ENERGY IN THE INDIAN HIMALAYA: AN OVERVIEW OF STATUS AND PROSPECTS

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INTRODUCTION

The Indian Himalaya is a vast chain of mountain ranges exhibiting tremendous agro-climatic, sociocultural and economic heterogeneity. This 0.6 million square kilometer tract of land is home to about 43 million people (1981 census), with an equal number of ruminant farm animals. The Himalaya is richly endowed with sites for the generation of hydroelectricity, just as it was once endowed with forest wealth.

The pattern of energy utilization thus far has been unsatisfactory, as there has been little improvement in the quality of life for the people living in the mountains. Watersheds are being continuously eroded, contributing to floods and siltation. Development of rural energy sources has an important role to play in the satisfaction of basic needs, the augmentation of employment opportunities, and the increase of agricultural and industrial productivity.

This book is an attempt to review experiences in rural energy planning in the Indian Himalaya. The papers have been selected from those commissioned by the International Centre for Integrated Mountain Development (ICIMOD) in collaboration with the Tata Energy Research Institute (TERI) as a part of their program on rural energy planning. Critical gaps in knowledge and experience exist in the formulation of regional energy policies and plans, in orienting energy technologies for Himalayan development, in energy-related institutional development, and in the diffusion of energy technologies. Establishment of a knowledge base was considered the first step in policy research before embarking on more practical work.

The book is divided into four sections, forming a sequence from the specific papers to the most general. A Steering Committee* met with the invited authors in June 1985, to discuss synopses of individual papers and interrelations between the papers.

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* Steering Committee Members:

Shri. J. A. Kalyana Krishnan, then Secretary of the Ministry of Environment and Forest; Dr. J. Gururaja, Director, Department of Non-Conventional Energy Sources; Dr. S. L. Shah, Consultant, Hill Development, Indian Planning Commission; Dr. R. K. Pachauri, Director, TERI; Dr. R. P. Yadav, Deputy Director, ICIMOD; Dr. Dilip Ahuja, TERI; and Shri T. M. Vinod Kumar, ICIMOD.

After these were prepared, they were discussed and revised at a meeting of the authors in Kathmandu, in January, 1986. For the most part, authors speak for themselves; the editors have not supplied caveats.

Energy Technologies for Himalayan Development

In the Himalaya, both humans and cattle need protection from the cold and often they share the same dwelling. The occupation pattern of these buildings shifts depending on the season. **Vinod Gupta** and **Ranjit Singh** describe the traditional architecture of Kashmir, Ladakh, and the Kullu Valley which is effective in retaining heat, but shuts out natural light. The influence of architects and engineers who are insensitive to local building traditions has for the most part been negative, especially from the point of view of energy conservation, mainly due to inappropriate use of building materials and designs. The authors propose solutions that will provide thermal comfort and adequate lighting by utilizing local materials, the wisdom of vernacular architecture and innovative modern designs using materials such as glass and *trombe* walls.

Ashok Gadgil maintains that energy consumption by the people of the Himalaya cannot be increased meaningfully through exclusive reliance on traditional sources of energy such as fuelwood, agricultural residues, and muscular energy. The paper suggests how more energy can be made available to people in this area by new and renewable sources, how current uses can be made more efficient, and waste heat recovered, in the attempt to improve the quality of life. Among new technologies, he discusses the potential of wind power and photovoltaics, especially of amorphous silicon cell technology, for which tremendous reductions in price are anticipated. Enormous scope for saving energy by improving end use efficiency of lighting and heating devices exists. He also describes in detail how passive solar and thermal technologies could be used in architecture, in production of vegetables and biogas, for hot water, and for preservation and storage of foods and medicines. Development needs in each of these areas are stated, along with the advice that for any diffusion effort to be successful, the socio-cultural milieu must be kept in mind.

