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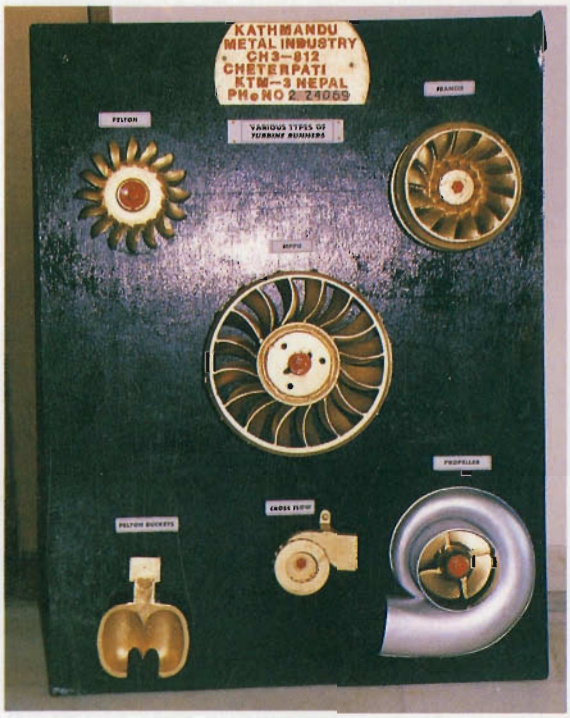
RURAL ENERGY AND RELATED TECHNOLOGIES

HMG, WECS

Report of the

Seminar on Rural Energy and Related Technologies in Nepal



Organised jointly by Agricultural Development Bank, Nepal, International Centre for Integrated Mountain Development, and Water and Energy Commission Secretariat, HMG, Nepal

Kathmandu, Nepal
26-28 March, 1991

ICIMOD Workshop Series

The International Centre for Integrated Mountain Development began professional activities in September 1984. The primary concern of the Centre is to search for more effective development responses to promote the sustained wellbeing of mountain people. One of the continuing activities of ICIMOD is to review development and environmental management experiences in the Hindu Kush-Himalayan Region. Accordingly, International Workshops are organized in major fields to review the state of knowledge and practical experiences, and also to provide opportunities for the exchange of professional expertise concerning integrated mountain development.

Workshops held included :

- **International Workshop on Watershed Management in the Hindu Kush-Himalaya**
  14-19 October, 1985, Chengdu, China
- **International Workshop on Planned Urbanisation and Rural Urban Linkages in the Hindu Kush-Himalaya Region**
  25-29 March, 1986, Kathmandu, Nepal
- **International Workshop on Off-farm Employment Generation in the Hindu Kush-Himalaya**
  3-5 May, 1986, Kathmandu, Nepal
- **International Workshop on District Energy Planning and Management for Integrated Mountain Development**
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- **International Workshop on Mountain Agriculture and Crop Genetic Resources**
  16-19 February, 1987, Kathmandu, Nepal
- **International Workshop on Women, Development, and Mountain Resources: Approaches to Internalising Gender Perspectives**
  21-24 November, 1988, Kathmandu, Nepal
- **International Symposium on Mountain Environmental Management**
  11-14 April, 1989, Kathmandu, Nepal
- **International Expert Meeting on Horticultural Development in the Hindu Kush-Himalayan Region**
  19-21 June, 1989, Kathmandu, Nepal
- **International Expert Meeting on Apicultural Development in the Hindu Kush-Himalayas**
  21-23 June, 1989, Kathmandu, Nepal
- **Regional Workshop on Hydrology of Mountainous Areas**
  11-15 December, 1989, Kathmandu, Nepal
- **Consultative Meeting on Mountain Risk Engineering**
  20-22 February, 1990, Kathmandu, Nepal

These Workshops were attended by experts from the countries of the Region, in addition to concerned professionals and representatives of international agencies. A large number of professional papers and research studies were presented and discussed in detail.

Workshop Reports are intended to represent the discussions and conclusions reached at the Workshop and do not necessarily reflect the views of ICIMOD or other participating institutions.

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International Centre for Integrated Mountain Development

Kathmandu, Nepal

Cover photographs:	Display during the Seminar at the Venue
Right	Hydropower Turbine Models - Kathmandu Metal Works
Top Left:	Corner view of the Exhibition
Bottom Left:	Wind-Generator Model - Nepal Yantrashala

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FOREWORD

The Seminar on Rural Energy and Related Technologies was held in Kathmandu from the 26 to 27 March, 1991. It was held partly in recognition of the fact that, in rural communities, the energy needs can no longer be met by relying on traditional sources and that adequate provision has to be made to find sustainable supplies of energy in the very near future.

It was, therefore, a matter of great honour to the sponsors that the Rt. Honourable Prime Minister, Mr. K. P. Bhattarai, inaugurated the seminar and that the Honourable Minister for Water Resources and Local Development, Mr. M. N. Nidhi, presided over the inaugural session. Their presence was instrumental in emphasising the importance of the theme of the seminar.

Rural Energy planning and management in the mountain areas of the Hindu Kush-Himalayan Region have been a priority in the ICIMOD mountain development agenda. This is in recognition of the fact that development in these countries cannot be conceived in isolation of and independent of developments in the field of rural energy.

Decreasing forest resources have put a great strain on the people of Nepal in terms of meeting their basic energy needs. People not only have to spend more time in collecting fuelwood but also have to meet their energy needs by using inferior forms such as agricultural residue and animal dung. This in turn means that the traditional use of these forms as plant nutrient and organic manures also diminishes.

Alternative energy sources, although full of potential, are yet to make a significant impact in terms of easing the overall situation. Technologies, such as micro-hydro, have as yet only realised a fraction of their potential in terms of the number of units established. Biogas development and dissemination have been less than satisfactory in areas of high potential for their uses, e.g, the *Terai*. Energy conservation technologies could be popularized all over Nepal to help conserve fuelwood use. Other non-conventional technologies, such as solar and windpower, are hardly being used at all in the rural energy sector.

The seminar deliberated upon important issues concerning rural energy and related technologies and has made suggestions and recommendations as to how they may be dealt with. The participation of technology producers, promoters, and facilitators in the seminar helped them understand each other's requirements.

ICIMOD's experience over the years has been that alternative technologies remain unexploited unless they are used in tandem with other main energy sources. It has also been observed that a decentralised approach to the planning and management of energy resources is necessary to achieve this end. Specific issues such as the relevant role of the

private sector, government sector, lending agencies, and NGOs, their strengths in pursuing a decentralized policy, and the constraints they face in doing so, assume great importance. It is with the objective of arriving at consensus concerning the future programmes of these organizations that this Seminar on Rural Energy and Related Technologies was organized by ICIMOD in collaboration and partnership with the Agricultural Development Bank, Nepal, and the Water and Energy Commission Secretariat of His Majesty's Government of Nepal.

I would like to take this opportunity to thank all those who worked so hard to make the seminar a success. In particular, thanks are due to Suresh Sharma, the coordinator, and the authors of the papers presented. Last, but not least, thanks are due to ICIMOD's cosponsors, the Agricultural Development Bank of Nepal and the Water and Energy Commission Secretariat of His Majesty's Government of Nepal. Without their wholehearted collaboration, the Seminar would not have been such a success.

E. F. Tacke
Director
ICIMOD

INTRODUCTION AND OBJECTIVES

Introduction

In Nepal, pressure on natural resources, caused primarily by an increase in population but also augmented by the demands of economic development, has reached a point where serious concerns regarding the environmental sustainability of the process are being voiced. The pressure is more serious in the case of forests because the demand for fuelwood, fodder, timber, and other forest products has led to a use of forest resources that is far beyond their regenerative capacity. The pressure is further accentuated by the demand for additional land for cultivation, which in most cases is procured at the expense of forest land. The end effect of these pressures is felt in terms of the disturbance in the symbiotic relationship between man and nature leading to a resource use pattern which is at variance with the long-term sustainability of the environmental system.

While the pressure on natural resources is one side of the consideration, the other side, which is equally important if not more, concerns the well-being of the Nepalese people. Because of the agrarian nature of the economy and its subsistence orientation, a continued dependence on natural resources is necessary for material well-being and for the attainment of an improved standard of living. The latter cannot be visualized under the existing conditions of low level energy consumption derived primarily from forest-based biomass sources. Technological inflexibilities and inadequacies in the utilization of biomass energy further aggravate the problem.

The spatial distribution of the demand for energy adds one more dimension to the issues at hand. The majority of the population resides in rural areas;the urban population in Nepal constitutes less than 10 per cent of the total population, and this is where energy supply needs to be enhanced. However, apart from forest-based biomass fuel, agricultural residue, and animal dung, the rural population has very limited access to commercial energy . It is not possible to visualize a significant increase in the supply of commercial energy in the short run as this would not only entail energy imports on a larger scale but would also require a better and more efficient distribution network inside the country,and this is not possible with the present level of transport infrastructure. Forest- based biomass supplies, as already observed, are on the decline. Thus, the only attractive option left is to exploit those alternative energy technologies which exhibit promise in similar conditions. It is in this context that rural energy and related technologies occupy an important place in the management of the energy sector in Nepal.

