Chapter 3
Review of Policies and Their Implications for RETs in the context of the Indian Himalayas

by Soma Dutta [1]

3.1 INTRODUCTION

India, with its population of about 900 million people, is a supply-constrained economy whose environmental resources are deteriorating at an alarming rate. Traditional biomass fuels (about 250 million tonnes of biomass is consumed every year) provide about one third of the total energy needs and over three fourths of all household energy. Coal, petroleum products, and electricity are the other important fuels. Among other constraints, lack of financial resources has led to inadequate growth in the energy sector, this in turn leading to shortages and shortfalls in all sectors, impeding economic and social growth.

The fragile ecology of the Himalayan belt is probably the worst hit by this ongoing environmental degradation. The people inhabiting the Himalayan region have traditionally had a very concrete relationship with their natural environs, depending on it for most of their subsistence needs, including fuel. In the absence of alternatives, such as fossil fuels, and given their low purchasing power, the people of the Himalayan region continue to depend predominantly on biomass-based fuels. This has led to a reduction in the supply of biomass fuels, meaning that the women have to walk further to collect fuelwood; inferior fuels like animal dung, bushes, weeds, twigs, and roots have to be used; or, in the worst circumstances, wood has to be purchased.

Renewable energy technologies are considered extremely suitable for hilly areas because of features like the decentralized and self-contained nature of operations and the reliance on locally available, non-depleting energy sources. Decentralized renewable energy systems are considered to be highly suitable, especially for off-grid electrification of villages in remote and inaccessible areas where transmission of grid power has been found to be difficult and uneconomical. Though these programmes have been in operation for well over a decade now, it is felt that they have not been able to make a significant impact on the lives of the people, especially considering the magnitude of the existing fuel crisis.

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3.2 Government Initiatives in the Energy Sector

In India, the key initiatives to deliver energy to the masses include the supply of electricity (for lighting, electrical appliances, and irrigation in the rural areas) and distribution of domestic cooking fuels like kerosene and (LPG) at subsidised prices. It should be mentioned that the majority of transactions in biomass, which accounts for about 40 per cent of the primary energy consumption in the country (Ravindranath and Hall 1995), continue to remain outside government control. In the energy sector, initially the major thrust was fuel substitution, namely supplying kerosene through the Public Distribution System (PDS) and power through rural electrification. Over the years, a number of afforestation schemes, such as wastelands' development and social forestry, have also been promoted for augmenting the supply of fuelwood. And finally, renewable energy programmes, including biogas, improved cooking stoves, and solar photovoltaic applications, have been implemented.

3.2.1 The Rural Electrification Programme

This programme is being implemented by the Rural Electrification Corporation (REC) and aims at supplying electricity to all villages. By the end of 1993-94, more than 85 per cent of the 580,000 villages in the country were reported to have been electrified and over 10 million pumps energised (CEA 1996). While this has been an impressive achievement, the number of households having electricity connections is still quite low, only about 30 per cent (Gupta 1997).

One of the important reasons for this is the unaffordability for the majority of people who could otherwise avail themselves of the benefit. The quality of supply has not been consistent either, because of poor loads and long distance transmission and distribution[2]. The energisation of pump sets for irrigation has gone on at a brisk pace, exceeding 10 million out of a total estimated potential of 14.5 million pump sets, but there are still a large number waiting for electricity connections. But an even more serious problem in this sector is the heavy subsidy for electricity given to farmers (in most states, the tariff is negligible — not more than half a rupee per unit). In many cases, the bill collection system, due to the diffused nature of the sector, is expensive and cumbersome. Given the fact that the tariff is extremely low, electricity is consumed in an inefficient and wasteful manner. Because of this, many state electricity boards (SEBs) have been incurring huge losses. Till March 1992, the cumulative loss of SEBs was IRs 41.2 billion (TERI 1996d). Also, the price of power for agriculture has become a major political issue, with middle-income and rich farmers representing a powerful lobby opposing any move to rationalise the pricing structure.

2 T & D losses due to technical reasons, pilferage, etc are estimated to be 23 per cent of the total power generation in India (TERI 1996d).

An important issue in the rural electrification programme is that, so far, rural electrification has meant extension of the conventional grid and nothing else. There has been no provision for decentralized power generation and distribution. Because of this, remote and inaccessible villages in several parts of the country, where grid extension is neither logistically nor economically viable, have not been able to benefit from rural electrification. It is estimated that about 87,000 villages are still in this category, and a majority of them are not likely to have grid electricity ever. A large proportion of these are in the Hindu Kush-Himalayan (HKH) region.

3.2.2 Supply of Commercial Fuels

Kerosene: Kerosene is being promoted as a subsidised fuel for the poor, the main distribution channel being the PDS. In India, kerosene is a deficit product, with 40 per cent of the requirements being met by imports. During 1994-95, the total consumption of kerosene in the country was about 8.9 million tonnes. Though field-level data on actual use in different sectors are not available, it is estimated that 60 per cent of it is consumed in the rural areas (CMIE 1996), primarily for lighting. According to the 1991 census, 7.2 per cent of households in the country used kerosene as a fuel for cooking. However, while 23.6 per cent of urban households use kerosene for cooking, only 1.3 per cent of the rural households do so (CMIE 1996).

Liquefied Petroleum Gas (LPG): Nearly 85 per cent of the total LPG in the country is consumed as cooking fuel in the domestic sector (CMIE 1996). Between 1980 and 1994, the demand for LPG grew at a rate of 7.5 per cent per year. The primary reasons for this high demand are its popularity as a cooking fuel and the existing subsidy on the fuel (Box 3.1). However, in spite of active promotion by the government, the 1991 census estimated that only 7.94 per cent of households (excluding Jammu and Kashmir) used gas for cooking.

An important issue in the use of LPG in India is that so far the penetration of LPG as a cooking fuel has been mainly in towns and cities rather than villages. Of all urban households in the country, 26.9 per cent use LPG, while only 1.2 per cent of the rural households use this facility (CMIE 1996).

3.2.3 Afforestation for Increasing Fuelwood Availability

A participatory approach to forest management in the form of social forestry (SF) was introduced in the 1970s with the objective of meeting the food, fodder, and fuelwood needs of the communities. During the seventies and eighties, several social forestry experiments were undertaken, significant among these being the Arabari in West Bengal and Sukhomajri in the Shivalik ranges. In 1990, the government of India issued policy instructions to all states to support the participation of local communities and NGOs in the management and conservation of forests.

Box 3.1: Subsidies on Kerosene and LPG: Who Are the Beneficiaries?

The primary issue in the supply of fuels like kerosene and LPG is that of subsidies. Initially, LPG was subsidised for the domestic sector with a view to promoting it as a cooking fuel. However, this has created an ever-growing demand in the urban areas with which the indigenous supply is unable to cope. Though imports of the two petroleum products have increased substantially over the past few years, the actual consumption of these fuels by consumers is greatly constrained by availability. Consumers often have to wait for a long time for LPG connections. As of 1 January 1995, there were 11.4 million customers on the waiting list (CMIE 1996). Also, the continued rationing of kerosene for rural and urban households and the problems experienced in getting even these rationed amounts reflect the restricted availability of the fuels.

Similarly, in the case of kerosene, the motive behind giving subsidies was to provide a clean, cheap, and efficient fuel for the low-income households in rural and urban areas. However, available information indicates that large quantities are pilfered for alternative uses in urban areas, e.g., to adulterate gasoline. As a result, shortages and non-availability are common in the Fair Price Shops, and people often have to buy from the open market, paying a much higher price than that fixed by the government.

The programme operates through forest committees (FC) at the village level and village forest workers (VFW). However, except for a few cases, social forestry programmes have suffered from restricted people's participation and the indifference of local communities. Typically, the management tasks of selecting species, distributing land, marketing produce, etc are looked after by the Forest Department, while the involvement of the people is restricted to the provision of hired labour for planting activities and cooperation in protecting the trees (Foley and Bernard 1984). Further, the afforestation of community lands has led to the curbing of the customary rights of the poor on these degraded lands to graze livestock and collect fuel, fodder, and other non-timber produce (TERI 1996c; Khan and Hasan 1995).

Micro-level studies have indicated that social forestry projects have done little to improve fuelwood supplies for the rural poor (Saxena, undated). It has been observed that wood produced in community forestry projects is rarely used by the rural people for fuelwood. The species' composition of social forestry plantations shows that exotic hybrids of *Eucalyptus* and *Acacia auriculiformis* together formed 80 per cent of the mixed plantations at the national level (Ravindranath and Hall 1995). Eucalyptus alone formed 30 per cent of the trees planted under community forestry programmes, and 71 per cent of farm forestry programmes. As a direct consequence, a large proportion of this wood gets sold in the markets and is not used for subsistence needs.

Farm forestry, which involves planting of trees on farmlands, has been more successful, in terms of numbers of trees surviving. It was hoped that, under this programme, the farmers would grow trees for their subsistence needs. However, trees were planted more for sale as poles or pulpwood rather than for fuelwood. The farm forestry programme is unlikely to benefit those with little or no land, whereas afforestation on common lands can be made to generate substantial benefits for these marginal classes of society. It has already been seen that farm forestry has helped the larger farmers to maximise economic returns from the land.

3.3 Renewable Energy Development in India

3.3.1 Development of Renewable Energy Policy

The first step in the promotion of renewables in India was the formation of CASE (Commission for Alternative Energy Sources) in 1981. The renewable energy programme started in the early eighties, with the setting up of the Department of Non-conventional Energy Sources (DNES) in 1982. In the early 70s, the Department of Science and Technology (DST) looked after solar and wind programmes, while the agriculture and rural development ministries were responsible for the biogas and improved *chulha* programmes. However, even these programmes were launched as national programmes only in the eighties. During the eighties, the emphasis of government initiatives in the renewables' field was to develop and demonstrate the technologies. This was done through large-scale demonstration projects and by subsidising the cost of various renewable energy technologies (RETs) to the users. During this decade, large programmes like the National Project on Biogas Development (NPBD), National Programme on Improved *Chulha*(s) (NPIC), and wind energy development programmes were introduced. The programmes were carried out by nodal agencies in each state in a coordinated implementation of individual programmes. Technology support centres or technical back-up units (TBUs) were also set up in universities and other research institutions. This approach helped to create a large manufacturing base and basic infrastructure; however, none of the technologies was successfully commercialised. The poor commercial demand for RETs was largely a result of poor reliability and the lack of remunerative tariffs and consumer-oriented features.