D. P. Sen Gupta's paper provides a glimpse of the known potential for micro, mini and small hydel sources and documents their sluggish development thus far. He presents cost analyses to show how small hydro projects compare favorably with larger ones, and also with extensions of the grid. The long gestation periods of large hydel schemes involve the lost opportunity cost of capital, generally not included in such comparisons. Making reasonable assumptions, he shows how it becomes uneconomical to extend the grid for distances over 10 km in the hills where potential for small hydel power exists. To further bring down costs, he suggests use of local skills, manpower, and adaptation of designs to suit site-specific conditions. To improve load factors he suggests, among other things, provision of electric connections to low income groups free of charge, and even promotion of the use of electric heat for cooking which will also reduce fuelwood consumption.

The Himalaya belt remains deficient in agricultural production. For various reasons, it has been economical to use either electricity or diesel for lift irrigation. **Dharam Singh** advocates the use of hydraulic rams, which are both cost-effective and easy to operate, to lift water for irrigation and drinking. The cost of a hydram unit ranges as high as Rs.150,000 with a water-lifting capacity of 30,000 gallons per day at lift magnification factors of 4 to 30. Equipment costs, however, are only 15 percent of total costs; the remainder is for civil works. The capital costs are around Rs. 20,000 per hectare of land irrigated. Based on his experiences in the Central Himalaya, the author describes the constraints to more widespread diffusion of this technology.

Factors that have limited the adoption of community-sized biogas plants in the hills include rocky soils, low temperatures, low livestock-person ratios, unavailability of land and water, and the social factors. In fact, only two large biogas plants are functioning in hill districts, these being in institutions. However, the conditions in valleys might not be so adverse. **Sushil C. Agrawal** suggests that the best returns from such systems are obtained when biogas is used for operating village-level industries and that these systems can best be managed by outside agencies. He cautions against premature transplantation of any technology in rural areas.

Energy and People

Based on extensive field experience, **Varun Vidyarthi** recounts factors that constrain or contribute to useful participation in rural energy programs. Villagers tend to be more skeptical about ventures which are based upon the successful organization of the villagers themselves. Other factors that might hinder participation include financial risk and involvement of the outside agency with the existing power structure in the village. For outside agencies this implies considerable involvement of time and resources in working at the village level, to develop local capabilities to ensure that sustained benefits reach the intended target groups. Eventually, the programs need to be managed by the participants themselves, but in the interim period it might be desirable to work through voluntary non-governmental agencies which have the desirable orientation, flexibility, and capability to match current macroconcern to local development requirements.

Padma Vasudevan and **Santosh** describe the various hardships faced by women in energy-related activities in the Himalaya. The out-migration of males to the plains for jobs imposes on women a number of duties that might otherwise be shared. Cooking, fuel collection, and water fetching take the major portion of their time and energy. Child care, agricultural tasks, and animal husbandry also make demands, leaving little time for leisure or remunerative activities. Harsh climate and difficult terrain make their work all the more arduous. Economic status, cultural beliefs, traditional definitions of gender and caste roles, and the degree to which the environment is eroded are some of the major factors influencing the lives of women.

Summarizing surveys conducted in this area, the authors find that great variations exist between households and between villages regarding the fuelwood crisis and perceptions of priority problems. The authors make a plea for introduction of technologies to reduce women's drudgery, and providing home-based employment with the necessary marketing infrastructure.

R. K. Pachauri hypothesizes that a progressively worsening cycle of effects has been initiated by energy scarcity. The increase in time allocated for collection of fuels results in decrease in the production of wage goods and other market activities. With examples from other areas, he shows that macro-economic studies grossly underestimated the non-farm employment provided by secondary forest activities, and that the brunt of curtailment due to deforestation is borne by women. With lower earnings, there is a reduction in household calorie intake which disproportionately affects housewives, who suffer further reduction in the time they are able to spend on productive activities. As a way out of this cycle, the author suggests enhanced availability of renewable energy devices such as biogas, improved stoves, small hydro and solar heating. Since the introduction of these technologies would require the establishment of necessary manufacturing industries and the development of skills to maintain these devices, tremendous employment potential would be generated if this were undertaken along with steps to modernize agriculture.