Nepal is estimated to have consumed about 9 million tons of coal equivalent energy in the fiscal year 1989/90. The forests, which provide the bulk of the energy used in the domestic sector, accounted for slightly over three-fourths of the total. Petroleum products, coal, and electricity together contributed only 5 per cent. The remainder comes from agricultural residue and animal dung.The continued heavy reliance on the forests to meet

energy needs, especially in view of the increasing population and decreasing forest area and density, is likely to impair Nepal's ability to promote environmentally sound and sustainable development strategies. Evidently, there is a need to gradually move away from forest-based energy sources to other renewable forms of energy in order to maintain the environmental health of the nation.

With a predominantly rural population, the shift from forest-based energy to other forms cannot be easily attained. To some extent, petroleum products can substitute fuelwood use in the domestic sector. But, since they are not available domestically, they have to be imported and thus are subject to external exigencies. Periodic oil shocks are difficult to absorb and affect the economy of small nations adversely. Moreover, imports of petroleum products involve convertible currency and are an unattractive proposition when trade and payment balances are negative. Finally, situations of uncertainty ,such as the one created by the recent Gulf War, further emphasise that too many factors interplay to make the oil supply situation extremely volatile.

Electricity is not accessible to a large number of rural households. It is unlikely that grid electricity can be made available to the rural population residing in scattered hill villages in the near future. Extending grid coverage to the rural hills is extremely costly. Besides, the generation costs and system losses are also very high in Nepal. However, in the rural *Terai,*the area covered by the electric grid can be increased.

While there are constraints, there are also opportunities. There are numerous rivers and streams that can be a source of power; both mechanical as well as electric. The mountains and hills of Nepal receive sufficient solar radiation to be transformed into power. Similarly, the *Terai* and lower valleys have enough biomass and organic waste to use in the production of biogas. As potentials are location specific, exploitation must also be within the same location. This calls for a strategy based on the framework of decentralised energy planning and management. Alternative energy technologies,that prove to be technically and economically feasible as well as socially desirable, should be an integral component of this decentralized framework.

ICIMOD's own experience in this respect clearly shows that such an approach is essential in addressing location-specific problems in a heterogeneous mountain environment and in building local capacity to absorb new alternatives for increasing energy input as well as for adopting energy conservation practices. District energy planning programmes, conducted in some of the member countries of ICIMOD, have also highlighted the need for investment in the learning process before definitive and replicable plans and programmes are possible. Existing institutions were seen, by and large, inadequate for promoting a decentralized approach. Thus, a fresh look at policy analysis and planning, energy linkages with other sectors, and monitoring and evaluation of various energy projects were seen to be necessary.

Nepal already has some experience in the use of these technologies. Micro-and mini-hydropower technology, biogas technology, the tapping of solar and wind energy ,and improved coooking stoves are promoted in Nepal through various agencies. These agencies are in the private as well as in the public sector. Numerous donor agencies and local organisations are involved in promoting alternative energy technologies through financial and technical support. While considerable progress has been made in promotion and dissemination of such technologies, still more could be done by sharing experiences of successful and problematic cases. To achieve this, a periodic exchange of views on energy programmes is essential. It is for this purpose that the Agricultural Development Bank of Nepal (ADB/N), the Water and Energy Commission Secretariat (WECS), and the International Centre for Integrated Mountain Development (ICIMOD) collaborated to sponsor and conduct a seminar on rural energy and related technologies.

Objectives of the Seminar

The overall objective of the seminar was to explore alternative approaches to energy development that are sustainable and which are guided by the principles of decentralised development with emphasis on the use of renewable resources. More specifically, the seminar aimed to:

(a) examine the energy sector and its components in the context of the sustainability or unsustainability of the present approach;

(b) examine and evaluate technologies and institutions that exhibit the potential to promote alternative energy development based on renewable resources;

(c) analyse the existing policies, investment priorities, and funding arrangements in order to identify areas that are compatible with the new approach;

(d) create awareness and promote dialogue among various agencies working in Nepal--international agencies/donors, national institutions, and local organizations-in the context of the issues, options, and possibilities that exist to promote a sustainable energy pathway; and

(e) arrive at broad consensus on a future programme and plan of action for the involved agencies.

The Seminar initiated discussion on the above issues among policy-makers, researchers, planners, and implementers involved in energy-related areas. Donor agencies and financing institutions also participated in the seminar.

The Seminar Programme and the Participants

The seminar programme is in Annex 1 and the participants' list in Annex 2.

The seminar was inaugurated on March 26th and the technical sessions took place the next day. Three papers were presented during the morning session and two more during the afternoon session. The first paper to be presented was 'An Assessment of the Energy Sector in Nepal'. This was followed by a paper on 'Development of Micro-Hydro Systems in Nepal'. 'Application of Biogas Technology in Nepal' was the last paper to be presented during the morning session. During the afternoon session, a paper on 'Biomass Production and Conservation of Energy through Improved Cooking Stoves in Nepal' was presented followed by a paper on the 'Role of Solar and Wind Energy in Nepal'. Each presentation was followed by a commentary on the paper and then discussion was open to the floor. This provided scope for discussion on issues of relevance to the seminar. The chairman of the morning and afternoon sessions briefly summarized the main points presented and the discussions that took place thereafter for respective sessions.

The third day of the seminar began with two video shows, one depicting alternative energy technology in action and another showing an Energy Village in Chengdu, China. The participants were then divided into four groups. The first group discussed a 'Rational Approach to Rural Energy Planning'. In all 12 participants took part in this discussion. The second group, composed of 12 members, discussed 'Planning and Implementation of Micro-Hydro Technology.' 'Planning and Implementation of Biogas Technology' and 'Planning and Implementation of Energy Conservation Measures' were discussed by the third and the fourth group respectively. There were 11 members each in the third and the fourth group. The group discussion and preparation of group reports took place during the morning session. The group chairmen presented their reports when the seminar reconvened for the plenary session in the afternoon. These reports were then discussed and approved with minor additions or modifications.

Before the conclusion of the seminar the heads of the three sponsoring institutions briefed the participants regarding future plans of action and/or the lines of thinking of their respective institutions.

A total of 64 participants attended the seminar.

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.

3

GROUP DISCUSSIONS

After the presentation of discussion on the papers, four working groups were formed to discuss and report on four thematic areas. Group 1 deliberated on a "Rational Approach to Rural Energy Planning". Group 2 focussed on the theme "Planning and Implementation of Micro-hydro Technology". Group 3 discussed "Planning and Implementation of Biogas Technology" and Group 4 examined aspects of "Planning and Implementation of Energy Conservation Measures". The papers presented in the seminar and the discussions arising from them provided the background for detailed deliberations by the working groups. The working groups were expected to highlight the major issues and come up with a set of recommendations that could be of use to concerned agencies in the planning and implementation of policies and programmes in the energy sector. The group reports were presented by the conveners of each working group at the plenary session and were discussed and subsequently adopted by the participants.

The issues raised and conclusions arrived at by each working group are summarized below.

Group 1. Rational Approach to Energy Planning

The Group first took stock of the existing approach to energy planning in Nepal. It was pointed out that a "rational" approach did not exist at present in Nepal's energy planning. Certain energy technologies had initial successes but these successes had little to do with consistent government efforts. This lack of consistency was attributed to institutional deficiencies. The relevance of particular technologies in the context of Nepal was not properly assessed. There was a pervasive lack of knowledge regarding local resource use. Financial incentives were lacking and, even in cases where there were some incentives, the support levels were not uniform. Lack of follow-up was regarded as endemic in the propagation and diffusion of technology. As a consequence second generation problems were rarely addressed. Lack of support for people-based planning was therefore quite obvious.

In view of the problems highlighted above, the group felt that the only rational approach to energy planning was an "integrated approach". Energy had to be viewed in totality and an integrated approach was therefore recommended. It was important to promote the energy sector's linkages with other sectors such as agriculture, industry, and transport within a certain geographical area. This in essence was one of the major advantages offered by area-based planning where strong intersectoral linkages contributed to the economic well-being of the people. To promote this integrated approach, it was also

necessary to take note of the respective role played by the private sector, government sector, financial intermediaries, and technology-promoting institutions. Alternative energy technologies played a far more important role in promoting local economies by following an "integrated approach". The group believed that there was the need for a focal point for energy planning and it was recommended that in Nepal's context the National Planning Commission should remain the institutional focal point. The group suggested that the NPC had to be strengthened in order to play the role of the focal point more effectively. The group felt that area- based planning provided the best opportunity for rational energy planning. The group recommended that the linkage between policy-making bodies, NGOs, and the private sector had to be meaningfully nurtured. To this end the NGOs and the private sector should be involved in discussions on policy and programme issues. The group called for a decentralized approach to rural energy planning and recommended that the active participation of user groups be sought in dealing with energy planning issues at the local level.

The issues and recommendations of the working group were endorsed by the participants with the observation that some pilot exercise should be undertaken in the development of energy villages.

Group 2: Planning and Implementation of Micro-Hydro Technology

In its report to the plenary session, this group also identified a number of issues and solutions regarding the planning and implementation of the micro-hydro system. One of the major issues was that there were too many breakdowns in micro-hydro systems and they took too long to repair. Skill levels in mechanical, civil, and electrical fields were low. New end uses of mechanical and electrical energy were not being adopted in many instances. As a result many schemes had low load factors. There was also no coordinated and systematic approach to research and development. The propagation of micro-hydro technology was lagging behind and, as a result, manufacturers had insufficient orders. Only one financial institution was really concerned with micro-hydro in a major way and therefore there was a dearth of financing agencies. The diffusion of micro-hydro also suffered from the fact that the electrification subsidy was limited and there was a backlog of requests not fulfilled. At the policy level the group noted the absence of a coordinating agency for micro-hydro development.