In line with the economic liberalisation of the economy, the nineties saw a shift in the renewable energy policy towards commercialisation and private sector participation. In 1992, 10 years after being set up, DNES was upgraded into a fully fledged ministry, MNES (Ministry of Non-conventional Energy Sources). Since then, the focus of RET promotion in India has shifted towards market development and commercialisation. The private sector has been strongly encouraged to participate in these programmes, especially wind power generation, by means of fiscal incentives and tax holidays. With these changes as the focus for promoting renewables, a large number of programmes to develop, demonstrate, and commercialise technologies has been introduced by the government. The physical progress of the RET programme is given in Table 3.1.

Table 3.1: Physical Progress of RETs in India

Programme	Cumulative Achievement up to March 1996
Family-sized biogas plants	2.4 million
Community biogas plants	1,623
Improved cooking stoves	22.56 million
Solar thermal systems (collector area)	364,354sq.m.
Solar cookers	406,652
PV water pumps	1,820
PV power units	909.3kWp
PV community lights/TV and community facilities	910
PV domestic lighting units	37,359
PV lanterns	81,059
PV street lights	32,870
Wind pumps	3,158
Wind farms	733MW
Mini-micro hydro	129MW
Biomass-based cogeneration	29MW
Biomass combustion-based power	14MW
Biomass gasifiers/stirling engines	29.62MW

Source: Naidu 1997

3.3.2 Review of RET Programmes

The Biogas Programme: Biogas technology promotion was taken up as a national-level programme with the introduction of the NPBD (National Project on Biogas Development) in 1981-82. Traditionally, it has been the largest among all the renewable energy programmes in terms of funding. The NPBD is promoted as a multi-model, multi-agency programme, so as to incorporate regional variations and to encourage NGOs to participate in the implementation of it. To encourage people to adopt the technology, subsidies partially covering the cost of installation are given to the beneficiaries.

Evaluation studies (NCAER 1989 and 1992) indicate that in spite of the large number of plants installed (over 2.4 million so far), the NPBD has not been an unqualified success. The National Council for Applied Economic Research (NCAER) at the national level, in 1992, surveyed 27,000 owners of biogas plants installed during the seventh plan and reported that 66 per cent of the plants were still in use. The reasons for biogas plants becoming dysfunctional can be broadly divided into two categories: structural (construction-related problems) and operational (usage-related problems). Constructional defects result mainly from the problem of availability of quality construction material, and poor-quality masonry skills. On the operational side, the main problem seems to be a shortage of dung required for initial charging. Many areas also suffer from shortage of dung and water for daily feeding. A recent study carried out by the Tata Energy Research Institute (TERI) (Dutta et al. 1997) showed that underfeeding of dung cannot always be attributed to unavailability. In the majority óf households surveyed in the study, the persons responsible for the feeding of the biogas plant, usually women, do not know the quantities of dung and water that are required to be fed daily. Thus lack of user education is also responsible for the improper mixing of dung and water. The main institutional problems relate to procedural delays in loan sanctioning and the disbursement of subsidies and the turnkey fee by government authorities and the lack of repair and maintenance support for the plants installed.

With all the effort that has gone into the programme, the overall impact of biogas has been rather small. Other important aspects are the potential realisation and penetration rate of the technology. As of now, only 18 per cent of the total potential has been realised, and it is estimated that, at the current rate of penetration, it will take more than 50 years to meet the full potential of biogas plants.

Improved Cooking Stoves: The National Programme on Improved *Chulha*(s) (NPIC) was launched by MNES in 1983 with the objectives of reducing the use of fuelwood; eliminating smoke from kitchens; reducing drudgery among women and improving their health; and generating employment in rural areas. The NPIC is the largest programme in terms of number of devices installed. During the initial years, improved cooking stoves for rural families were almost fully subsidised. Currently, the cooking stoves (fixed mud type) cost about IRs 100, 50 per cent of which has to be met by the beneficiary. The programme also offers incentives to self-employed workers (SEWs), implementing agencies and cooperative stores, fair price shops, and so on which serve as sales' outlets.

Like the NPBD, the performance of the NPIC has been mixed. MNES data show that nationally 72 per cent of the stoves are in use (MNES 1996). Other studies show use levels varying from 33 per cent in West Bengal to 79 per cent in Rajasthan (TERI 1989). The largest drawback of the stove programme is the inability to design stoves that suit local conditions. In large measure, this can be linked to the target-oriented approach adopted for dissemination which is not flexible enough to involve the local people, especially women, in stove design. The main reason for people discarding the improved *chulha*(s) was the inability to cook certain kinds of traditional food on them. Sometimes improper construction or usage also led to more fuel being used than saved. Though it is technically a simple device, proper construction and adherence to design specifications are critical to the success of the stove.

Small Hydropower Generation: The small hydro programme in India is aimed at the development of micro, mini, and small hydro schemes of up to a 3MW capacity for power generation and other applications (MNES 1996). Interest in this sector arose when the Central Electricity Authority (CEA) estimated a potential of about 5,000MW for projects of up to a 5MW in capacity in India in the mid-seventies. CEA has now compiled information on over 1,600 sites with a potential of 7,000MW of up to 15MW unit capacity. Currently, rough estimates of MNES place the potential at 10,000MW.

In order to provide a sharper focus to this renewable source of energy, the responsibility of small hydro development of up to 3MW in capacity was transferred in February 1989 from the Department of Power to MNES. Since then, several new initiatives, such as financial assistance for surveys and investigation, detailed project report (DPR) preparation, and interest subsidy schemes on commercial projects, have been announced by MNES to promote small hydro development in India.

Another significant development in the sector has been the UNDP-GEF sponsored project to prepare a master plan for development of small hydropower in the hilly regions, which has been launched with funding of US$ 7.5 million. Under this project, it is planned to set up 20 commercially viable small hydel demonstration projects, upgrade 100 water mills, train personnel, and involve NGOs and local people in promoting the use of electricity for cooking and other purposes. Apart from the UNDP-GEF projects, the main source of funds for small hydel development is the US$ 70 million made available to IREDA through a World Bank loan to set up irrigation canal/dam-based small hydro projects of up to 15MW in capacity.

Solar Photovoltaic Programme: The SPV programme was initiated in 1975 by the Department of Science and Technology. Central Electronics Limited (CEL) was made responsible for product development, while research on solar cells and the development of photovoltaic materials were entrusted to R&D laboratories and academic institutions.

Today, the SPV programme includes a variety of systems for rural, remote area, and industrial applications. Some examples are self-contained village home lighting and street lighting; solar lanterns; water pumping for drinking and irrigation; telecommunications; and the powering of refrigerators for vaccine storage in rural health centres. Of the PV installations, roughly 30 per cent have been on a commercial, non-subsidised basis for telecommunications, signalling, defence, and similar applications (Mathur 1997). Applications in the rural areas have largely been on a demonstration basis. The main problem with the rural applications has been poor reliability, which is often not due to failure of SPV devices, but a result of substandard system components and poor system design.

Solar Thermal Technologies: The Solar Thermal Energy Programme (STEP) was launched in 1984 to promote the use of solar energy for direct thermal applications such as water heating, space heating/cooling, drying, desalination, cooking, water pumping, and power generation.

Water heating: Solar water heating through flat plate collectors has been a popular programme. This programme, which was based on subsidies and demonstration programmes earlier, was restructured in 1993, with the subsidies being replaced by fiscal incentives offered to manufacturers and soft loans to users. As of now, the market for solar water heaters seems to be restricted to commercial users, such as hostels, hospitals, food-processing industries, and dairies. In the rural areas, almost all the installations have been on a demonstration basis for institutions like hostels, schools, government buildings, and health centres.

Solar cooking: The solar cooker programme was launched in 1982-83 with a central subsidy of IRs 150 and IRs 15 as a service charge for each cooker. The subsidy was withdrawn in 1994; however, MNES still provides grants for publicity, promotion, and demonstration to the state nodal agencies. Currently there are around

60 manufacturers of solar cookers in the country. In its present form, the solar cooker is an inconvenient device marred by inflexibility in product features. The key issue in commercialisation is to develop a more user-friendly and convenient device.

Wind Energy Programme: The wind energy programme is aimed at catalysing the commercialisation of wind power generation on a large scale in the country. A wind resource assessment exercise undertaken by MNES, covering 25 states and union territories, has identified a potential of about 20,000MW. The initial efforts in setting up large wind farms in the late 80s were supported by multilateral agencies, particularly DANIDA. Following the initial experience, the demonstration of large wind farms and the offering of attractive incentives by the government, the wind power sector has grown rapidly in India.

Biomass Gasifiers: The gasifier programme in India was launched in 1986 by MNES with a 3.7kW gasifier based on wood gasification, of which over a thousand systems have been installed to date. An evaluation report (Ramana and Sinha 1995) covering approximately 20 per cent of the gasifiers installed by 14 nodal agencies in India found that a little under 45 per cent of the systems were in use, with just 14 per cent being used in the dual-fuel mode. Over 25 per cent of the gasifiers were either used intermittently (about 7 per cent) or not used at all, the gasifier being a probable means of obtaining, by trade-in, a diesel pump set at a cost lower than the market cost (18%). Nearly 57 per cent were never used after commissioning, while a little under five per cent of them were never commissioned, even though the gasifier had been delivered to the site for installation. Even for the gasifiers working, the field level performances are not very well documented.

3.4 Review of Sectoral Policies with Energy Implications

India has pursued a planned approach to development, with the state playing a vital role in the key sectors, such as banking, basic industries, utilities, and infrastructure. Traditionally, the role of the private sector has been strictly regulated. A departure from this approach was the reform package introduced in 1991 which focused on the investment regime, trade policies, the financial sector, taxation, and public enterprises. The main objectives of this package were to reduce the capital intensity of India's growth process, lessen its reliance on the unsustainable expansion of the public sector, and achieve high and sustainable growth of output and employment.

3.4.1 Energy Planning in India

The first initiative in energy policy in India was the promulgation of the Electricity Supply Act, 1948, during the first five-year plan. It stipulated that power generation should be carefully regulated and sold at economic rates. This period also saw a rapid expansion of large hydropower facilities. The second five-year plan emphasised the development of the capital goods and infrastructural industries through direct government investment, which meant a rapid increase in demand for energy, all these industries being energy-intensive. As a result, the primary emphasis of the third five-year plan was power generation. The next two plans concentrated on building up self-reliance in the energy sector, mainly through antagonisation of equipment for power generation.

The potential of renewable energy technologies was articulated for the first time in the sixth five-year plan. In the sixth plan, the main elements of the energy strategy were the accelerated exploitation of domestic conventional energy resources, effective management of oil demand, energy conservation, exploitation of renewable sources of energy (e.g. forestry and biogas), and increasing investment outlays for R&D in emerging energy technologies.

