of communities taking a lead in this regard through afforestation programmes. This programme should try to increase biomass output from shrubs and wild plants. Research and development and extension activities were called for in this respect. He also mentioned that in some areas of the hills, shrubs were used for green manure. Mr. Kayastha observed that ICS with all their benefits also posed some practical problems. For example, in the hills the human back was the main mode of transportation and ceramic ICS transported this way broke easily leading to greater wastage and therefore higher costs. Nevertheless, in the middle hills the forests cannot supply enough fuelwood at the current rate and therefore conservation was needed through higher use of ICS. The solution lay in producing ICS locally by using local material and local artisans. If the skill was not available, training and demonstrations should be provided to the local people. The idea was to minimize cost, if possible, even rendering them cost free. This way a higher adoption rate could be attained. Mr. Kayastha concluded by observing that a three-pronged strategy for rural energy management was called for: viz., replacing fuelwood used for energy by other alternative technologies where feasible, production of more fuelwood by increased afforestation, and conservation of energy by use of efficient end use devices such as ICS.

The floor discussions raised a number of queries concerning the non-use of stoves distributed, lack of maintenance, the high rejection rate, availability of data, the involvement of women, alternative fuels, and proper assessment of socioeconomic conditions.

During discussions it was noted that many stoves broke easily, especially during contraction and expansion. When stoves were government-distributed, owners often did not clean them but rather expected the Government to send someone to clean and maintain them; it was also added that some designs were difficult to clean. Additionally, some stoves were structurally deficient. In the context of the high rejection rate, it was suggested that this might be because energy was not normally monetised in rural areas; perhaps the stoves would be more acceptable in urban and semi-urbanized areas? There were suggestions concerning the adaptation of localised technologies and the need to involve women. The speaker responded to this latter by informing the participants about the RECAST/WDD Project in Panauti.

5. Role of Solar and Wind Energy in Nepal: Problems and Propects

Mr. Lakpa Tsering presented the paper and supplemented his presentation by slide shows. The main point made by the speaker was that solar and wind energy could be exploited to

provide energy in the rural areas of Nepal. Because of the paucity of data, the potential of these two alternative sources of energy was yet to be ascertained on a national scale. However, Western Nepal exhibited better possibilities for solar energy exploitation because of its being less influenced by the monsoon. The wind potential in the northern belt of the country could be used for electricity generation while, in the southern region, it could be used for pumping drinking water as well as for irrigation purposes for many months of the year. Past efforts in the use of solar and wind generators had been extremely limited and on an *ad hoc basis*. Careful technological as well as economical considerations were needed in order to promote the use of these alternative sources of energy. What was necessary was a programme that would initially start as a pilot project with emphasis on data generation and on bridging the existing data gap. As time went by, the programme could be strengthened to include actual exploitation of this renewable resource.

Commentator's Observation and Floor Discussion

Dr. Madan Lal Shrestha commented on the paper by stating that the paper underlined a serious lack in the study of these two aspects of energy technology. They were both in the rudimentary stages - but there were many developments. The usual argument put forward was that these technologies were expensive to install but it should be remembered that they are clean sources of energy. He also stressed the importance of examining the atmospheric properties of specific sites. He stated that, although the paper stressed the more favourable conditions for the application of these technologies in Western Nepal, and the influence of the monsoon in creating unfavourable conditions in the east, the precipitation did not differ so much. The west might have comparatively more sunshine hours than the east but on the leeside of the mountains there were usually more sunshine hours. The commentator believed this question had not been sufficiently addressed in the past, that wind data were not systematically accumulated, and that wind, temperature, and humidity were not taken fully into consideration in the use of windmills. He closed by stating that a general, detailed survey of wind force and solar radiation was absolutely necessary if useful inferences and data were to be drawn.

After the commentator's observations, the floor discussion commenced. It was pointed out that Tribhuvan University had constituted an Energy Research and Development Group in 1973 and that most of these points, reiterated during this session, had been made even then. There was insufficient emphasis on research and systematic data collection for which the primary costs were high but for which the long-run payoffs were considerable. Windmills were simply put up and left to collapse. Obviously wind and solar energy should be used, but how to do so had not been explored. There was a need for cooperation between engineers and technologists so that study could be coordinated. Far too many recommendations were simply recorded and not acted upon.

Some participants believed that the cost of technology had been seen in terms of investment only, not in terms of payoff, and hence the assumption that the costs of solar and wind energy were prohibitive. Another question concerned operational costs as opposed to

installation costs. It was pointed out that proper cost benefit analyses of solar and wind energy installations had not been conducted. In answer to this, the example of the high price of solar cookers that could not generate enough heat to fry was cited. Enterprises constructing such devices were asked to consider the capabilities of their products in terms of cost-benefit to the consumer. It was generally agreed that concerted action was needed in this area. The final comment came from a speaker who regretted that the historical aspects had not been covered by the paper. The speaker believed that these aspects would have revealed why solar and wind energy had not been tapped. There was basically no interaction between user and scientist. Technologies were often promoted by outside forces. Preliminary investigations into solar and wind energy had started 14 years ago. The comments made then were being reiterated in this forum. Wind did have potential, so did hydrogen as a fuel of the future. Recommendations should be sent to all the concerned organisations and definite action should be taken this time.

Chairman's Conclusion

The Chairman, Mr. R. P. Sharma, in summing up the issues arising from the discussion of these two papers (energy conservation and solar and wind energy), stated that there were four aspects to consider.

1) Availability of basic materials and costs.
2) Processing costs.
3) Effectiveness of end use devices.
4) Impact on the environment.

It was obvious that traditional forms of energy would still be used for some time to come. If the import of petroleum products increased, the country would be bankrupt. Therefore afforestation and the continuing use of biomass was essential to meet our energy needs, although it should be remembered that traditional forms of energy also produced carbon monoxide and carbon dioxide. Nepal was also endowed with wind power, sunshine, and hydropower on varying scales. All these needed to be exploited if rural masses were to be provided with more energy. The chairman wondered what stopped us from harnessing clean energy?

The chairman said that it was the processing costs that made some energy technologies cheaper and others costlier and it was for this reason that some of the technologies lay unused in spite of their potentials. Most of the technologies used now were the products of basic research done by the industrialized countries in the past. Solar energy alone could provide 100 times more energy than the current global energy requirements, but exploitation of solar energy required basic research and this was beyond the scope of developing nations. Developed countries were not putting much effort into this because of political and other considerations. Thus indigenous R and D efforts were necessary if non-conventional energy forms were to be exploited.

The chairman emphasized that it was important to enhance efficiency in using energy. ICS used less fuel for the same work compared to normal stoves and thus saved fuelwood. Efficiency was necessary not only in the use of biomass fuel but also in other energy usages. He recalled that in a recent conference that he had attended in Kuala Lampur, Malaysia, an energy efficient bulb, consuming only 15 watts of power but producing lumens equivalent to those produced by a 100 watt conventional bulb, was demonstrated. He observed that this was the type of end use efficiency that should be attained. But at present, efficient end use devices were costly in the developing countries, as a consequence of which energy continued to be used inefficiently.

The chairman then went on to classify technologies according to their impact on the environment. Some were environmentally friendly - while others were inimical to the environment. Technologies that had negative impacts on the environment had to be used very selectively or else there could be irreversible damage to the environment. The long-term energy development plan, therefore, should assess the environmental impact of the plan. This had not been done so far in Nepal.