A number of solutions to deal with the issues highlighted above were also noted. Training on operations and maintenance was suggested by the group at three levels - for operators, for local seminar, and for manufacturers. Training to enhance the skill levels of manufacturers, installers and entrepreneurs was suggested. The promotion of new end uses, training, support services, and the promotion of financial incentives in the form of subsidies and tax exemptions was recommended. The establishment of a coordination unit for research and development was suggested to foster a systematic approach to R & D. The group expressed the opinion that there was an urgent need to induce more financing institutions to promote micro-hydro. More funds had to be sought to make

electrification subsidies available to a larger number of schemes. It was also stated that there was a need to establish a coordinating agency for micro-hydro development at the central level.

The group came up with three major recommendations. First, it was recommended that a coordinating unit for micro-hydro development be established in the Ministry of Water Resources. Secondly, the group recommended the establishment of a Task Force to (a) prepare a detailed inventory of constraints and potentials related to micro-hydro systems and (b) to prepare a detailed plan to significantly increase the dissemination of micro-hydro systems under the leadership of WECS. Thirdly, the group recommended the establishment of a lobbying group that included the representation of the Association of Hydropower Manufacturers and all parties concerned with micro-hydro development.

Group 3: Planning and Implementation of Biogas Technology

The group presented its report under four major themes: 1) the role of biogas in rural energy, 2) government institutions and subsidy policy, 3) research and development, and 4) promotion and dissemination of biogas. That there was the potential to establish a million biogas plants in Nepal was indicative of the major role of biogas in rural energy. Together, these plants would mean a savings of 10 million metric tons of fuelwood (i.e., 100,000 hectares of forest land). In terms of nutrient value, it would result in a saving of 1.3 million metric tons of nitrogen, 1 million metric tons of phosphorous, and 0.35 metric tons of potassium. Biogas would also have other indirect benefits arising from stall feeding, improved sanitation, and improvement in the quality of life. This potential of biogas should be realized during the planning and implementation phases for biogas technology.

The group stated that, insofar as government institutions and subsidy policies were concerned, there clearly was a need for long term commitment to the dissemination of biogas technology. The group recommended the creation of a Department of Rural Energy Development that would coordinate efforts to establish use of alternative energy in rural areas. The group decided that since the cost of biogas plants was higher for users at the present there was clearly a need to continue with subsidies. However, this could be provided either through institutional support or through direct subsidy to the users. The group pointed out that subsidy should perhaps not be a "forever" proposition. The group recommended that the subsidy provisions be retained in the coming Eighth Plan. The achievements, however, should be reviewed after the plan period before continuing with such a policy in future.

On the topic of research and development in the biogas technology area, a number of needs were identified by the group. Cost reduction was imperative if biogas technology was to be widely disseminated. Alternative uses had to be found for spent slurry. Research was also needed on alternative feed materials. The issue of gas production in cold regions had also to be addressed in order to make biogas a viable proposition at higher altitudes. Last but not least there was also the need to develop biogas appliances so that use could be

diversified. The group also recommended that encouragement be provided to the private sector in the research and development area.

Regarding the promotion and dissemination of biogas the group suggested that the private sector should be encouraged to construct biogas plants, particularly family-sized plants. The group noted the creditable work done by ADB/N in the area of credit provision for biogas, but believed that there was a need to involve other lending organizations if the potential for biogas dissemination was to be realized. More attention needed to be paid to manpower training both in construction as well as in extension work regarding biogas technology. The group also felt that there was a need to look at the institutional aspect of community biogas plants.

The group recommended that the role of the Biogas Company should be limited to research and development, extension and communication, training, and monitoring for quality control. More private sector initiatives should be encouraged. The group noted the need to provide import facilities for construction materials to the private sector.

Group 4: Planning and Implementation of Energy Conservation Measures

The group presented its report by emphasizing that introduction of new technologies and ideas in the context of the existing rural culture and economy had to take proper cognizance of both the technological and the institutional aspects. With respect to each technology, the group identified the technology potential, assessment of resources on which the technology is to be based, the R and D status of technology, demonstration and field trial aspects, and commercialization and popularization aspects. The group restricted its deliberations to improved cooking stoves (ICS), kerosene and electric stoves, biomass, and solar and wind energy.

Regarding ICS it was noted that the potential was high but a number of problems related to maintenance, durability, etc had come to the fore. Adaptation had to be made on local varieties and there was a need to create an institutional base for dissemination/diffusion of ICS at the local level.

On the topic of electric and kerosene stoves, the group stated that more awareness had to be aroused through the dissemination of appropriate information regarding efficiency.

Concerning biomass, three technologies were considered: gasification, densification, and charcoal. In the first case there was a need to monitor regional and international R and D. Regarding densification the focus needed to be in supporting the manufacturers in areas of materials and production processes. Charcoal was more efficient than fuelwood and attention had to be focussed on making its use more popular.

On the topic of wind energy the group stated that general as well as site-specific resource assessment was called for as this was lacking in Nepal.

Regarding solar energy, at least six technologies were identified (solar drying, flat-plate solar, P/V remote, P/V pumping, PV storage, and solar cookers). Solar drying as well as flat-plate solar-water heaters in particular had clear potentialities. The focus needed to be on reducing costs and bringing these technologies into wider use at the household as well as at the industry level.

With this review of the status of different energy conservation technologies, the group made a number of recommendations. The group felt that energy conservation and alternative technologies and practices had to be linked to the development agenda of the country. Many technologies existed in the solar, wind, and biomass fields. In propagating and disseminating these technologies, priorities had to be worked out.

The group recommended that an agency be established to coordinate/promote activities in alternative energy technologies. Such an agency would prioritise technology options and select specific technologies for promotion, development, demonstration, and dissemination on a regional or sectoral basis. Such an agency would also be responsible for mobilising resources and laying down criteria for the allocation of resources for research, demonstration, and commercialization with respect to particular technologies.

The agency would also be responsible for developing or supporting the development of energy conservation and education packages for dissemination through existing national programmes. The group felt that the agency should also act as a clearing house for information on alternative technologies and also monitor the technology-related activities of different agencies.

The group felt that for technologies such as ICS a link with local formal or informal institutions was essential in both the processes of adaptation and dissemination.

The group recommended that wind energy was a potential source. At the present moment, however, the focus in Nepal should be on a general resource assessment backed by some site-specific, in-depth studies.

Chairman's Conclusion

The Chairman of the session, Dr. Mahesh Banskota, summarized the discussions. He observed that the present seminar on Rural Energy Technologies represented a most interesting collaboration between three very special institutions. The Agricultural Development Bank of Nepal, apart from playing a leading role as a commercial bank for the agricultural sector, had been a pioneer in promoting improved rural technologies that incorporated rural energy development. The Water and Energy Commission of His Majesty's Government had played an important role in the systematic development and

management of energy resources in Nepal. The International Centre for Integrated Mountain Development (ICIMOD), while not directly involved in energy programmes in the field, had brought together the experiences of several countries in the development of energy programmes in mountain areas. Thus, the united effort of these three institutions represented a major step forward in the integration of policy-level thinking with practical experience not only here in Nepal but also in other countries with mountainous regions.

The Seminar, with its different topic areas, had clearly indicated the availability of enormous potentials. Use of biogas, micro-hydel, and solar sources at present account for only a very small fraction of the total energy supplied, compared to traditional sources such as forests. Thus, the technological options in the field of alternative energy supply were not lacking even for mountain areas, although the appropriateness of any one technology might be in question. It was important to understand this point because, in many cases it was not the absence of technology per se but the inability to use it that acted as a constraining factor in the development of mountain regions.

This seminar had also raised the issue of the underlying energy linkages between different sectors. In the past, energy planning and development was often undertaken without fully understanding the energy linkages between sectors. This resulted in an extremely poor performance from the established energy system. In view of the relative advantage of one energy technology vis-a-vis another for specific activities, it would be generally more useful to talk about combinations of appropriate energy technologies rather than just one technology. If biogas worked well with respect to household cooking, micro-hydel was better suited for limited scale non-agricultural processing. Planning of energy systems should consider the needs of transport, agriculture, and industry and identify appropriate options and linkages. It was probably one of the main reasons behind the poor end use of established rural electrical systems at present.

The issue of costs and prices was raised time and again by many speakers during the discussions. Underlying issues of costs were related to the questions of user charges, subsidy, and ultimately sustainability of rural energy technologies. Many of the proposed rural energy technologies were not affordable by the very poor in developing countries, and consequently the real options for the poor were not even being discussed. Biogas was mainly an alternative for land holding groups with some cattle, while micro-hydel required relatively large initial investments.

The Government and many supporting agencies were already concerned about the increasing subsidy burden of many energy projects. Unless effective ways to increase end use or reduce costs per unit could be identified, many rural energy technologies would become unsustainable. The question of cost was therefore very critical in the continuing economic viability of rural energy technologies.

This Seminar also raised many questions regarding the importance of an institutional set up for more effective energy planning and of a management system dealing with specific issues of pricing, technology, integrating end uses, and matching energy demand and

supply. There were additional aspects regarding promotion and training. A central coordinating unit for rural energy technologies was also thought to be useful. The integration of the private sector and NGOs was seen to have important potentials, especially in some areas.