In the seventh five-year plan, a major pòlicy initiative was to increase the use of coal in households and of electricity in the mass transport sector so as to reduce dependence on oil. The plan stressed the development and accelerated use of renewables in both rural and urban areas.

The eighth plan put emphasis on close cooperation and coordination between the different ministries and departments within the energy sector. It envisaged an integrated approach to solve energy problems, especially those being faced by the rural population. As in previous plans, the emphasis was on indigenous efforts and self-reliance in the energy sector (PC 1992).

In both the eighth and the ninth plans, energy conservation has been identified as a major thrust area in the energy sector. In addition, the following have been identified as other important areas for the ninth plan (CMIE 1996): a) speedy completion of ongoing and approved power projects; b) provision of fiscal incentives and concessions for broadening the involvement of the private sector in the hydro sector; c) autonomy for State Electricity Boards (SEBs) so that they may run in a commercially viable manner; d) steps to reduce the cost of supply, transmission, and distribution (T&D) losses; theft of power; and to improve the Plant Load Factor (PLF); e) use of decentralized energy sources for rural electrification; f) augmentation and improvement of T&D facilities and necessary renovation and modernisation of existing generating stations; and g) special emphasis on cogeneration.

3.4.2 Energy Policy

Energy prices in India are administered and, in general, do not reflect costs. Kerosene is heavily subsidised because it caters to the energy needs of lower-income households in rural and urban areas. Electricity tariffs are also lower than the supply costs, leading to inefficiencies in use, especially in the agricultural sector, and mounting losses for the SEBs. Similarly, LPG, which is actually used mainly by urban middle- and upper-class households, is heavily subsidised. Currently, efforts are being made to rationalise the energy tariff structures. Regional tariff commissions have been constituted by the central government to advise the constituent systems in this respect.

It has been said that the singlemost important constraint being faced in the commercialisation and large-scale dissemination of renewables is the prevailing prices of fossil fuels. As these have been artificially pegged at levels which are much lower than their costs, they render the economics of renewables even more unfavourable than is actually the case.

Though renewables have been identified as a priority area since the sixth plan, the funds made available for the sector do not reflect the same. In the eighth five-year plan, out of the total allocation made to the energy sector, the power sector received 69 per cent; petroleum, 21 per cent; and coal, nine per cent. In contrast to this, allocation for the renewables' sector was 0.8 per cent of the total. Unless these distortions are rectified in the future, renewables can at best be expected to play a peripheral role in the energy scenario in the country.

3.4.3 Power Policy

Power generation in India has traditionally been controlled by the government sector. Currently, several ministries are involved in the formulation of power policy, while the overall planning and coordination at the national level is carried out by the Ministry of Power. Power supply for rural electrification, including energisation of pump sets for irrigation, is the exclusive responsibility of the state electricity boards/corporations and undertakings and electricity departments in the state sector (MOP 1997).

Over the years, the demand for electricity has been increasing at a rate outstripping its availability. Electricity consumption grew at an annual compound rate of 10 per cent during the period from 1950 to 1993-94. Across the country, the SEBs have suffered huge financial losses on account of factors such as the low tariffs charged to the agricultural sector, high T&D losses, and low plant load factors of power plants.

Under the new power policy announced in 1991, the private sector can now set up coal, hydel, gas, wind, or solar projects of any capacity. The package of incentives in the policy overcomes legal, administrative, and financial restraints, and so makes private investment attractive (Box 3.2).

In the recent past, some initiatives have also been taken to create remunerative markets for power generation based on non-conventional energy. Guidelines have been sent to the states on general policies and facilities for wheeling/banking/purchase of power from such projects. It has been proposed that the states consider purchasing such power at a minimum rate of IRs 2.25/kWh (Gupta 1995), which would be escalated at a minimum rate of five per cent every year. In accordance with this, several states have come forward and announced attractive policies for private sector power projects based on non-conventional energy sources.

It is important to mention here that, whereas some of the states have taken initiatives in promoting non-conventionally based power generation, currently neither

Box 3.2: Salient Features of Policy Initiative on Private Sector Participation in Power Generation

Flexibility to SEBs - The SEBs have been provided with the flexibility to negotiate power purchase agreements through the August 1994 amendment to tariff notification, which allows for a determination of tariffs in deviation from the norms laid down in the two-part tariff notification, provided the tariff is less than the normative tariff.

Power purchase agreement (PPA) guidelines - The SEBs have been strengthened in their capability for negotiating PPAs with private promoters directly. Detailed principles for negotiating PPAs for the Indian private power projects have been issued to SEBs.

Competitive bidding for awarding projects - It was decided in January 1993 that no private sector project proposal would be considered by CEA if it is not awarded through competitive bidding.

Captive/co-generation plants - The new power policy advocates, *inter alia*, the sale of excess power to the grid according to mutually agreed rates, access to the transmission grid of the state on payment of wheeling charges, third party access to direct sale of power, etc. Co-generation plants now require the approval of the SEB and CEA only if the plant capacity is more than 25MW. It has also been decided to permit the establishment of captive power plants fully dedicated to an industry/ group of industries by an independent power company without having to go through competitive bidding.

the laws and regulations governing power generation and distribution, nor the periodic modifications effected in these laws, explicitly mention or encourage renewable energy sources. Therefore, regulatory measures must be introduced if RETs are to operate on a level playing field. There is also a need to minimise and simplify the various clearances required for the setting up of RET-based power generation facilities.

3.4.4 Industrial Policy

In recent years, the thrust of the industrial policy in India has been to remove barriers to entry and do away with limits on capacity or investment. The new industrial policy introduced in 1991 and encapsulated in the Industrial Policy Statement of July 1991 restricts only 16 industries for compulsory licensing (for social, security, strategic, or environmental reasons).

Within the Ministry of Industries, several initiatives have been taken to look at the environmental (especially pollution-related) aspects of industries. In energy conservation, the government plays a regulatory as well as a promotional role. Regulatory mechanisms include energy audits, the evaluation of new technology and equipment and the enforcement of energy efficiency norms in equipment and technologies. An interdepartmental fuel efficiency committee has worked out fuel efficiency standards for various industrial sectors, including the automobile industry.

3.4.5 Foreign Investment Policy

Several steps have been taken by the government to dismantle the system of controls and regulations, and now foreign investment is permitted in all industries except in a few reserved for strategic or defence reasons since 1991. The present policy for foreign direct investment and foreign technology transfer agreements does not lay down any restriction in regard to the level of foreign equity holdings or the sectors eligible for foreign investment. At the same time, the additional list of industries eligible for automatic approval of up to 51 per cent foreign equity covers a wide range of industries. Industries eligible for higher (74%) foreign equity include those in the infrastructural sector, non-conventional energy, and a few others. It is expected that the procedure of automatic approval by involving fewer regulations and controls will provide an impetus for foreign investment in the priority sectors.

3.4.6 Export and Import Policy

The main feature of the export and import (EXIM) policy, which has been announced for the period from 1 April 1997 to 31 March 2002, is a reduction in restrictions (MOC 1997). It has been declared that capital goods, raw materials, intermediates, components, consumables, spares, parts, accessories, instruments, and other goods will now be eligible for free importation, which means that they may be imported without any restriction, except to the extent that such imports are regulated by the Negative List of Imports. Further, to help improve infrastructural facilities in the power sector, capital goods supplied to power projects, which are carried out under the procedure of competitive bidding, have been made eligible for a refund of terminal excise duty, as also for special import licenses.

Though the industrial policies, by and large, are favourable towards technology transfer and foreign investment, these two options must be treated with caution. It has been said that an important reason for the rapid expansion of wind farm capacity in India has been the favourable import policies (Kishore 1994). Imports are allowed with concessional or no duties on either components or complete machinery. However, through the generous incentives offered, the import policies have also resulted in foreign wind machine manufacturers being subsidised to a great extent, and this creates favourable markets for them with no attendant gains for the domestic industry such as development of production facilities. It is yet to be seen whether this level of wind farm activities will be sustained if the tax and other import concessions are withdrawn.

3.4.7 Environmental Policies

The main regulatory environmental law in India is the Environmental (Protection) Act, 1986. Other laws, such as the Air (Prevention and Control of Pollution) Act, 1981, and Water (Prevention and Control of Pollution) Act, 1974, are more specific in nature and coverage. Among the other natural resources' protection acts are the Forest (Conservation) Act, 1980, and the Wildlife (Protection) Act, 1972, extended to cover biosphere resources, and the Hazardous Wastes (Management and Handling Rules), 1989. The Central Pollution Control Board and the state boards handle the regulatory functions under the air, water, and environment acts. Ambient standards have been set for air, water, noise, industrial emissions, and effluents, and rules have been designed for managing hazardous wastes. There is a mandatory clearance required on environmental aspects of all projects valued over IRs 500 million. A comprehensive project-specific EIA (Environmental Impact Assessment) report based on four-season measurements (one year) is required to be submitted to a committee (the Impact Assessment Agency), formed by the Ministry of Environment and Forests (MoEF), for environmental clearance.

3.4.8 Forestry Policies

The forestry themes for the sixth (1980-85) and the seventh (1985-90) five-year plans were 'development without destruction' and 'forests for survival' respectively. Since 1985, social forestry efforts were supplemented with wastelands' development works under the National Wastelands' Development Board. The new Forest Policy of 1988 places emphasis on meeting the needs of the local communities and on safeguarding their traditional rights and concessions subject to the carrying capacity of the forests. Under this policy, the domestic requirements of fuelwood, fodder, non-timber forest produce, and construction timber required by the tribals and the rural poor are to be regarded as the first charge on forests. It also emphasises creating a massive people's movement and involving them in the conservation and management of forests. Subsequently, another circular was brought out by the MoEF in June 1990, supporting the involvement of village communities and NGOs in the regeneration, management, and protection of degraded forests.

The real issue in forestry laws and legislation in India does not seem to be one of shortages of fuelwood or fodder, but rather one of control, access, and use of forests. Though the acts vest the power of regulation and management in the state, the most degraded forests are under extreme biotic pressure, and often the rights of the people to use such lands are established.

3.4.9 Social Policies

The eighth five-year plan emphasised human development as the core of all developmental efforts. It emphasised involving people in the process of development by empowering them with adequate financial resources, technical and managerial inputs, and decision-making authority. The *Panchayati Raj* institutions have been revitalised through such recent legislation as the 73rd Constitutional Amendment Bill. State governments have also enacted enabling legislation providing for elected bodies at the village, intermediate, and district levels, with adequate representation for weaker sections and women.