Regional Energy Status

The four papers in the next section survey the energy situation from a regional perspective. **Manzoor Alam** and **Majid Hussain** describe the physiography of Jammu and Kashmir, and note the extremes in weather condition which make consumption of various fuels in winter twice that of summer. Hydel generation is lowest in the winter, exactly when demand is highest. This has led to excessive reliance on fuelwood as an energy source; about 80 percent of the energy consumed in the state is from firewood. The average per capita consumption is 3.8 quintals per annum of which 1.6 quintals are twigs and branches. The consumption is higher in rural areas than in urban areas, reflecting both the easier availability and possibly the lower efficiency of end use. The urban areas consume more electricity, kerosene, and LPG. The supply of electricity is far short of demand, which the authors claim is retarding the industrial growth and development of the state. Hence, they recommend speedier development of hydro projects and of non-conventional energy sources which would also reduce pressure on forest and lessen ecological degradation.

Using satellite imagery data, **D. D. Pant** and **S. P. Singh** have estimated the land-use pattern in the Central Himalaya; about 22 percent is snowbound, agriculture takes up 14 percent, reasonable forests exist on 20 percent, whereas degraded lands and forests occupy close to 36 percent. Urban areas and grasslands make up the rest. The single major problem they see in this region is the need to revive the forest cover. They feel this can best be done by the replacement of the present crop system as practiced in the hills by a tree-farm system. Looking at a system that includes both the plains and the mountains, they assign a protective role to the mountains and a productive role to the plains, which would take care of the food needs of the hill people. By reducing the biotic stress on existing forests, a tree-farm system would aid in the recovery of even oak forests, which in the middle elevation belt would be rapid. The authors also assess the potential of several renewable energy sources in reducing the pressure on forests and find wind energy and microhydel particularly promising.

Giving details of topography, climate, and population changes in the northeast region, **T. Mathew** sets the stage for descriptions of energy use patterns in the agriculture, industry, and transport sectors. Both the dominance of the use of firewood for domestic energy and the practice of shifting agriculture are leading to deforestation. There is the need for afforestation with fast-growing species. The potential for solar energy seems limited because of extensive cloud cover on most days of the year, but the use of coal in the domestic sector is expected to increase. The region has enormous hydel potential on the tributaries of the Brahmaputra and the Barak, but the author cautions against their rapid development as the region is prone to earthquakes and landslides. Development of microhydel seems to be more economical and has potential to provide power to villages in the shortest amount of time. Besides its use in agriculture, rural electrification holds much promise for improving the quality of life and the promotion of cottage industries and artisan trades.

Nowhere is the nexus between energy and environment as evident as in the tribal societies of the northeast. **P. S. Ramakrishnan**, through extensive research, has found much merit in the shifting agriculture practiced there; it is between 25 and 500 times more energy efficient than modern agriculture and meets the diverse needs of the farmer for cereals, vegetables, tubers, and fibres. Mixed cropping provides an insurance against failure of some crops. The economic return from a 10-year cycle is found to be equal to that from terraced cultivation with modern inputs. However, the life of terraces in the region is only 6 to 8 years on account of heavy rains, whereas shifting cultivation with a 10-year cycle could be maintained indefinitely. Unfortunately, population pressures have shortened the cycle to 4 or 5 years, making it both ecologically and economically non-viable. As a way of reducing pressure on the land to allow more efficient, longer cycles, the author recommends confining cereal cultivation to the valleys, encouraging horticulture and plantation crops on the slopes, and animal husbandry. Only a revegetation strategy could correct the current distortions in tribal societal function.

Energy Planning

J. P. Painuly has scrutinized the existing microstudies and macrostudies on energy consumption patterns in the hill districts of northern India. Microstudies reveal variations in consumption levels and macrostudies reveal that the consumption of domestic energy is between 25 and 70 percent greater in the hills than the rest of the country. The per capita consumption of firewood (obtained at "zero" private cost) is twice the national average, whereas consumption of coal, electricity, LPG, and kerosene are all below the national average. The use of dung for cooking increases moving towards the plains from the hills.