In the past there had been too much talk about integrated energy development without any significant progress being made. This Seminar had also raised the issue of the need for an integrated approach. The present collaboration between ADB/N, WECS, and ICIMOD should now be continued in order to implement concrete steps towards the development of prototype rural energy planning in mountain areas. The Chinese experience in this respect provided very useful guidelines on how to proceed in implementing integrated energy planning.

4

ALTERNATIVE ENERGY TECHNOLOGY EXHIBITION AND VIDEO PRESENTATION

During the Seminar, an exhibition of alternative energy technologies was held to demonstrate technological capabilities available in the country. Private sector companies participated in the exhibition by displaying models of their wares. The technologies exhibited were of the exploitation of water power (different turbine models, multipurpose power units), biomass (electricity generation through biogas, slurry, different biogas digesters, and ICS with single and double wall inserts), solar energy (solar cooker), and wind energy (windmill). Low wattage cookers of different capacities were also displayed. Additionally, charts and photographs showing different kinds of technology displayed by different organizations.

The idea behind the exhibition was to initiate mutual exchange of ideas among different agencies participating in the seminar. During the three days of the seminar, technology producers from the private sector explained their problems and proposed possible solutions. Because of the informal nature of the interaction, there was a great deal of appreciation of different points of view. This in itself could be considered a good beginning.

Participating Agencies/Institutions and the Items They Displayed

Organization/Manufacturer	Items displayed/charts, photographs displayed
1. Biogas Company, Kathmandu	1. Demonstration of electricity generation through biogas slurry
	2. Various models of gas generation and its application
2. Agricultural Development Bank/Nepal	1. Maps, photographs
	2. Models of alternative energy technology application within a village area
	3. Map of places covered by alternative energy technologies
3. Water & Energy Commission Secretariat	1. Study reports conducted by WECS

4. Royal Nepal Academy of Science and Technology (RONAST)	1. Photographs of paddle-wheel generators, paddle-wheel pumps, Natural force ferry boat, wheel pump, solar PV electricity, wind classifier.
5. International Technology Development Group (ITDG), UK.	1. Photographs depicting various activities conducted on micro-hydro and its end uses
6. *Bijuli Dekchi Udhyog*, Butwal	1. *Bijuli dekchi* of various capacities (200-800W)
7. Research Centre for Applied Science and Technology (RECAST)	1. Photographs of different ICS 2. Models of insert single and double wall stove.
8. Kathmandu Metal Industry	1. Working model of Peltrie Set, 2. Different turbine models 3. Charts and photographs
9. Nepal *Yantra Shala*, Patan Industrial Area (PIA)	1. Crossflow model 2. Windmill
10. National Structure and Engineering (PIA)	1. MPPU 2. Cast-iron stoves
11. *Balaju Yantra Shala*	1. Crossflow turbine 2. Charts and photographs
12. Sunworks Nepal, Kathmandu	1. Solar Cooker 2. Charts and Photographs of solar energy use
13. Yeti and Company	1. Books and catalogues on solar photovoltaic energy
14. Central Electronics Ltd. India	1. Catalogues and photographs on solar photovoltaic energy

Video Shows

The first video show was entitled 'Looking for the Alternative' which was especially commissioned for the seminar. It showed how alternative energy technologies weremeeting the energy requirements of the rural population. Water turbines, micro-hydro technologies, biogas technology, ICS technology, and solar heating as well as low wattage cookers were some of the technologies covered by the film. The duration of the film was 25 minutes.

The second film shown was about an Energy Village in Chengdu, China. The film depicted how agro-ecological training, along with biogas and ICS integrated with innovative animal husbandry practices, could lead to a dramatic increase in the supply of energy for rural communities.

5

MAIN CONCLUSIONS AND RECOMMENDATIONS

The papers presented in the seminar and the ensuing discussions thereafter, in the plenary session as well as in the groups, identified the main issues pertaining to planning and management on the rural energy scene. Technological options and their strengths and weakness, as well as constraining factors in their wider application, were identified. The current roles of various organizations involved in the rural energy sector were discussed and modifications that were necessary to make them more responsive to the needs of the situation identified. The conclusions that were arrived at during the seminar are reported below.

There was a general consensus that the Government will continue to exercise a dominating influence in directing rural energy development along a sustainable path. Therefore, it was essential that the expected objectives of the rural energy development programmes be stated more explicitly. To do so, an energy development strategy as such should be the starting ground. Hence, the primary requirement was to formulate an energy development strategy that could be supported by policy measures that operationalized the strategy.

The institutional/organizational dimension of the Government's involvement in the sector was also brought to the attention of the seminar. It was the government and semi-government institutions that were in the forefront in the management of the rural energy sector. They were further being coordinated by a central coordinating body. But the extent of coordination, especially inter-institutional interaction with respect to each other's programmes, left much ground to be covered. This could have arisen as a result of the inflexibility of bureaucracy. Whatever the reason, there was clearly an institutional vacuum as far as the planning and programming of alternative energy technologies and their implementation were concerned. Therefore, it was recommended that a government department to deal with alternative energy technologies, capable of taking the programme to the grass roots' level, be created or an existing organization strengthened in this capacity. What form this department should take and what institutional affiliation it should have were details that could be worked out once it was agreed that such a department was necessary.

While the Government took a prime lead in the planning and programming of the rural energy sector, private sector manufacturers, NGOs, and actual users were others who played equally important roles. Yet they have had little say in policy planning. This anomaly could be reduced to a great extent if the Government made a deliberate effort to solicit their participation in policy planning as well. The Seminar, therefore, recommended that the Government take a lead in this respect and create a national body; consisting of representatives of the private sector, NGOs, R & D institutions, academic, and government institutions; and consult the body periodically for policy planning and implementation.

Human resource development was one of the major concerns voiced in the seminar. The existing low level of skills at every stage was seen as an impediment to an accelerated dissemination of alternative energy technology. Therefore the seminar recommended that a major effort be made to upgrade the skill of relevant personnel at different levels of technology production and use. In particular, those related to the training of operation and maintenance personnel such as operators, local seminar operators, and manufacturers, in the case of micro-hydro, and construction and extension workers in the case of biogas and improved cooking stoves. Additionally, training was also recommended for manufacturers, installers, and entrepreneurs in the case of micro-hydro technology.

Government support for promotion of alternative technology was another issue that was discussed intensively. It was pointed out that both the micro-hydro and the biogas programme had progressed in response to the government decision to provide subsidy. At the same time it was also observed that the Government could not go on providing subsidies indefinitely. In this context, the need for a higher R and D and demonstration expenditure to increase efficiency as well as to reduce the cost of using the technology was underscored. It was pointed out that private manufacturers, financial institutions, and the Government could join hands to provide for R and D as well as demonstration expenses. Therefore, it was suggested that in view of the attractiveness of alternative energy technologies, the support to these programmes in the form of subsidies should continue but with the provision that the subsidies would be withdrawn in a phased manner. This called for a long-term commitment to technology promotion and was to be backed by necessary financial allocations.

Regarding specific technologies, micro-hydro technology rapidly gained in popularity during the eighties. One of the major reasons identified was the government support to the programme in the form of capital cost subsidy. However, of late, there had been a slow down in the programme. Therefore, one of the recommendations of the seminar was to look for ways to expand the use of this technology beyond its traditional area concentration; in and around Bagmati Zone in the Central Development Region and in and around Lumbini Zone in the Western Development Region. To do so, it was necessary to encourage private sector manufacturers in other areas as well. The encouragement could be in the form of access to credit on easy terms. Commercial banks could play a useful role in this respect. Currently, only ADB/N played a main role in the promotion of this technology. Therefore, it was recommended that other commercial banks too follow ADB/N's footsteps and actively pursue this technology. Additionally it was also recommended that HMG support ADB/N for the expansion of micro-hydro technology in rural areas.

Biogas technology ,too, posed similar problems. In order to encourage rapid dissemination of biogas technology, it was necessary to bring in private sector participation. Therefore, the seminar recommended that the private sector be encouraged to produce biogas plants, particularly family-sized ones. In order to achieve higher private sector participation, the seminar also recommended that other lending agencies, apart from ADB/N, be involved in the programme. It was further recommended that favourable

consideration be given if expanding the biogas programme necessitated providing import facilities, especially for construction materials, to the private sector.

An expanded programme on micro-hydro technology required a high degree of coordination among different agencies involved in the programme. This was unlikely to be achieved in the absence of an institution designated to play this role. It was therefore recommended that a coordinating unit under WECS be established to play this role. Related to this was another recommendation regarding establishment of a task force to draw up details on the inventory of constraints and potentials for the attention of policy-makers. The task force would also prepare a programme for wider dissemination of the technology and present it at the relevant policy planning level.

Expansion of the biogas programme also required attention on different aspects of biogas technology. The seminar noted that a strong research and development effort was required if biogas technology was to succeed in Nepal. The Gobar Gas Company and Agricultural Implements Pvt. Ltd alone could not be expected to produce and promote this technology in a significant way. The seminar, therefore, noted the need for wider participation from the private sector in producing and promoting biogas technology. It was recommended that the Biogas Company gradually move away from actual construction and concentrate on R and D and associated activities such as information dissemination, extension, training, and monitoring for quality. It was further recommended that R and D efforts on alternative feed materials for the digesters, as well as reduction in the material cost of digesters, be undertaken by the company to tailor the technology to local conditions. Private sector companies should be encouraged to produce biogas plants.