The focus on decentralization and the creation of local institutions, which is clearly a focus of the current social polices, is a good opportunity for the energy sector today. It is now being realised that, in the rural energy programmes, the lack of people's participation (especially among women) in project planning, implementation, and monitoring is an important reason for lacklustre performance. The local institutions created under the *Panchayati Raj* Act provide an opportunity and mechanism for involving local communities in the planning and execution of rural and renewable energy programmes.

It is clear that the success of renewables in India will depend not just on policies in the renewables' sector, but also policies in other sectors. It will also depend on the political commitment as well as the finances made available to the sector. Within the energy sector, it is important to create a level playing field between renewable and other sources of energy. In recent years, some initiatives in this direction have been taken in terms of efforts towards rationalisation of energy prices and creation of a conducive atmosphere for power generation based on non-conventional energy. However, the impact of these on renewables is yet to be seen.

3.5 Energy Systems in the Indian Himalayas

The Indian Himalayas cover an area of 542,700sq.km., spanning 11 states in the northern and north-eastern parts of the country. A population of over 31 million inhabits this area, corresponding to an average population density of 57/km^2. This population density is very low compared to the adjoining plains. Arunachal Pradesh is the most thinly populated region, with a population density of 10/km^2. Another important aspect relating to the composition of these populations is that almost all of them, especially in the north-east, have large tribal segments.

More than 82 per cent of the population of the Indian Himalayas lives in villages with a low level of social and physical infrastructure, including communications. This has direct implications for the energy sector, it being both difficult and expensive to supply commercial fuels to these areas, so that people are forced to rely more on biomass-based fuels. The primary occupation of the people is agriculture, with almost 80 per cent of the work force engaged in this activity. Agriculture in hilly areas is largely rainfed and at a subsistence level. As there are very few industries in these areas, migration rates are high.

3.5.1 The Power Situation

The geographical inaccessibility of the region is the main constraint in supplying conventional fuels to it. More than two thirds of the total hydropower potential (84,000MW) exists in the Himalayan region, a considerable part in the north-east (32,000MW). However, in 1990, hydropower generation in the region was just 0.6 per cent of the estimated annual potential. The potential developed in the north-eastern states to date is only 253MW - 0.8 per cent of the total available potential (Singh and Ramana 1997). Currently, a major portion of electricity generation is through thermal power, followed by hydroelectric and diesel-based projects, as reported in Table 3.2.

Table 3.2: Installed Power Generation Capacity from Different Sources in HKH states (MW)

State	Gas	Steam	Diesel	Hydel	Total
Arunachal Pradesh	-	-	15.8	23.5	39.4
Assam	244.5	330	20.7	2	577.2
Himachal Pradesh	-	-	.1	272.1	272.2
Jammu and Kashmir	150	-	6.8	180.3	337.1
Manipur	-	-	9.4	2.6	12
Meghalaya	-	5	2.1	186.7	193.8
Mizoram	-	-	21.1	3.4	24.4
Nagaland	-	-	3.6	3.2	6.8
Sikkim	-	-	2.7	30.9	33.6
Uttar Pradesh	-	4,064	6.2	1,504.5	5,574.7
West Bengal	100	3,356.4	22.4	46.5	3,525.2

Source: TERI 1996a

Partly responsible for this gross underutilisation is the fact that the construction and maintenance of long transmission lines in hilly terrain requires large investments and long gestation periods. The inaccessibility and difficult terrain are also responsible for the high T&D losses resulting in the very high costs of power supply. A look at the average tariffs charged in these states shows that electricity is heavily subsidised by the government (Table 3.3).

3.5.2 Rural Electrification

Most of the remote hilly villages in the region have not been electrified so far. Only the more accessible villages have been connected with grid electricity, which is of poor quality with high voltage fluctuations and long hours (and days) with no supplies at all. In other villages, electricity is supplied by diesel generators for lighting purposes. The following figure shows electrified villages as a percentage of the total number of villages as well as a percentage of 'electrifiable' villages. Thus, it can be seen that 50 per cent of the villages in Meghalaya have been electrified, while and the rest are not electrifiable through grid electricity. Figure 3.1 also shows the percentage of rural households with access to electricity.

Table 3.3: Status of Power Generation

State	Unit Cost of Power Supply (in IRs/kWh) (1994-95)	Average Consumer Tariff (in Irs/kWh) (1994-95)	T&D Losses (including unaccounted commer. losses) (%)
Arunachal Pradesh	-	-	42.0
Assam	2.84	1.59	22.4
Himachal Pradesh	1.11	1.09	18.8
Jammu and Kashmir	2.09	3.30	46.4
Manipur	-	-	23.9
Meghalaya	1.67	0.99	17.9
Mizoram	-	-	31.9
Nagaland	-	-	33.5
Sikkim	-	-	22.6
Uttar Pradesh	1.82	1.23	24.4
West Bengal	1.88	1.46	16.0

Source: TERI 1996d

Figure: 3.1 Rural Electrification of HKH Region

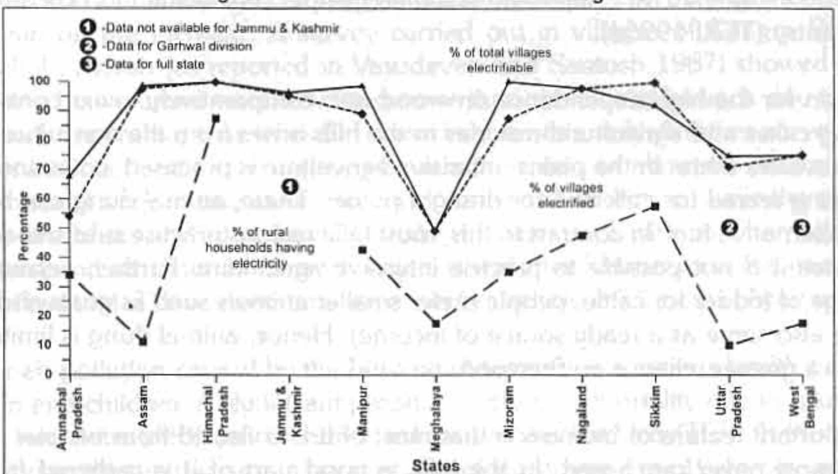


Figure 3.1 Rural Electrification of HKH Region

3.5.3 Domestic Energy Use Patterns

There have been no large-scale energy surveys in the HKH Region. According to NCAER 1981 (a survey on rural energy consumption in the northern states), the annual per capita energy consumed in the hill region was reported to be 251KgCR as compared to 199kgCR for rural northern India. The corresponding per capita figure indicated in NCAER 1985 was 257KgCR for hill areas and 206 for all India (Painuly 1987).

The high dependence on biomass is shown by the census data collected in 1991 (see Tab. 3.4). The table shows that in all Himalayan states, among all fuels, wood

Table 3.4: Distribution of Households by Type of Fuel Used for Cooking (1991 in per cent)

State	Cow dung	Electri-city	Coal/ Coke	Char coal	LPB	Wood	Biogas	Kero-sene	Others
Arunachal Pradesh	0.07	0.22	0.04	0.08	4.40	87.78	0.08	6.35	0.65
Assam	1.45	0.19	0.30	0.47	4.46	87.96	0.09	2.65	2.40
Himachal Pradesh	26.36	0.14	0.44	0.82	12.91	52.10	0.35	5.82	1.00
Manipur	0.28	0.18	0.08	0.44	6.66	85.50	0.39	3.26	3.16
Meghalaya	0.11	0.80	0.26	2.31	3.54	85.35	0.13	6.78	0.58
Mizoram	0.03	0.22	0.02	0.18	8.75	74.83	0.06	14.38	1.50
Nagaland	0.18	0.07	0.06	0.03	2.67	93.11	0.08	3.16	0.64
Sikkim	0.02	0.40	0.34	0.26	2.63	74.47	0.23	21.24	0.42
India (excl. J&K)	15.39	0.31	3.47	0.77	7.94	61.50	0.49	7.16	2.91

Source: CMIE 1996

is the most commonly used. The penetration of commercial fuels, such as electricity, coal, and cooking gas, has been insignificant. Data on the number of LPG domestic users show that the HKH states had less than five per cent of the LPG consumers in the country (TERI 1996d).

A reason for the high dependence on wood and comparatively lower contribution of dung cakes and agricultural residues in the hills arises from the agricultural practises prevalent there. In the plains, intensive agriculture is practised, cows and buffaloes being reared for milk and for draught power. There, animal dung can be used as an alternative fuel. In contrast to this, most hilly regions practise subsistence farming, since it is not possible to practise intensive agriculture. Further, because of a shortage of fodder for cattle, people prefer smaller animals such as goats and sheep (which also serve as a ready source of income). Hence, animal dung is limited and there is a greater reliance on firewood.

An important feature of biomass is that most of it is collected from various sources and almost never purchased. In the hills, a good part of it is gathered from the forests. The NCAER survey (NCAER 1985) showed thatm in rural Meghalaya, almost 70 per cent of the wood used as fuel was being collected from the forests. Because of the cold climate, an important end use of domestic energy is space heating. NCEAR 1985 showed that 92.8 per cent of the households in Himachal Pradesh, 66.7 per cent in Jammu and Kashmir, and 93.9 per cent in Meghalaya were using energy for space heating. At the national level, the percentage of families that use energy for this end use is only 26.8 per cent.

The key features of the energy use pattern in the HKH Region can be summarised thus.

- Energy consumption is dominated by biomass fuels, mainly wood.
- Dependence on biomass resources for fuel is governed by availability (distance from forest).

- Cooking and space heating are the primary end uses of energy.
- Biomass fuels are not usually purchased. They are collected and, for this reason, the cost is in terms of the labour expended to collect it.
- Energy needs are often not the 'felt' needs; there are always more serious and impending one's needing attention.
- Energy systems are closely associated with environmental issues.

3.5.4 Social and Environmental Implications of Energy Use

It is important to note that the heavy reliance on wood has several social and environmental implications. The most serious is probably the impact on women's lives. Women have traditionally shouldered the responsibility for procuring fuelwood for their homes. In the hills, they also participate actively in agricultural operations. In areas where the men migrate seasonally to the plains for employment, the women are left in charge of such operations as well as their home responsibilities, including the collection of fuel and fodder. With forests becoming scarce, the burden on women has been on the increase. A survey carried out in villages of Kangra District in Himachal Pradesh (as reported in Vasudevan and Santosh 1987) showed that 70 per cent of the women were travelling more than six kilometres each day to collect fuelwood, expending four to eight hours daily on this task. Another survey in five villages in Solan and four villages in Shimla indicate that about 60 per cent of the women spent three to four hours per day in fuelwood collection, while the rest spent one to two hours each day. In the Himalayan village of Dwing in Chamoli District, women spend six to ten hours each day and walk five kilometres uphill each day to collect firewood. The average time spent per household is 7.2 hours (Agarwal 1991).