The author projects an increase in total fuel requirements (over 1981 levels) by 41 percent in 1991 and by 128 percent in 2001. If the ABE (Advisory Board on Energy)-recommended per capita consumption of 680 kcal per day per household is to be attained, a threefold increase in present levels would be required. The author presents various options. To increase fuelwood supply is imperative, while substantial increases in the provision of biogas, LPG, electricity, and coal will prove difficult. The efficiency of device end use will have to be improved. A three-tier agency for implementation and monitoring of integrated energy programs is recommended.

In any planning exercise, regionalization is important. This involves identifying areas with relative homogeneity of certain characteristics, which differ from adjoining areas. This can be used both to aggregate or disaggregate units, because the output of this exercise is a hierarchical structure. Depending on whether the characteristics are physical or socioeconomic, regionalization is formal or functional. The regional structure needs to be periodically re-evaluated because of changes in man-environment relationships, and in the objectives for which regionalization is attempted.

The Himalaya display enormous diversity. Nowhere else are small natural regions more sharply separated with respect to structure, height, slopes, and vegetation. **L. S. Bhat** surveys past attempts at formal regionalization and notes that a latitudinal division into the Siwaliks, the Lesser Himalaya and the Greater Himalaya, and a longitudinal division into the Western, Central, and Eastern Himalaya, form the first attempt at disaggregation. It is interesting to note that the southern slopes of the Lesser Himalaya which face the valleys are bare, whereas the relatively inaccessible northern slopes are still covered with thick forests. In a separate exercise in functional sub-regionalization, using demographic and socioeconomic variables, the districts of the Indian Himalaya region have been classified into five developmental regions.

As the traditional methods for compiling resource inventories are of little use for inaccessible regions, Landsat Imagery becomes an important source of data. It has the advantages of offering synoptic views, repetitive coverage and uniformity. **P. N. Gupta** analyzes data related to the population, annual demand, and export of fuelwood, and establishes the main priority for resource planning as the reversal and rehabilitation of badly eroded watersheds. He maintains that remote sensing techniques provide the most rapid and cost-effective method in a number of areas related to energy planning, including identification of priority areas for afforestation, biofuel plantations, preliminary selection of locations for microhydel or other renewable energy sources, and assessing the environmental impact of human activities. In many instances, however, these have to be supplemented with aerial photography and cartographic information for detailed planning.

Micro-experiments in rural energy planning are trials conducted in order to study what happens and to gain new knowledge regarding the contribution of rural energy toward meeting development needs. Macro-application deals with activities for the rapid dissemination of rural energy innovations for production, generation of employment, and for the satisfaction of basic needs for the intended beneficiaries. Because of the current gaps in knowledge, the practice of rural energy planning is indeed an experiment. **T. M. Vinod Kumar** develops a system of regionalization, multilevel energy planning, extension, and implementation for the Indian Himalaya. He sees scope for complementary roles to be played by government, voluntary agencies, academic institutions, and people in rural energy planning and implementation activities in the region.

Looking Ahead

The authors in general support energy-centered development planning efforts, especially at the district level. There are 76 districts in 12 states and union territories in the Indian Himalayas. National energy planning efforts are becoming increasingly refined and many institutions have been developed to deal with problems and issues that arise. State governments usually follow in the steps of the central government; however, most implementation takes place at the district level which is conspicuous for its lack of any such institutions. There is a need to start district planning ventures and incorporate energy as a focus.

Many of the problem areas and issues identified by the authors cannot be resolved in view of the lack of data and secondary sources of information. Furthermore, existing surveys are imperfect and need to be periodically updated and revised. These were identified as major constraints for planning and implementation exercises in the region.

Strengthening decentralized energy planning and management in the Indian Himalaya calls for developing methodologies which have been field-tested in the Himalaya, preparing case study materials for training generalist district-level planners and managers, and above all, nurturing the training capacity of potential training institutions. This has been identified as a second phase program for ICIMOD, to be developed as a regional program for the Hindu Kush-Himalaya.