Biomass conservation, the seminar noted, was one of the essential components of rural energy planning and management. Technologies that contributed towards this end had to be encouraged. Gasification, densification, and carbonisation were identified as having potentials for rural use. The present capabilities available in the country for promoting these technologies were limited. Therefore, it was recommended that efforts be made to find out what was available in the region and internationally regarding gasification technology. This required monitoring of regional and international R and D efforts. It was further recommended that support to densification technology must be provided by way of support to manufacturers in the area of material and production processes. Further, in view of the increase in efficiency brought about by carbonisation, it was recommended that efforts to popularize charcoal in place of new biomass be carried out.

ICS that showed conservation potential but lacked effective field programmes were the focus of intense discussion. It was stated by the group that conservation efforts must be made a part of the development agenda. Therefore, it was recommended that the ICS programme be integrated with other development programmes to make it more effective. It was further recommended that the ICS programme be based on local factors, i.e., institutions, materials, and skills. The Seminar also recommended that energy conservation efforts should not be limited to biomass energy sources and should include petroleum and

electric energy. It was recommended by the seminar that producers of efficient end use devices should receive proper encouragement.

In view of the limited expertise available in the country, as well as the limited resources available for planning and developing alternative, renewable energy resources, it was recommended by the seminar that donor agencies should increase their support to HMG by way of additional financial and technical help. The seminar further recommended that ICIMOD should collaborate closely with HMG in developing policies and programmes for the use of renewable energy resources, as the former, with its regional focus, was capable of drawing upon experiences available in the Hindu Kush-Himalayan Region.

The seminar noted that more research was required to answer some of the pertinent issues raised. It was important to enquire further into the question of the effectiveness of subsidy in promoting any particular technology. Similarly, it was important to know what impact pricing interventions had on efficiency and equity and whether the policy promoted alternative energy technologies. The Seminar also noted that the 'Energy Village' concept deserved further consideration and a pilot action programme should be launched to begin with. Research and data gathering were necessary to further evaluate the potential of solar and wind energy.

ANNEXES

ANNEX 1

SEMINAR ON RURAL ENERGY AND RELATED TECHNOLOGIES

26-28 March, 1991
Kathmandu

TIME	DAY ONE SESSION - 26 MARCH	TIME	DAY TWO SESSION-27 MARCH
3:30-4:00 PM 4:00-4:45 PM	o Registration o Inaugural Session o Arrival of the Chief Guest, Rt. Honorable Prime Minister Mr. K. P. Bhattarai o Welcome Address - Dr. Tilak Rawal General Manager, ADB/N o About the Seminar - Dr. E. F. Tacke Director, ICIMOD o Inaugural Address by the Chief Guest - The Honourable Prime Minister, Mr. K. P. Bhattarai o Chairman's Note - The Honourable Minister for Water Resources & Local Development, Mr. M. N.Nidhi o Vote of Thanks - Dr. C. K. Sharma Executive Secretary, WECS	9:00-10:30 AM --------- 10:30-10:45 AM --------- 10:45-11:45 AM	o Presentation - "An Assessment of the Energy Sector in Nepal" Speakers: Mr. Mohan Shakya Mr. Suresh Sharma - Commentator's Observation - Floor Discussion - Speaker's Response --------- T E A --------- o Presentation - "Development of Micro-hydro Systems in Nepal: Problems and Prospects". Speaker: Dr. Deepak Bajracharya - Commentator's Observation - Floor Discussion - Speakers' Response
4:45-5:15 PM	Tea and Alternative Technology Exhibition	11:45 AM-1:PM	o Presentation - "Application of Biogas Technology in Nepal: Problems and Prospects" Speaker: Mr. R. K. Pokhrel - Commentator's Observation - Floor Discussion - Speaker's Response - Chairman's Conclusion of the Morning Session: Dr. C. K. Sharma

DATE	DAY TWO CONTD.
2:00 PM- 3:15 PM	o Presentation - "Biomass Production and Conservation of Energy through Improved Cookingstoves in Nepal: Problems and Prospects" **Speaker:** Mr. K. M. Sulpya - Commentator's Observation: Mr. B.P. Kayastha - Floor Discussion - Speakers' Response
3:15 PM-3:30 PM	**T E A**
3:30 PM-4:30 PM	o Presentation - "Role of Solar and Wind Energy in Nepal: Problems and Prospects" **Speaker:** Mr. L. Tsering - Commentators' Observation Dr. M. L. Shrestha - Floor Discussion - Speaker's Response - Chairman's Conclusion of the Afternoon Session: - Mr. R. P. Sharma
4:30 PM-5:00 PM	o Formation of Discussion Groups **Group 1**: Rational Approach to Rural Energy Planning **Group 2**: Planning and Implementation of Micro-hydro Technology **Group 3**: Planning and Implementation of Biogas Technology **Group 4**: Planning and Implementation of Energy Conservation Measures

TIME	DAY THREE-28 MARCH
9:00 AM-9:30 AM	o Video on Alternative Energy Technologies, 'Looking for Alternatives' - Group Discussions
10:30 AM-10:45 AM	**T E A**
10:45 AM-1:00 PM	o Group Discussion and Preparation of Group Reports
1:00-2:00 PM	**L U N C H**
2:00-3:45 PM	o Plenary Session: Presentation of group reports, discussion and adoption of reports by the seminar; seminar chairman: Dr. Mahesh Banskota
3:45-4:00 PM	**T E A**
4:00-5:00 PM	o More video films on rural energy technology and exhibition of appropriate technology

ANNEX: 2

LIST OF PARTICIPANTS

AGRICULTURAL DEVELOPMENT BANK, NEPAL

1. Mrs. G. Sijapati
2. Mr. H. G. Gorkhali
3. Mr. M. B. Bista
4. Mr. P. N. Regmi
5. Mr. S. B. Pradhan
6. Dr. T. Rawal
7. Mr. U. P. Banskota

BALAJU YANTRA SALA, KATHMANDU

8. Mr. S. L. Baidhya

CENTRAL ELECTRONICS LTD., INDIA

9. Mr. R. K. Raidan

CENTRE FOR RURAL TECHNOLOGY, KATHMANDU

10. Mr. G. R. Shrestha

EAST CONSULT

11. Mr. N. Gurung

GERMAN AGENCY FOR TECHNICAL COOPERATION, KATHMANDU

12. Mr. M. Bach

GOBAR GAS COMPANY

13. Mr. R. K. Pokhrel

HILL FORESTRY DEVELOPMENT PROJECT, KATHMANDU

14. Mr. P. B. Khatri

INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT, KATHMANDU

15. Mr. B. Bhatta
16. Dr. E. F. Tacke
17. Dr. M. Banskota
18. Dr. R. P. Yadav

INTERNATIONAL DEVELOPMENT ENTERPRISE, KATHMANDU

19. Mr. Peter Schultz

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP

20. Mr. A. Brown U.K.
21. Mr. L. Perera Sri Lanka
22. Mr. Mark Walthan Kathmandu

MINISTRY OF AGRICULTURE

23. Dr. G. Thapa

MINISTRY OF FINANCE

24. Mr. K. R. Pandey

MINISTRY OF FOREST AND SOIL CONSERVATION

25. Mr. R. Bista

MINISTRY OF WATER RESOURCES

26. Mr. V. S. Shrestha

NATIONAL PLANNING COMMISSION, KATHMANDU

27. Mr. C. B. Khadka

28. Mr. R. P. Sharma

NEPAL COAL LIMITED, KATHMANDU

29. Mr. D. Bhattarai

NEPAL ELECTRICITY AUTHORITY, KATHMANDU

30. Mr. H. O. Shrestha

31. Mr. R. B. Shrestha

NEPAL FORUM FOR ENVIRONMENTAL JOURNALISTS, KATHMANDU

32. Mr. K. P. Sigdyal

NEPAL OIL CORPORATION

33. One representative

PRIVATE ENTREPRENEUR, BIRATNAGAR

34. Mr. P. Adhikari

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35. Mr. V. M. Shrestha

ROYAL NEPAL ACADEMY FOR SCIENCE

36. Mr. G. Shakya

SOLAREX, KATHMANDU

37. Mr. P. B. Adiga

38. Mr. U. N. Sigdyal

STRUCTO NEPAL

39. Ms. Y. Sherpa

SUNWORKS, KATHMANDU

40. Mr. N. Prasad

THE RISING NEPAL

41. Mr. B. Bhattarai

UNDP

42. Mr. S. Acharya

UNICEF

43. Ms. Shanta Khadgi

WATER & ENERGY COMMISSION SECRETARIAT, KATHMANDU

44. Mr. A. P. Pradhan

45. Dr. C. K. Sharman

46. Mr. D. L. Shrestha

47. Dr. H. M. Shrestha

48. Mr. Larry J. Haas

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4.	Mr. L. Tsering	ICIMOD
5.	Dr. D. Bajracharya	ICIMOD
6.	Mr. A. M. Nakarmi	KMI
7.	Mr. K. M. Sulpya	RECAST
8.	Mr. M. Shakya	WECS
9.	Mr. L. Bhattarai	WECS
10.	Mr. Sunil Rimal	WECS

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Ms. Greta Rana	ICIMOD
Mr. S. B. Khadka	ADB/N