Indoor air pollution caused by the burning of biomass is a serious health hazard for women and children. A significant proportion of infant mortality due to acute respiratory infections (ARI) can be attributed to biomass burning (TERI 1996d). It has been shown that, in the case of traditional cooking stoves, only 10-15 per cent of the heat is used for actual cooking, while the remainder is dissipated in the kitchen in the form of heat and smoke. This problem becomes particularly severe in times of scarcity when households may be forced to switch to inferior and more smoky fuels.

3.6 The RET Experience in the Indian Himalayas

With features such as difficult terrain, inaccessibility, poor infrastructure, the low income levels of the resident population (CMIE 1993), and a large renewable natural resource base (solar, wind, hydro, and biomass resources), the hills provide an ideal niche for the deployment of renewable energy technologies. This has been well recognised by planners, and new and renewable sources of energy (NRSE) in the hilly regions of India have been promoted for the last ten years or so. However, the rate of dissemination in the hill states has been considerably slower than in the rest of the country. Though the figures shown in Table 3.5 appear impressive in

Table 3.5: Installation of Renewable Energy Technologies in the Indian Himalayas

Description	Unit	All India	North-East	H.P.	J. & K.	Sikkim	Total
Family-size biogas Plants	No.	2,367,798	204,293	37,871	1,297	1,606	245,067
Improved cooking stoves	No.	19,611,272	118,556	528,527	256,796	35,965	939,844
Solar thermal systems							
- Domestic type	No.	12,517	18	819	33	21	891
- Industrial type	No.	6,142	151	143	72	26	392
Solar cookers	No.	288,028	1,002	13,349		20	15,373
PV water pumps	No.	463			4		4
PV plants	kWp	N.A.	39				39
PV systems	kWp	3,605	273	39	48	12	372
Windpower	kW	732,600					0
Small and micro-	No.	161	50	13	6	6	75
Hydropower	MW	120	33	9	3	7	52
Biomass gasifiers/ Stirling engines	No.	1,604	10	2	4		16

Note: The north-east region includes Manipur, Meghalaya, Mizoram, Nagaland, Arunachal Pradesh, and Assam; information on Uttarakhand, the Hill Districts of West Bengal and Assam are not included, since only state-level information is available and only a small percentage of the area falls under the HKH region; information on biogas and wind power is as of March 1996; information on improved cooking stoves, PV water pumps, mini- and micro-hydropower and biomass gasifiers is as of April 1995; information on solar thermal systems, solar cookers, and PV systems is as of March 1993.

Source: TERI 1996d; MNES 1996; CMIE 1996

themselves, it can be seen that they form a very small proportion of the total sum in India. The proportion would be even smaller if the devices which are actually being used are considered.

3.6.1 Small Hydropower Projects

There are a large number of rivers, rivulets, and streams existing naturally in the hills which represent an immense energy potential. Current estimates show that close to 10,000MW of energy can be generated for the country from this source. Out of the 84,044MW of potential already identified, the Indian Himalayas accounts for 76 per cent (63,705MW). Among the hill states, the maximum potential for exploiting small-scale hydropower is in Arunachal Pradesh, followed by Himachal Pradesh and Uttar Pradesh. Interestingly, Himachal Pradesh and Uttar Pradesh are also the states that have the highest proportion of electrification among the hill states.

While hill streams have been harnessed for generating electrical power only since the late nineteenth century in India, use of this technology for mechanical power applications has been prevalent for hundreds of years. In hill villages, traditional water mills are used extensively for agro-processing and cottage industry applications. Though the exact number of such water mills is not known, it is estimated that there may be around 200,000 sites in operation today (Kumar 1997).

There are a number of agencies looking after the small hydro sector in the Himalayan states. Though there is no uniformity in the institutional set-up across states, agencies like the Power Department, state electricity boards, and state-level nodal agencies for development of renewables are involved in all the states. The following table lists the various agencies involved in the mini-micro hydel sector and their responsibilities in the HKH states. In some states, a few NGOs are also playing an active role in this sector.

Some evaluations have been carried out by different agencies to assess the performance of existing small hydro systems. Many of these schemes are still under construction, and hence their performance has yet to be seen. An evaluation of RETs installed under the North-eastern Council (NEC) plan in the North-eastern States (TERI 1996b) showed that several systems which were sanctioned in 1989-90 have still not been completed. The time and cost overruns have been mainly due to financial constraints and inadequate management (TERI 1994a). In the case of non-operational plants, the primary reasons for their shutdown are damage caused by floods during monsoon and damage in components which have never been repaired. Another study which reviewed and documented the status of Mini- Micro-hydropower (MMHP) in India (TERI 1994a) showed that most of the functional plants are operating at sub-optimal capacity (Box 3.3).

Box 3.3: Poor Performance of MMHP in India

Low load factors - As the village-based systems are being used for domestic applications, mainly lighting, the peak load timings are very short. In the absence of industries using this energy, most units remain underloaded for a large part of the day. When the load is below the power generation capacity of the power plant, the power generated is itself reduced by reducing the throughput to the power plant, which means a highly sub-optimal use of energy.

Technical constraints and operational problems - MMHP installations have been facing a number of technical and operational problems, such as:

- silting during the monsoon season, which damages the turbine;
- damage to civil works caused by floods, which occur almost every year; and
- absence of workshop facilities, which makes it time-consuming and expensive to transport the defective components to a workshop for repair.

People's involvement - In most MMHP installations, efforts are not made to involve the users or the local people in the planning, execution, operation, and maintenance of the systems. As a result, when these systems develop some snag or failure, users simply revert to the traditional systems and do not bother to inform the implementing agency about the problem.

Source: TERI 1994a

3.6.2 Improved Cooking stoves

The performance of cooking stoves has been evaluated by several agencies in terms of fuelwood conservation, the reduction or removal of smoke from kitchens, reduction in cooking time, and employment generation. A study conducted by TERI in the Garhwal Hills of Uttar Pradesh (TERI 1992) revealed that 54 per cent of the beneficiaries were using the improved cooking stoves for cooking all their meals, while another 17 per cent used them only during winter, and 17 per cent did not use them at all. The main problems faced by the users were: a) difficulty in cooking preparations such as tea and rotis; b) smallness of the firebox door, which required additional effort in terms of chopping the wood into small pieces; c) frequent choking of the smoke passage; and d) strong winds restricting the smoke exit and resulting in flame coming out of the mouth of the stove.

A more recent study (TERI 1994b) showed that: a) people find it inconvenient to chop wood into small pieces for the improved cooking stoves; and b) users modify the cooking stove according to their requirements (often decreasing the efficiency of the improved models in the process). Another recent study carried out in the North-eastern states by TERI (TERI 1996b) showed that the overall acceptance of the improved, fixed mud cooking stoves has been low. The primary reason for this is the incompatibility between the traditional cooking practises of the people and the features of the models introduced under the NPIC. In the hilly parts of the North-eastern states, the traditional cooking stove performs the multiple functions of cooking, space heating, smoking and drying of food articles and, at times, lighting. The commonly promoted fixed, smokeless models have not been able to address these requirements, and hence have had a limited acceptability. The other significant reason in the area is that, even though the overall biomass resource base is deteriorating rapidly, wood is still abundantly available in most of the North-eastern states. As a result, people do not really feel the need to conserve fuelwood (Singh and Ramana 1997).

3.6.3 Biogas Plants

Micro-level studies and evaluations indicate that in spite of the higher level of subsidies offered in the hills, biogas plants there have not performed satisfactorily. In the North-east, biogas plants have been installed mainly for institutions, not for individuals. Consequently, the 'real' response to the technology is difficult to gauge. An evaluation revealed that in the seven states, 24 per cent of the surveyed plants were found to be in use (TERI 1996b). The main reasons for their not functioning were shortage of dung and lack of maintenance for the installed plants. Further, most plants in the region were installed in the eighties and are of the floating dome- KVIC model type. These have a metal gas holder, which requires regular painting to prevent corrosion. Most KVIC plants were found to be corroded and lying in a state of disrepair at the time of the survey. Out of the 83 KVIC plants surveyed, only 11 were in use.

3.6.4 Solar PV Technology

There are some climatic constraints in promoting solar PV technology in hilly areas. These include the high number of cloudy days and shading caused by surrounding hills. TERI 1996c revealed that nearly 50 per cent of the village-based systems in the North-eastern states are currently non-functional. The main problem with PV systems is that the users are not accountable for the maintenance of the systems, which are heavily subsidised. Users display an indifferent attitude, especially in the case of devices installed for community use, such as street lighting systems, and problems of vandalism and thefts are common. The difficult terrain and poor infrastructure also result in unavailability of spare components, component failure, and lack of trained technicians for the large-scale dissemination of these devices. Notwithstanding the importance of these handicaps, the biggest obstacle to programme dissemination is a lack of training in system maintenance for users. Other common operational problems are batteries discharging, tube lights becoming non-functional, and difficulty in procuring distilled water.

3.6.5 Solar Thermal Systems

The overall performance of solar thermal devices in the hill regions has been mixed. TERI 1996c revealed that, apart from Arunachal Pradesh, the functional performances of the systems installed under the NEC schemes have been less than 50 per cent. The main operational problems faced in the operation of SWHs in the hilly regions are damage caused by rains, hailstorms, and floods; breakage of glass panels; rust formation; degradation of insulation material over time; and pipeline leakages.

3.6.6 Biomass Gasifiers

Biomass gasifiers for electrical applications have not been successful in the hilly regions. In the north-eastern states, wood-based gasifiers have been promoted as demonstration units by the lumber industry and by a few silk reeling units. There are two main reasons for the poor performance of these systems (Singh and Ramana 1997). Firstly, as the gasifiers require wood chopped in small pieces, their operation calls for extra manpower, which increases the cost of operation. Further, as electricity is heavily subsidised (the tariff for the industry is between IRs 2.5 - 3 per unit), the cost of generating electricity with a gasifier works out to more than purchasing it from the SEB. Gasifier-generated power costs roughly IRs 2.37 per unit, without taking into account the cost of investment. Thus, in the present scenario of subsidised tariffs for electricity, gasifiers for power generation remain an unviable option for small industries. Though there have been too few attempts from which to generalise, gasifiers, when used for thermal applications, have worked well.

3.7 The Institutional Framework and a Policy Review of RETs in the Indian Himalayas

3.7.1 The Institutional Framework for the Implementation of RET Programmes

The apex body responsible for the dissemination of RETs in India is the MNES. In the nineties, in line with the rising expectations from renewables, several institutional changes were effected in the institutional framework for the implementation of RET programmes. The most significant among these was the restructuring of the MNES. In July 1993, the MNES was restructured on the basis of the end use of technologies and is now organized into the following groups: a) Rural Energy I, which covers biogas, improved cooking stoves, and biomass programmes; b) Rural Energy II, which is responsible for lighting and water pumping end uses, rural applications for solar thermal technology, and human and animal energy; c) Urban and Industrial Energy, which pertains to domestic energy and process heating; passive architecture; urban, municipal, and industrial wastes; and energy conservation; d) Power, which is responsible for power generation through wind, small hydro, bioenergy, co-generation, and grid-connected solar applications; and e) New Technologies, covering geo-thermal energy, alternative vehicle fuels, ocean energy, and the tidal energy programme. The main advantage of this restructuring was that now each sector consists of integrated programmes to meet the different energy needs.

The main financing agency for renewables in India is the Indian Renewable Energy Development Agency (IREDA) - a separate financial institution set up in 1987 by the MNES to play a key role in implementing renewable energy programmes by offering loans on soft terms to users and manufacturers of the different RETs. A few of the state governments and state electricity boards have also adopted guidelines and policies aimed at promoting renewable energy projects in their states. In addition to funding from the government, IREDA has been successful in getting funds from multilateral and bilateral donor agencies.

Nationalised banks also provide loans directly to users for some RETs. In rural areas, financing biogas plants through banks is quite an established practise. Each state has a designated lead bank which coordinates loan facilities within the state. At the central level, the National Bank for Agriculture and Rural Development (NABARD) is responsible for overall coordination.

The RET programmes in each state are implemented by a number of government and non-government agencies. Typically, NPBD is looked after by the agricultural department or the state agro-industries corporation, 'NPIC by the Rural Development or *Panchayati Raj* department; solar, thermal, and SPV programmes by the state energy development agency', and small hydro by the power department or the state electricity board. In most states, these government departments are also looking after many other programmes and projects. For example, the rural development department in most states is responsible for all activities pertaining to rural development such as health and sanitation, rural roads, minor and medium irrigation, and soil and water conservation.

3.7.2 Review of RET Policies in the HKH Region

For all the RETs, special provisions in the form of additional incentives and subsidies have been designed for the hill states, in view of the inaccessibility and remoteness of these areas as well as the low purchasing power of the people inhabiting them. In this section, these policies have been reviewed and analysed for each of the RETs.

Small Hydropower: For small hydropower generation, the MNES provides subsidies and IREDA provides soft loans for construction of small hydro projects. Under its capital subsidy scheme, the ministry has so far supported 90 projects aggregating to a capacity of around 104MW in 17 states (Garg 1997). Under the subsidy scheme, the MNES provides a maximum capitalised interest subsidy of IRs 11.2 million perMW for SHP projects of up to 3MW capacity in the hills. For projects of up to 100kW in capacity, a capital subsidy of up to IRs 15,000 per kW is also given. Currently, the ministry also provides 100 per cent support for detailed survey and investigation and 50 per cent support for detailed project report preparation, subject to certain benchmarks. Several state governments have also allocated funds for small hydropower development.

A scheme for decentralized power supply through lightweight portable micro-hydel sets of up to 15kW in capacity was introduced in the eighth plan. Fifty demonstration sets have been distributed to seven states for installation and evaluation. The ministry has met the costs of the sets, while local bodies are supposed to incur the expenditure for civil works and transmission links. Up to September 1996, 15 sets had been installed in West Bengal (WB), Uttar Pradesh (UP), Jammu and Kashmir (J&K), and Himachal Pradesh.

The ministry has been encouraging state governments to develop and announce incentive packages to attract private sector participation in the implementation, operation, and maintenance of small hydro schemes. As of now, amongst the Himalayan states, such initiatives have been taken only by UP and Himachal Pradesh. The key features of these incentive packages (which mainly provide for the wheeling and banking of power generated, a floor level buy-back rate for generated electricity, and third party sales of the generated electricity) are shown in Table 3.6.

In spite of these efforts by the states to promote small-scale hydropower through special provisions to attract the private sector, the level of development has not met expectations, either in terms of the scale of intervention or the performance of installed devices. Only Uttar Pradesh and Himachal Pradesh have framed policies to attract private sector participation. Even in Himachal Pradesh (HP), the entrepreneurs who have applied for developing small hydropower plants are from outside

Table 3.6: Incentives Offered by State Governments to the Private Sector for Small Hydropower Generation

Items	Uttar Pradesh	Himachal Pradesh
Rates/Charges for:		
Wheeling	2 per cent of energy generated 2.5 per cent for sale to third party	2 per cent of energy generated
Banking	Allowed for one year	Allowed with additional charges
Buy back by SEB	IRs. 2.25/kWh	IRs. 2.25/kWh
Third party sale	Allowed	Allowed
Incentives:		
Concessions	-	No sales tax on power generation and transmission equipment and building material. Income tax exemption for 5 years and 30 per cent exemption for 5 years thereafter.
Royalty on water	10 per cent of electricity generated	No royalty up to 1MW capacity for the first five years and 10 per cent thereafter; 10 per cent royalty on installed capacity from 1MW to 3MW.
Single window agency	Non-conventional Energy Development Agency (< 3MW); UP Laghu Jal Vidyut Nigam (>3MW)	HP state electricity board/HIM-URJA

Source: Compiled from MNES 1996 and TERI 1996a

the state (TERI 1996a). The incentives and facilities offered by the state governments are usually not clear, nor is there any transparency. As a result of this, private investors are not fully convinced of suitable returns from the venture. Also, only UP and J&K have created a separate agency for the installation of small- mini- micro-hydropower projects.

Improved Cooking Stoves: The MNES provides certain additional incentives for the adoption of improved cooking stoves in the hills, compared to the plains. All beneficiaries are eligible to receive 50 per cent of the cost of a portable *chulha* (in the plains this level of subsidy is offered only to the Scheduled Caste and Scheduled Tribe categories). In addition, high altitude metallic *chulha*(s) are also promoted in the hills; and for these 50 per cent of the cost is subsidised.

There is a number of implementation- and programme-related factors responsible for the limited acceptance of improved cooking stoves in the hills. Some of the important issues are a) incompatibility of stove design with traditional lifestyles and cooking practices; b) inadequate R&D on suitable models; and c) unsuitable mode of programme dissemination.

Biogas Plants: The central government subsidy given to beneficiaries in the hills is almost double the amount given in the plains (for a $2m^3$ plant, IRs 3,200 compared to IRs 1,800 in the plains). Most of the hill state governments also give additional subsidies for biogas plant installation. A state like Arunachal Pradesh (AP) provides a 90 per cent subsidy on biogas plants, while Manipur gives IRs 1,500 per biogas plant in addition to the central subsidy.

There are some basic problems with respect to the operation of biogas plants in the hills.

Dung Availability - As the cattle are left to graze in the open, the availability of dung for the biogas plants is poor.

Water Shortage - A $2m^3$ capacity biogas plant requires 50 litres of water every day. Water is, however, fast becoming a scarce commodity in most hill areas (CSE 1997). As a result, the women are forced to spend more time and effort fetching water. A village-level study showed that 57 per cent of the women in Almora spend more than three hours daily fetching water for their homes (Vasudevan and Santosh 1987). Thus water scarcity is a serious issue in the adoption and success of the technology.

Ambient Temperature - The existing biogas plant models function optimally at an ambient temperature of around 35°C. At low temperatures, bacterial activity slows down, resulting in a substantial decrease in gas generation, and stops completely below 10°C. As the ambient temperature in winter falls to significantly low levels in the hills, gas output goes down.

The main policy issue in the case of biogas plants for the hilly regions is that of suitability of existing designs and models for the specific climatic conditions of the hills. The first major initiative in developing models suited for the hills was the development and inclusion of the Swastik model biogas plant in the MNES's approved list for the NPBD.

Solar PV Technology - As with other renewables, the state provides subsidies for PV devices. Arunachal Pradesh (AP), for instance, gives free solar lanterns to small villages (less than 50 households). All beneficiaries in the hilly areas also get a subsidy of 50 per cent of the cost of all systems under the socially oriented schemes of the MNES (MNES 1996). At present, a solar lantern programme is also being supported by GEF, which is executed by IREDA.

The primary issue in the promotion of solar PV devices in India is the cost factor. Power generation through PV is an expensive proposition. At the present rates, a PV system for electricity generation costs about IRs 400/Wp, or IRs 400 million per MW, which is roughly 10 times the investment cost for a thermal power plant (Kishore 1997). The energy costs are in the range of IRs 25-30/kWh. A comparison of the cost of Indian PV modules with the international prices shows that it is unlikely that PV electricity will become cheaper in the near future in India.

It has been said that SPV electricity makes economic sense for very remote villages where the cost of extending the grid to the location is higher than that of installing an SPV system. But this is true only of very small loads. In reality, once SPV lighting is provided to a village, the demand for other amenities, such as fans and heaters, is likely to increase. The SPV system is unlikely to be able to meet the increased demand, and the grid may after all have to be extended, thus defeating the purpose of the SPV system.

Solar Thermal Systems: Solar thermal devices have been promoted primarily as demonstration programmes or at such institutions as government hospitals and primary health centres. Community solar water heaters (SWHs), like other community use devices, face the problem of indifference on the part of users, including lack of regular maintenance. Some states, such as Assam, are now developing management systems whereby the users will be required to pay a monthly service charge to be used for repair and maintenance of the systems.

3.7.3 Learning from RET Experiences

The experience of RETs in the hill states shows that there are several lacunae in the existing set-up which hinder their performance. These are related to areas like policy and planning, implementation procedures, and the institutional framework. There are technology-specific barriers as well as ones common to all programmes and technologies. The basic constraints on the diffusion of technologies in hill regions are related to geographical and physical infrastructure. The low levels of income and awareness among the population hinder the adoption of technologies and necessitate subsidising their cost, at least for the majority of the target group. Additionally, the difficult terrain and working conditions, along with the poor physical infrastructure, make it extremely difficult to put in place repair and maintenance networks, and this adversely affects the reliability and performance of the installed devices.