Commentators

Dr. Vinayak Bhadra	Arun EIA Project
Mr. Prachar M. Singh	NEA
Mr. D. Joshi	Central Division of Soil Science, NARC
Mr. B. P. Kayastha	Ministry of Forest & Soil Conservation
Dr. M. L. Shrestha	Department of Hydrology & Meteorology

ANNEX: 3

Group 1: Rational Approach to Rural Energy Planning

1.	Sigdya,l K. P.	NEFEJ	**Group Chairman**
2.	Acharya, Suresh	UNDP	
3.	Banskota, Mahesh	ICIMOD	
4.	Bhattarai, Deepak	NCL	
5.	Gurung, Narendra	East Consultant	
6.	Khadka, C. B.	NPC	
7.	Shakya, Mohan	WECS	
8.	Suresh, Sharma	ICIMOD	
9.	Shrestha, Ganesh Ram	CRT	
10.	Shrestha, H. O.	NEA	
11.	Shrestha, V. M.	RECAST	
12.	Sigdyal, U. N.	Solarex	

Group 2: Planning and Implementation of Micro-hydro Technology

1.	Pradhan, S. B.	ADB/N	**Group Chairman**
2.	Baidhya, Shanker Lal	Balaju Yantra Shala	
3.	Bajracharya, Deepak	ICIMOD	
4.	Bista, M. B.	ADB/N	
5.	Brown, A. P.	ITDG	
6.	Nakarmi, A. M.	(KMI) Kathmandu Metal Industry	
7.	Lahiru, Perera M. A.	Sri Lanka ITDG	
8.	Pradhan, P. M. S.	NEA	
9.	Rimal, Sunil	WECS	
10.	Shrestha, V. S.	Ministry of Water Resources	
11.	Sijapati, G.	ADB/N	
12.	Walthman, M.	ITDG	

Group 3: Planning and Implementation of Biogas Technology

1.	Joshi, Dhurba	NARSC	**Group Chairman**
2.	Adhikari P.	ADB/N	
3.	Bach Manfred	GTZ	
4.	Banskota Uttam P.	ADB/N	
5.	Bhatta B. R.	ICIMOD	
6.	Gorkhali H. G.	ADB/N	
7.	Pokhrel R. K.	Gobar Gas Company	

8.	Regmi P.N.	ADB/N	9
9.	Singh Kiran Man	ADB/N	
10.	Shakya G.	RONAST	
11.	Yadav R. P.	ICIMOD	

Group 4: Planning and Implementation of Energy Conservation Measures through Improved End Use Devices (ICS+ Solar and Wind Energy)

1.	Haas, L.	WECS	**Group Chairman**
2.	Adiga, P. B.	Solarex	
3.	Bhattarai, B.	TRN	
4.	Bhattarai, Lila	WECS	
5.	Khadgi, Shanta	UNICEF	
6.	Khatri, P. B.	HFDP	
7.	Raidan, R. K.	Central Electronics Ltd. India	
8.	Sharma, P.	ICIMOD	
9.	Shrestha, Madan Lal	Department of Hydrology & Meteorology	
10.	Sulpya, K. M.	RECAST	
11.	Tshering, Lakpa	ICIMOD	

AN ASSESSMENT OF THE ENERGY SECTOR IN NEPAL: IMPLICATIONS FOR THE PLANNING AND MANAGEMENT OF RURAL ENERGY

Suresh Sharma, Mohan Shakya, Lila Bhattarai, Sunil Rimal

This paper deals with energy demand patterns, end uses of different energy sources, and Nepal's energy resource base and its use; the strategy, policies, and programmes in the energy sector; and the major issues and options pertaining to the rural energy scene. The paper also highlights the components of an integrated approach to rural energy development in Nepal.

Most of the Nepalese live in rural areas and will continue to do so for some time in the foreseeable future. Currently, the population distribution between rural and urban Nepal is 90:10 and by the end of the next 20 years the distribution is expected to be 78:22. In numerical terms, this means that approximately 24.4 million Nepalese will live in rural areas by 2010 A.D. The number is almost one and a half times the current population. The current population distribution between the mountains (including the hills) and the *Terai* is 53:47 and this is expected to be 47:53 by 2010 A.D. When discussing rural energy, it is the energy needs of this population that demand attention.

The current level of energy consumption is low in Nepal; less than 500 kg of oil equivalent per capita. Traditional energy sources, meaning fuelwood, agricultural residue, and animal dung, provide 95 per cent of the total energy and the balance is met through use of commercial energy in which petroleum, oil and lubricants (POL) are most important. Although the share of traditional sources remained stable at around 95 per cent during the 1980s, there has been an increased use of agricultural residue and animal dung to compensate for a decreased use of fuelwood in the domestic sector. The share of electricity has been less than one per cent in the total energy budget of the country, even though growth in the demand for electricity was fairly high during this period. Demand for hydrocarbons too showed a high growth rate. Transport and industry were the main users of hydrocarbons. Petroleum, all of which is imported, places a strain on the State exchequer and POL imports accounted for about 30 per cent of the receipts from exports during the 1980s, even though for some years the figure has been as high as 50 per cent.

Energy demand projections by source of energy and the consuming sector were made by the Water and Energy Commission Secretariat (WECS). The projections were made for the year 2000/01 with 1985/86 as the base year. The total energy demand was expected to grow at a rate of 1.9 per cent per annum with an expected domestic sector demand at 1.7 per cent per annum. The industrial, commercial, agricultural, and transport sector demand growths were estimated to be 5.1, 4.5, 8.5, and 5.2 per cent per annum respectively. Demand projections by energy sources showed a negative growth rate for fuelwood. Demand for other energy sources ranged between 3.3 per cent to 8 per cent per annum. The projections thus showed that the share of fuelwood in the total energy would decrease over the years to about 55 per cent in 2000/01. This decrease would be partially caused by an increased use of agricultural residue and animal dung and partially by an increased use of commercial energy in which POL and, to some extent, electricity, are

expected to play important roles. The decrease in fuelwood supply will be acute in the *Terai* where the energy deficit will be met by an increased use of agricultural residues and other biomass. Alternative energy technologies and their possibilities therefore should be examined in terms of geographical dimensions.

There is a gross mismatch between Nepal's energy resource endowment and its actual use. In terms of the theoretical potential, hydropower, with 1461×10^6 GJ raw energy available, is the most abundant energy resource accounting for about 79 per cent of all available energy. Forests with 293×10^6 GJ raw energy available is the second-most important source. Other sources such as agricultural residue, animal waste, solar power, and fossil fuel exhibit relatively low theoretical potential. The location of major hydro-electric plants and transmission and distribution lines; location of small hydropower units; and the location of alternative energy plants in the country indicate that major hydro-plants are concentrated in and around the capital region and that the transmission lines are mostly confined to the *Terai*. Rural energy resources in Nepal exhibit a trend of unsustainability arising out of a combination of the factors discussed so far and it is necessary to address this issue with demand and supply management measures.

Regarding the strategies, policies, and programmes in the energy sector, there is lack of a clear and articulated strategy as a result of which energy planning has tended to move away from the overall goals of socioeconomic development planning in Nepal. Planning for hydropower development has been taken to be synonymous with energy development, but the direct benefits of large hydropower projects do not reach the rural masses as they have no access to electricity or other associated benefits. Indirect benefits certainly do not reach them and this can be attested by the poor standard of living of the majority of the rural people. While planning documents discuss the exploitation of alternative energy sources in the rural areas, in actual practice this has never been translated into concrete action. Investment allocations during the 7th Five Year Plan show that water resource development programmes, which were basically for exploiting large hydropower projects, received an allocation of Rs 4,757 million. In the same plan period, alternative energy programmes received an allocation of Rs 50 million or only about 1 per cent of the allocation for the water resource sector. The figures clearly indicated where the government priority lay in the energy sector. The implications for the rural energy sector were that, in addition to the low priority accorded, there was no attempt to integrate various sub-sectors within the energy sector itself.

Pricing policy has been one of the main tools used in managing the energy sector in Nepal. But the goals of various pricing policies have often been in conflict with one another, especially as the Government appeared to promote different socioeconomic goals, such as equity, efficiency and, revenue considerations, through the pricing policies. It is observed that the relative prices of various energy forms (e.g, fuelwood, electricity, and POL) do not reflect their true scarcity value resulting in implicit encouragement of the use of scarce resources. The divergence between the private and social cost of resource use has led to this situation. This policy has resulted in distortions in resource allocation resulting in insufficient generation of investable funds. There have been organizational deficiencies that have resulted in the different organizations dealing with particular energy forms using pricing policies to meet their own sub-sectoral objectives. Thus, the effect of the pricing policy was the reduction of fuelwood supplies in rural areas. The policy even encouraged fuelwood exports from deficit regions. The policy did not systematically bring about changes in rural energy consumption. There has been no appropriate organization to implement policies in rural areas.

Another major policy, the energy conservation policy, lacks a consolidated approach even though biomass conservation is likely to have the greatest impact on rural energy supplies. Regarding the promotion of improved cooking stoves (ICS), instead of following a target-oriented approach, where the number of ICS distributed are the sole criterion of success, it would be preferable to concentrate programme efforts in areas where backup services could also be provided.

An important component of the government policy has been that of providing subsidies in the energy sector. Although in different forms, the Government has subsidized electricity, fuelwood, biogas, micro-hydro, ICS, and many other energy technologies. Since subsidy had to come from government revenue, a rethinking on the rational, mechanism, and extent of subsidy was urgently required. Government support to the energy sector should not necessarily mean the provision of subsidies.

Biogas and solar and wind energy programmes have potential but have yet to be exploited in Nepal.

It is apparent that rural energy sector should be treated in an integrated manner. The elements of an integrated approach to rural energy planning are:

- integration of economic and energy planning,
- ensuring that energy contributes to the economic well-being of the rural populace by linking energy, agriculture, and agro-processing activities,
- trade-offs on conflicting objectives, and
- exploitation of local resource potential.

The approach used by the Chinese Academy of Science, Chengdu, in implementing energy villages could be a guide in this respect.

Major options available to policy planners are the use of energy to transform the economy, promotion of water resources for rural energy by using a decentralized approach for water resource development, and the reduction of dependence on the forests by pursuing a combination of policy tools such as pricing, conservation, management, and resource ownership. Additionally, enhanced reforestation, higher investment in the improvement of end use devises, and conservation education should also be emphasized in this context. Finally, the location-specific potentials of biogas, micro-hydro, solar and wind energy have to be exploited by following a decentralized planning and management approach.

Nepal requires foreign assistance to exploit its potential energy resources. The country could derive maximum benefits from this assistance if it supported components of a national strategy on energy development that are a part of a well-thought out overall development strategy. Otherwise, each donor is likely to promote and invest in projects that they think Nepal needs. This may or may not be relevant to the majority of Nepalese people.

DEVELOPMENT OF MICRO-HYDRO SYSTEMS IN NEPAL: PROBLEMS AND PROSPECTS

D. Bajracharya, A. M. Nakarmi, & K. M. Singh

The micro-hydro systems discussed in the paper include improved ghattas, multipurpose power units (MPPU), and turbines, all below 100 kW capacity. The principal parties involved in the development and dissemination of these units are village entrepreneurs and local community groups, equipment manufacturers, and the Agricultural Development Bank of Nepal (ADB/N) as the main promoter and resource mobiliser on behalf of the Government and donor agencies. The paper argues that the pattern of development has been encouraging, particularly over the last fifteen years, but additional efforts, in a much more intensive and consolidated manner, are necessary, if the potentials are to be tapped effectively. The existence of some 25,000 traditional ghattas in the country is a rough indicator of the required level of dissemination. Considering there are currently about 600 micro-hydro units (other than the traditional ghattas), the rate of expansion has to increase by several orders of magnitude. For this purpose, specific attention has to be directed to (a) formulating clear government policies, (b) establishing a practical institutional framework, (c) assessing energy demand and supply possibilities based on available resources, and (d) demonstrating the Government's political will through increased budgetary allocations and emphasis on manpower training.

Analysis of available information shows that technical innovations and the manufacturing of equipment locally have played critical roles in the dissemination of micro-hydro units since the mid 1970s. Also, the Government's policies, since 1984, of delicensing installations below 100 kW and, since 1985, of providing a subsidy on the electro-mechanical costs of power generation have proved to be effective incentives. However, dissemination appears to be concentrated mainly in the vicinity of Butwal and Kathmandu. The more remote and inaccessible districts are to a large extent ignored. There are indications that from 1986 onwards, some form of saturation had been reached in the relatively accessible areas and the rate of installation of micro-hydro units is on the decline. ADB/N's loan amount on an annual basis has been decreasing but prices have been increasing. There is a long list of customers who have applied for adding-on induction generators for electrification but the limited amount of money made available by the Government for subsidies has made it difficult to respond to these requests.

Six samples cases were cited for elements of success and failure. On the whole, the modest success achieved in micro-hydro systems can be attributed to the following factors:

- meeting of locally felt needs (e. g., agroprocessing, lighting, lift irrigation, etc.) at affordable costs;
- reliance on technologies (equipment as well as civil works) that are easily understood and provision of training for operation and maintenance;
- gradual build-up of entrepreneurship with support services provided by ADB/N and manufacturers; and

- reasonable integration of organisational and management functions at different levels (e.g., the Government's policy of delicensing and subsidy, promotional efforts by ADB/N, provision of reliable technology, services by manufacturers, and strengthening of organisations at the local level).

The options for the future may be seen in two ways: (a) continuation of the present strategy as the minimum, but preferably with greater concentration on dissemination in remote areas; and (b) emphasis on diversified end uses of electricity and mechanical power to increase the load factor and promote productive activities. To this end, the role of the different parties concerned must be seen in an integrated fashion. The role of the Government and the involvement of the banks have to extend beyond the current practices of loans and subsidies. Particular emphasis is needed with respect to the national coordination of micro-hydro activities, systematic planning in conjunction with the principles of decentralisation, mobilisation of greater amounts of funds, and provision of better incentives to all parties concerned. The manufacturer is currently too heavily involved in every step from site survey to installation of equipment to provision of repair and maintenance services. On top of that, the eight or nine manufacturers are based in Butwal and Kathmandu and the servicing of remote installations is a controversial point. Emphasis is needed on improving the spread of manufacturing and servicing seminar in order to encourage more rapid dissemination in remote areas. Technical support to manufacturers is also crucial (e.g., establishment of steel foundries with casting facilities; organisation of training and study tours; and provision of importing facilities with respect to bearings, electronic load controllers, and generators above 20 kW; etc.).

Research and development (R & D) is the weakest factor in micro-hydro development. This is happening mostly in an *ad hoc*, uncoordinated fashion. A more integrated approach to R & D is advocated with particular focus on the following:

- assessment of micro-hydro potentials and development of systematic location-specific plans;
- cost-effective equipment design and civil works with specific emphasis on governor technology;
- consolidation of hydrological, geological, and socioeconomic information; and
- a quality control centre for performance testing and standardisation.

Action research projects and training programmes need to be promoted in conjunction with these.

The key to success lies ultimately with the local people who are the users and the beneficiaries of micro-hydro systems. Their organisational strength and entrepreneurial pursuits need to be boosted if the micro-hydro system is to be used for purposes other than just milling and lighting as has been the case until now. Complementary support services and a favourable policy environment are critical inputs if these attempts are to take off.

APPLICATION OF BIOGAS TECHNOLOGY IN NEPAL: PROBLEMS AND PROSPECTS

R. K. Pokharel, R. P. Yadav

The shortage of energy is a serious constraint to the achievement of sustainable development. Predominant dependence (95%) upon traditional energy sources, such as fuelwood, agricultural residues, and animal wastes, characterises the energy situation in Nepal. Among traditional energy sources, fuelwood alone constitutes 75 per cent. Poorly-managed forests have to shoulder this immense burden to meet the increasing demand for energy. Therefore, the search for and promotion of alternative options to meet energy needs is of paramount importance.

One of the alternative sources of energy for cooking in the rural areas is biogas. It has been estimated that the potential number of biogas digesters could be about one million in Nepal.

Although initiatives to promote biogas began in 1975 during the International Agricultural Year; more systematic efforts began only in 1977 with the establishment of the Biogas and Agricultural Equipment Development (Pvt) Ltd. as a specialised company through joint investments from the Agricultural Development Bank, the Nepal Fuel Corporation, and the United Mission to Nepal. The company aims to construct and provide services for operation and maintenance, to train local manpower, and to conduct problem-oriented research and development.

The Biogas Company initially promoted the Floating Steel Drum type of biogas digester, a technology imported from India, but during the last six years emphasis has almost exclusively shifted to the promotion of the Fixed Concrete Dome type, a technology imported from China.

A total of 5,739 biogas plants was installed in Nepal between 1974/75 and 1989/90 in a proportion of 3:1 between the *Terai* and Hills. In the fixed dome design, the size of the biogas plant in common demand is 10 cubic metres, whereas in the case of the floating drum design the popular size is 200 cubic feet. The attachment of latrines to the biogas plant is also being promoted. This has increased the production of biogas as well as manure and is a good method of using night soil which otherwise would have been wasted. It has also improved the sanitation of the villages.

It has been estimated that the construction of 25,000 plants over a period of five years would require a government subsidy of about 288 million rupees if 50 per cent of the capital cost of biogas installation is subsidised. On the other hand, the estimated total value from replaced fuelwood and additional plant nutrients would be about 1,085 million rupees. This would bring the net benefit of biogas plants to about 800 million rupees after deducting the government subsidy. The total benefit comes to three times the total government subsidy. Assuming the lifespan of a biogas plant to be about 25 years, with an annual net benefit of 800 million rupees a year, the total projected benefits over 25 years would be about 20 billion rupees.

It is also estimated that through the installation of 25,000 biogas plants, about 1.44 million mandays of unskilled and semi-skilled labour would be used, the value of which is approximately 50 million rupees.

Similarly, the other intangible benefits are the stall-feeding of livestock, relieving rural women from the task of burning hazardous fuelwood and from the physical hardships caused by several hours of travel each day in search of fuelwood, and improved sanitation in the villages.

The Biogas Company is planning to decentralise and to promote the privatisation of its activities, gradually limiting its role to research and development and to supervising and monitoring biogas plants installed by private firms and individuals.

The main issues discussed in the paper and the recommendations made have been outlined below.

1. The Government does not have a consistent policy for the promotion of biogas to meet energy needs. This is reflected in the *ad hoc* nature of its subsidy policy. Therefore, it is now high time for the Government to make a firm policy commitment in this area, in particular, and towards the development of renewable energy resources in general.