Cost and Financing Barriers

High Cost of Renewables - Currently, the majority of RETs are not defensible purely on economic grounds. As compared to conventional fuels, they cost more, in terms of both initial investment requirements and in terms of cost of energy (Ramana and Sinha 1995).

Pricing of Commercial Fuels - In the case of renewables in India, the high subsidies on commercial fuels such as electricity and diesel (the subsidies in hill states are higher still) are largely responsible for the unfavourable market economics bearing on RETs.

Policy and Planning Barriers

Mismatch between Technologies and Local Needs and Preferences - In many of the programmes, little attention has been paid to the issue of matching technologies with people's needs. Many a time, technologies have been promoted with the expectation that the people will modify their lifestyles in accordance with the technology.

Dissemination Approach - Most rural and renewable energy programmes have been run as centralized target-oriented programmes exclusive of other programmes (TERI 1996c). However, experience suggests that, for determining the feasibility or adaptability of a particular technology or programme, it is important to consider the priorities of the intended target group and bring about an integration of various development programmes (TERI 1992) as required.

Supply-side Planning - The promotion of renewables in the hills has largely meant making RET devices available to consumers. The issue of demand-side management has not been given adequate attention. The traditional supply-oriented approach to meeting the energy needs of the people has had several other drawbacks: not enough attention has been paid to social, cultural, family, and religious practises; efficient technologies have been introduced in areas where traditional and 'preferred' fuels like wood are available abundantly and free of cost; the felt needs of the people have not been taken into account; and the identification of target groups for information dissemination and training has been faulty (Rijal 1997).

Failure to Incorporate the Interlinkages between Components of Livelihood Systems - A distinguishing feature of mountain economies is that the various sub-systems of the natural resource base, such as the agricultural economy, fuel, fodder, cattle rearing, and water, are closely interlinked. This interdependence manifests itself in many ways and has implications for both energy and non-energy sectors. The current policies do not take into account this vital aspect of mountain ecology.

Absence of a Reliable Database - As the potential of renewables is extremely site-specific, especially in mountainous regions, weather data should be recorded very closely over a period of time at a series of weather stations. For technologies like solar, wind, and hydropower, adequate and accurate basic data have not been collected so far. At times, decisions are based on incomplete data, and this has led to poor system performance.

Institutional Constraints

Multiplicity of Agencies and Duplication of Effort - Most of the hill states have different government departments implementing renewable energy programmes.

As all these departments have their own programmes, renewables are often accorded lower priority. Further, as most of the implementing agencies are already understaffed and accessibility in hilly areas is difficult, it becomes difficult for the implementing agencies to provide adequate maintenance support for the installed devices.

Lack of Monitoring Mechanisms - Experience has shown that the monitoring mechanisms for renewable energy programmes are often ineffective (TERI 1994b, TERI 1996b). This is primarily because of a lack of accountability and proper reporting mechanisms in the programmes.

Low Level of Participation of NGOs and Local Bodies - Except for the NPBD and NPIC, the participation of local institutions and NGOs in RET promotion has been minimal. Experience has shown that NGOs can contribute significantly to certain stages of the implementation process such as the identification of appropriate interventions, the motivation to adopt the technology, and the repair and maintenance of the installed systems. There are a large number of NGOs working in the HKH Region; however, till now, their strengths have not been harnessed effectively.

<u>Technological Barriers</u>

Lack of Local Manufacturing Capabilities - Insufficient efforts have been made to develop local manufacturing facilities for the RETs in the hill states. As a result, all the equipment has to be imported from the plains, leading to increase in costs.

Low R&D Investments in RETs - Product development for many of the technologies has not reached the stage at which they can be taken up for large-scale dissemination. R&D has still to come to grips with several climatic and weather-related constraints that these technologies face.

3.7.4 Issues in National RET Policy

There are several issues and constraints that hinder the development of the renewables' sector as a whole. The three most important issues are outlined below.

<u>Economics of RETs</u>

Compared to conventional energy sources, RETs have not been economically viable, because of various technological and other constraints (refer to Table 3.7). The problem is heightened by the fact that the market prices of most fossil fuels are heavily subsidised by the government, creating an imbalance in the overall pricing structure.

Inadequate Budgetary Allocations

The cumulative government expenditure on the renewable energy sector between 1980 and 1992 was in the range of IRs 12 billion (Mathur 1997). This compared poorly with the power sector, where the investment was over IRs 800 billion. In the eighth plan (1992-97), the allocation to renewables was less than one per cent of the total funds allocated to the energy sector.

Table 3.7: Cost of Energy from Various Technologies

Technology	Unit	Capital cost (IRs/Unit)	Cost of energy (IRs/kWh)
Centralised Power Generation			
- Wind farm	kW	30,000	3.15
- Small hydro	kW	30,000	1.65
- Coal thermal[1]	kW	25,000	
300km	ton	413	1.13
800km	ton	543	1.26
1,000km	ton	595	1.31
Decentralized Power Generation			
- Solar photovoltaic	kWp	220,000	20.69
- Gasifier			
- Agro-waste	kW	10,500	1.23
- Wood-waste	kW	7,500	1.49
- Biogas dual-fuel	kW	9,500	0.42
Grid Connections[2]			
1km		43,000	1.31
5km		215,000	1.85
10km		430,000	2.52
15km		645,000	3.19

1 Coal cost with transport cost @ IRs 0.26/t-km and marginal pithead cost of IRs 335/t; PLF 55 per cent; coal consumption 0.7kg/kWh.

2 Contribution of distribution line for different distances from 33kV grid.

Source:Ramana and Sinha 1995

Inadequate Emphasis on R&D

R&D efforts in renewables in India have been lacking in several respects. The R&D expenditure of the MNES is in the range of five per cent of the total annual spending. In the past, most of the research expenditure has been used for training, resource assessment, evaluation, and demonstrations, and a very small proportion for basic technology development or improvement.

In the rural context, the main shortcoming of the research programme has been the inability to develop models and designs specifically suited for mountain areas. In this context, it may be mentioned that between 1976 and 1993 more than half the total expenditure on research in renewables was spent on wind energy (54%), followed by solar photovoltaic (10%), while biogas and improved cooking stoves, which are the largest programmes, received only nine per cent of the total allocation (TERI 1994b). Finally, no specific efforts have been made to collate the research findings and consolidate the efforts of the different institutions.

3.7.5 Future Directions in Renewable Energy Development

Some changes are taking place in renewable energy policies at national level. The MNES has chalked out an ambitious programme for the expansion of the renewables sector. Currently, the ministry is in the process of formulating a comprehensive renewable energy policy which will cover government, industry, research institutions, non-government organizations, local communities, and users (Gupta 1997). The main thrust of this policy is to create awareness, foster development and demonstration, accelerate commercialisation, and help to create an effective institutional structure and delivery mechanism for planning, development, installation, operation, maintenance, and repair. The ministry also plans to introduce special legislation to promote renewables.

3.8 Target Areas and Future Directions for Renewable Energy Policy

In the context of the Indian Himalayas, it is clear that a far greater emphasis will have to be placed on renewables if they are to make a meaningful contribution to the existing energy systems. The overall thrust of the policy will have to be on developing low-cost, efficient technologies suited to local conditions.

3.8.1 Recommendations for Specific Technologies

Mini- Micro-hydropower

In the last decade or so, there have been commendable efforts both by the MNES and state governments to develop small-scale hydropower. However, there are still several problem areas which need to be addressed. These are: a) poor loads of mini/ micro hydel power stations; b) operational and technical problems; c) inadequate maintenance support for installed systems; d) accordance of low priority to MMHP projects by the SEBs and state-level power departments; e) slow pace of private sector participation; f) absence of a manufacturing base in the hill states; and g) delays in project execution, leading to time and cost overruns.

National and state policies are needed to come to grips with the above issues. Some initiatives and policy measures that can help in this direction are:

- collection and compilation of basic data and baseline information in a ready-to-use form,
- commissioning of studies on developing strategies for load development,
- setting up of state-level agencies exclusively responsible for developing the small-scale hydropower sector,
- involving NGOs and local institutions in planning, installing, and maintaining at the village level, and
- developing a regional manufacturing base for small hydropower equipment.

Improved Cooking Stoves

Though there are several lacunae in the programme, improved cooking stoves are still the most feasible option existing among various renewables. Some specific recommendations to improve the performance of the programme are as follow.

- R&D to concentrate on developing devices which are efficient and more convenient to use.
- For dissemination, focus attention on specific areas. The best market for improved stoves will be found in areas, generally conurbation areas where there is excessive demand for biomass and people are forced to buy fuel.

Biogas Technology

As of now, none of the existing models, *Deen Bandhu*, KVIC, or Swastik, are really appropriate for dissemination in the hills; for example, KVIC, because of the heavy weight of the gas holder and the deep excavation it needs, and *Deen Bandhu*, because of the difficulty in cutting a spherical foundation for it, which means that the model cannot be constructed in areas with stony strata. The primary focus should be on developing new models suitable for hilly regions, preferably prefabricated ones, so that the involvement of local masons can be minimised.

Solar PV Technology

SPV technology should be used for very specific applications only or for those having a high social value such as storing medicines and drugs in remote primary health centres (PHCs), or for supplying drinking water in a water-scarce area. It is a well-established fact that, given the substantial investment required, these devices will have to be subsidised for the foreseeable future. Experience has shown that setting up local-based repair and maintenance systems can go a long way to improve the programme performance of solar PV technology.

Biomass Gasifiers

The gasifiers' programme for electricity generation is still in the design and development stage, and a reliable and cost-effective technology needs to be developed before it can be taken up for large-scale dissemination.

Solar Thermal Systems

The main problem with the current flat-plate, collector-type solar water heaters (SWHs) is scale formation, leading to blockage of the pipes after a few years. In their present form, SWHs are not suitable for hilly and cold regions, since they cannot be used in sub-zero temperatures. There have been some efforts in this direction by a few NGOs, such as LEDeG in Leh; however, there is still a long way to go to commercialisation and large-scale dissemination.

Solar Cookers

For many hill areas, solar cookers would be ideal, since there is enough sunshine available and the prevalent food habits (preparations mainly involve boiling) are suitable for the use of solar cookers. The main problem with the solar cooker programme has been that it has not reached the right target group of low-income households. It has been purchased and used primarily by high-income groups, for use as a cooking device along with LPG stoves. Also, there is a need to make the appliance more user-friendly and flexible if it is to have a larger market.