2. There is no specific department or ministry responsible for promoting the development of renewable energy resources. At present, several departments and ministries are engaged in promoting different energy technologies but their efforts are not coordinated, rendering it hard to identify one institution to plan and implement renewable energy policies. Since activities are uncoordinated and isolated, there are no systematic future plans or perspectives. It is important to make a specific department in the Government responsible for the development of renewable energy resources.

3. The initial installation cost of existing biogas designs is high and beyond the reach of the majority of rural families in Nepal. Research into more cost-effective designs is essential if biogas is to be accessible for poor households as well.

4. Low gas production during the winter months, particularly in the colder hilly regions, has been a constraint to the promotion of biogas in the hills and mountains. Research is needed for identification of methods of maintaining higher temperatures in the digester pit so that optimum gas production can be ensured throughout the year.

5. There is very little publicity, particularly of the audio-visual kind. A better extension and dissemination programme is essential.

6. There is an insufficiency of trained manpower to build, supervise, and repair biogas digesters. Training at different levels is essential.

7. Construction materials such as cement, G.I. pipes, biogas lamps, and other appliances are unavailable in some parts of the country. They are also difficult to transport in the remote hilly areas. Transportation subsidies will be necessary if biogas plant installation in inaccessible areas is to be promoted. Here again, a definite government policy is needed to assess the amount of subsidy required.

8. Community biogas plant construction has not been successful in many places. This is largely because of institutional failures rather than the shortcomings of technology. There is a need to search for improved institutional mechanisms to promote community biogas to enable poor households, who cannot afford and maintain a small plant on their own, to derive benefits from jointly owned biogas plants.

9. The Agricultural Development Bank has already taken a lead in the promotion of biogas. Other commercial banks should be encouraged to participate in the promotion of renewable energy resources.

BIOMASS PRODUCTION AND THE CONSERVATION OF ENERGY THROUGH IMPROVED COOKING - STOVES IN NEPAL: PROBLEMS AND PROSPECTS.

K. M. Sulpya

Biomass fuel is the main form of energy in rural areas; both for domestic as well as industrial use. This has led to a heavy use of forest resources to meet fuelwood needs. Additionally, forests have been used for agricultural and commercial purposes as well. This has affected forest density and has led to reduced crown cover, resulting in fuelwood scarcity. Also, agricultural residue and animal dung are being increasingly used as energy sources. Therefore, there is a need to reduce the pressure on biomass resources by using them more efficiently and effectively. This could be achieved by using technologies such as densification, biogas production, thermochemical gasification, and bio-energy plantation. But, at present, these technologies are not being exploited in Nepal and it will be some time before such capabilities are developed. In the meantime, a more efficient and effective use of biomass can be made by using improved cooking stoves (ICS)

ICS have been promoted in Nepal for some time already, but it has only been since the early 1980s that laboratory work and research and development activities have been conducted in the country. Different types of ICS, such as ceramic, mud and brick/stone, mud, and metallic stoves have been designed and developed. These ICS have a higher range of efficiencies (from 21.5 to 26.7 per cent) in field conditions. An associated benefit of ICS with chimneys is reduction in the level of carbon monoxide in the kitchen.

The Community Forestry Development Project carried out large-scale distribution of ICS. A few other agencies were also involved in ICS distribution with donor support. There has been no uniformity in the type of ICS distributed nor has there been uniformity in the approach used in distribution. In the past, types of distribution have ranged from free distribution to sales. Monitoring the programme involves assessment according to geographical region and back-up technical services are virtually non-existent.

An evaluation of the ICS programmes shows that when access to fuelwood is poor people tend to use ICS. There were instances of stoves remaining unused when received free alongside examples of people paying up to Rs 150 per stove. It was also observed that in some areas the ICS produced and distributed had structural deficiencies. Three of the principal factors involved are:

- that the priorities of rural women vary a great deal - saving energy is not a top priority;
- that mass adoption of unifocal ICS needs to be replaced by broader-based development projects in which ICS are integrated as a component, e.g., improved kitchen conditions and sanitation; extra-income generation; and biogas for lighting cooking, kitchen gardens, and agro-forestry; and
- that the distribution of ICS through commercial channels is likely to succeed more rapidly in the monetized urban and semi-urban areas where firewood is purchased rather than collected.

In future, the ICS programme should be launched in a more systematic manner. This would help in realising the potential benefits of ICS. The main elements that should be considered relate to design and certification, training and extension, monitoring, and inter-agency coordination.

Testing and certification should be done prior to the distribution of ICS. RECAST can act as a technical back-up unit and can test the efficiency of the stoves and certify them. Training should be given for research, production, promotion, marketing, and management at various levels and should include programme implementors, artisans, local village people, and the ultimate users (women). A regular monitoring and review system is necessary, respective roles of lead and supporting agencies should be defined and support provided accordingly. Inter-agency cooperation and coordination are vital in this respect. The involvement of women should be augmented and improved, and they should be trained in production, distribution, and extension methods.

The ICS programme on its own with a focus on energy conservation only is shown to be ineffective. For improved impact, the ICS programme, along with other rural development activities, should be promoted as a package.

ROLE OF SOLAR AND WIND ENERGY IN NEPAL: PROBLEMS AND PROSPECTS

Lakpa Tsering

The overall energy situation of Nepal indicates that it is predominantly dependent upon traditional sources of energy. In fact, traditional energy resources account for 95 per cent of the total energy consumed out of which about 75 per cent is fuelwood. Nepal has abundant hydropower potential but no appreciable, known deposit of oil, coal, or natural gas. Exploiting indigenous energy sources is vital as a sizeable proportion (about 30 per cent overall but as high as 50 per cent in some years) of export earnings are used for imports of petroleum products. Exploiting solar and wind energy becomes important in order to ease the energy situation.

The average solar energy potential of Nepal is 6 kW hour per day from 8 hours of sunshine. This is more favourable in Western Nepal. Because of the lack of a research and development infrastructure and of manufacturing capability, the country depends mainly on the import of solar devices from other countries.

Solar energy is used on a limited scale in the country. Nepal has a fairly long experience in the use of solar water heaters. There are 20 to 25 manufacturers of this device in the country, and it is used for both domestic and industrial purposes. One limitation of its usage in certain industries is that the outlet water temperature is not hot enough. Solar energy has been traditionally used for drying agricultural and other products. Several models of solar driers are available. Although potential for its use is quite considerable, a major constraint is the high cost. Nepal's experience in the use of the solar cooker as an alternative to fuelwood for cooking is almost non-existent. Some of the constraining factors in this context are its high cost, the uncertainty of weather conditions, breakage of glass, and the need for adjustments to the sun's direction from time to time.

Although a number of solar pumps have been installed by ADB/N for lifting water for domestic and irrigation purposes, one constraining factor for its mass adoption is its high cost. In remote areas, where there is no power infrastructure, solar panels have a comparative advantage over other energy systems. This advantage has been used in Nepal, where 64 out of 75 remote area wireless stations have photovoltaic back-up. Use of solar generators for rural electrification by Nepal Electricity Authority (NEA) with French assistance has been done in some areas. The relative costing of four units-at Kodari, Tatopani, Simikot, and Gamgadhi-shows that the bigger the solar plant capacity, the less the generating cost per kW power generation. However, as compared to hydropower, it is many times more expensive for equivalent power generation.

In view of the extreme heterogeneity of the topography, it is difficult to generalize on wind potential as it is a site-specific technology. No wind potential on a national scale is currently available. Studies indicate that wind potential for power generation is favourable for the Palpa, Tansen, Lo Manthang, Mustang, and Khumbu regions of Nepal. Presently, a three year wind assessment study for Jomsom Mustang is being carried out by RONAST. There have been many attempts to introduce wind generators into the country . Among the more recent ones is the 20 kW wind generator erected by NEA at Kagbeni, in Mustang. This unit is facing some problems.

RECAST has experiences in field testing the Indian prototype, Apoly 12 PU500, on the RECAST premises at Kirtipur and at the Kalwalguri Training Centre, Jhapa. The performance of both units has been disappointing. Soon after installation, failures involving distortion of rotor blades during strong winds, pump foundation failures, and the uprooting of the rotor blade assembly system have been experienced.

The general recommendations made in the paper included the formulation of a suitable national policy that will make solar and wind devices competitive in the open market, the promotion of a free-flow of information on these two technologies, the training of the nationals as an important component of solar and wind energy development strategy, development of national research and development capacity (especially applied research to begin with), and mobilisation of international assistance (both in terms of finances and technology transfer) to promote environmentally sound solar and wind technologies.

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Founding of ICIMOD

The fundamental motivation for the founding of this first International Centre, in the field of mountain area development, was widespread recognition of the alarming environmental degradation of mountain habitats and the consequent increasing impoverishment of mountain communities. A coordinated and systematic effort on an international scale was deemed essential to design and implement more effective development responses to promote the sustained well-being of mountain communities.

The establishment of the Centre is based upon an agreement between His Majesty's Government of Nepal and the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) signed in 1981. The Centre was inaugurated by the Prime Minister of Nepal in December, 1983, and began its professional activities in September, 1984.

The Centre, located in Kathmandu, the capital of the Kingdom of Nepal, enjoys the status of an autonomous international organisation.

Director : Dr. E.F. Tacke

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- **Pakistan**

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