Wind Energy

Very few wind energy systems have been installed so far in the hilly states. Most of the HKH Region falls within the low wind speed area (<1.39m/s) (Mani and Mooley 1983). However, there are some pockets in the Northeast where the average wind speed is about 8m/s, and such areas have been found suitable for wind pumps and, to some extent, for aero-generators (TERI 1996b). If wind power is to make a substantial contribution to the hilly regions, more emphasis will have to be placed on basic resource assessment studies and wind mapping in more locations.

Other Areas of Research

In addition to these technologies, there are certain others that are in the development and demonstration stages. These include solar heating of buildings through solar passive architecture, and this has been tried in areas such as Leh. However, none of the projects has gone beyond the demonstration stage yet. Another possible application is the use of greenhouses for the growing of horticultural crops to extend the agricultural year. This technology is already being promoted as part of a government programme in Ladakh, however, applications in other areas have been negligible.

The issues that have not received adequate attention so far are the following.

<u>Applications for Space Heating</u> - In all hill areas, space heating consumes a great deal of energy (NCAER 1985). The traditional devices used for space heating are *bukharis* and open-hearth cooking stoves, which are extremely inefficient (Gadgil 1987).

<u>Efficiency Improvements in Household Appliances</u> - End use efficiency of electrical appliances can make a considerable difference given that the cost of electricity is very high.

3.8.2 Dissemination and Implementation of RETs

Geographical Focus and Cluster Approach

To create the maximum impact, any dissemination strategy should have a geographical focus, i.e., a concentrated deployment of a particular technology, based on a careful matching of technologies with needs and resource base. For example, improved cooking stoves that save on wood should be promoted in areas with fuel scarcity. Such areas will include geographical pockets with high population density and a heavy stress on forest resources. This will help to realise economies of scale in the installation of devices, thus reducing the costs of transporting material and equipment, and also facilitating better monitoring and repair services.

Prioritisation of Technologies for Dissemination

One problem with renewable energy technology promotion in India, which is especially pertinent to the hilly areas, is that they were disseminated before they had reached a sufficient degree of maturity or before local factors had been taken into account adequately. This aggressive promotion led to unreasonably high expectations on the part of these areas. In the context of hills, the promotion of wood-based gasifiers in the North-east is one such example. Similarly, even though the technical constraints of solar thermal systems for the hill climate have not yet been resolved, such systems are being promoted actively. This has led to failures in the field.

Hence, there is a strong case for prioritising technologies based on their stages of development and suitability to hill conditions, in order to focus on those that are cost-effective and have the greatest chance of success.

Involvement of NGOs and Local Institutions

In light of the difficult geographical conditions and the limited manpower and physical infrastructure available to implementing agencies, there is a strong case for involving NGOs in the dissemination of RETs. NGOs can be involved in training village communities in the upkeep and maintenance of systems and the development of local maintenance networks.

3.9 Conclusions

In conclusion, it should be reiterated that the energy needs and use patterns of the people living in the hills are very specific, and quite different from those in the plains. Thus, the basic policy requirement in the hills is to focus on the needs of the people and to tailor interventions according to them. In the context of renewable energy development in the hills, the policy will have to (a) focus on developing options that are suitable for local needs, (b) prioritise technologies for dissemination, (c) set in place efficient and workable systems for the repair and maintenance of technologies, and finally (d) rationalise price distortions caused by the existing pricing of commercial fuels. Lastly, the interlinkages existing within the mountain ecologies need to be understood and incorporatd into the policy framework. Unless these issues are addressed at the policy level, the impact of interventions will, at best, be short-term.

Selected References

Agarwal, B., 1991. *Engendering the Environment Debate : Lessons from the Indian Subcontinent.* CASID Distinguished Speaker Series No. 8. Michigan State University. USA : Centre for Advanced Study of International Development.

CEA, 1996. *General Review* 1993-94. New Delhi, India: Central Electricity Authority.

CMIE, 1996. *India's Energy Sector*. Mumbai, India : Centre for Monitoring Indian Economy.

Dutta, S.; Rehman, I.H.; Malhotra, P.; and Ramana, P.V., 1997. *Biogas: The Indian NGO Experience*. New Delhi, India : Tata Energy Research Institute.

Foley, G. and Bernard, G., 1984. *Farm and Community Forestry*. London : Earthscan and International Institute for Environment and Development.

Garg, H.P., 1997. 'Renewable Energy Programme and Vision in India'. In *Energy Opportunities*, Vol. 13, No.1.

Gupta, A.K., 1995. 'Renewable Electricity in India: Progress, Promotion and Policy'. In Ramana, P.V., and Kozloff, K. (eds) *Renewable Energy Development in India: Analysis of US Policy Experience*. New Delhi : World Resources' Institute and Tata Energy Research Institute.

Gupta, A.K., 1997. 'Renewable Energy in India : Progress, Policy, and Prospects'. In Ramana P.V. (ed) *Rural and Renewable Energy : Perspectives from Developing Countries.* New Delhi, India : Tata Energy Research Institute.

Khan, N.A. and Hasan, S., 1995. 'Forest Management through People's Participation: Practices and Problems in India and Nepal'. In *Asian Journal of Environmental Management*, Vol. 3, No.1.

Kishore, V.V.N., 1994. 'Some Application Oriented R&D Needs for Efficient Use of Biomass-Energy'. In *Souvenir: Proceedings of the National Solar Energy Convention 1994*, December 27-28, 1994. Thiruvananthapuram, India: National Solar Energy Society of India.

Kumar, A., 1997. 'Small Hydro Development in India: Some Issues to Ponder'. In Ramana, P.V. (ed) *Rural and Renewable Energy : Perspectives from Developing Countries.* New Delhi, India: Tata Energy Research Institute.

MNES, 1996. *Annual Report 1995-96*. New Delhi, India : Ministry of Non-conventional Energy Sources, Government of India.

MOC, 1997. *Export and Imports Policy, 1 April 1997-31 March 2002*. New Delhi: Ministry of Commerce, Government of India.

MOP, 1997. *Annual Report 1996-97*. New Delhi: Ministry of Power, Government of India.

Mani,A. and Mooley, D.A., 1983. *Wind Energy Data for India*. New Delhi, India : Allied Publishers.

Mathur, A., 1997. 'Development and Deployment of Renewable Energy Technologies in India: A Technology Policy Perspective'. In Ramana, P.V. (ed) *Rural and Renewable Energy : Perspectives from Developing Countries*. New Delhi, India: Tata Energy Research Institute.

NCAER, 1981. *Report of Rural Energy Consumption in Northern India*. New Delhi, India: National Council for Applied Economic Research.

NCAER, 1985. *Domestic Fuel Survey with Special Reference to Kerosene*, Vols. 1 and 2. New Delhi, India : National Council for Applied Economic Research.

NCAER, 1989. *Evaluation Survey Study of Household Biogas Plants Set Up During 1984-85 and 1985-86*. New Delhi, India: National Council for Applied Economic Research.

NCAER, 1992. *Evaluation Survey of Household Biogas Plants Set Up During Seventh Five Year Plan*. New Delhi, India: National Council for Applied Economic Research.

Naidu, B.S.K., 1997. 'Renewable Energy for Sustainable Development: Indian Scenario'. In Ramana P.V. (ed) *Rural and Renewable Energy : Perspectives from Developing Countries*. New Delhi, India : Tata Energy Research Institute.

PC, 1992. *The Eighth Five Year Plan, 1992-97*, Vol. 2. New Delhi: Sectoral Programmes of Development. Government of India: Planning Commission.

Painuly, J.P., 1987. 'Household Energy Demand and Energy Supply Potential in Hill Areas'. In Dhar, T.N. , Sharma, P.N. (eds) *Himalayan Energy Systems*. Nainital, India : Gyanodaya Prakashan.

Ramana, P.V. and Sinha, C. S., 1995. 'Renewable Energy Program in India'. In Ramana, P.V., and Kozloff, K. (eds) *Renewable Energy Development in India : Analysis of US Policy Experience*. New Delhi: Tata Energy Research Institute and World Resources' Institute.

Ravindranath, N.H. and Hall, D. O., 1995. *Biomass, Energy and Environment - A Developing Country Perspective from India*. Oxford, UK: Oxford University Press.

Singh, D. and Ramana, P.V., 1997. 'Renewable Energy Programs in North East India'. In Ramana, P.V. (ed) *Rural and Renewable Energy : Perspectives from Developing Countries*. New Delhi, India: Tata Energy Research Institute.

TERI, 1989. *Evaluation of Improved Stoves in Tamil Nadu, Rajasthan and West Bengal*. New Delhi, India: Tata Energy Research Institute.

TERI, 1992. *Dissemination of Improved Cookstoves in Hill Areas - A Case Study*. New Delhi, India: Tata Energy Research Institute.

TERI, 1994a. *Mini-Micro Hydro Power Technology (MMHP), Status Report - India*. New Delhi, India: Tata Energy Research Institute.

TERI, 1994b. *Socio-Economic Impact Assessment of Urjagram Projects*. New Delhi, India: Tata Energy Research Institute.

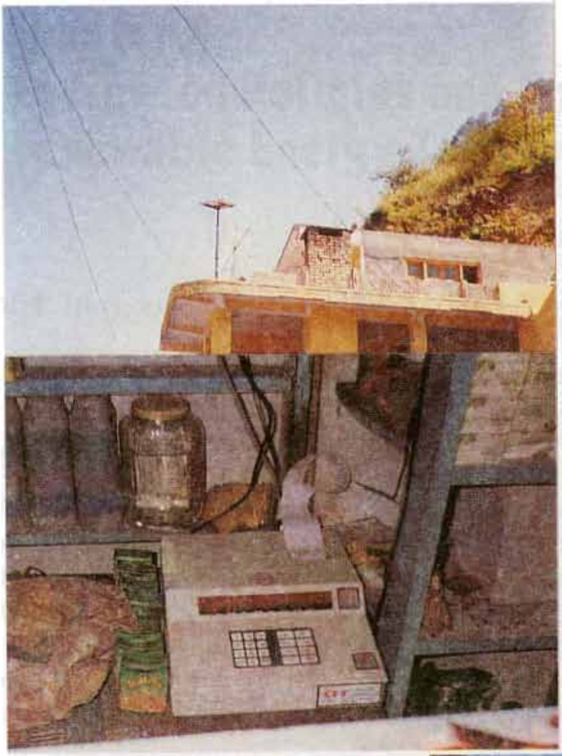
TERI, 1996a. *Capability Assessment of Indian Himalayan States for Small Hydro Power Development*. New Delhi, India: Tata Energy Research Institute.

TERI, 1996b. *Evaluation of Renewable Energy Technologies Implemented under North Eastern Council Plan*. New Delhi, India : Tata Energy Research Institute.

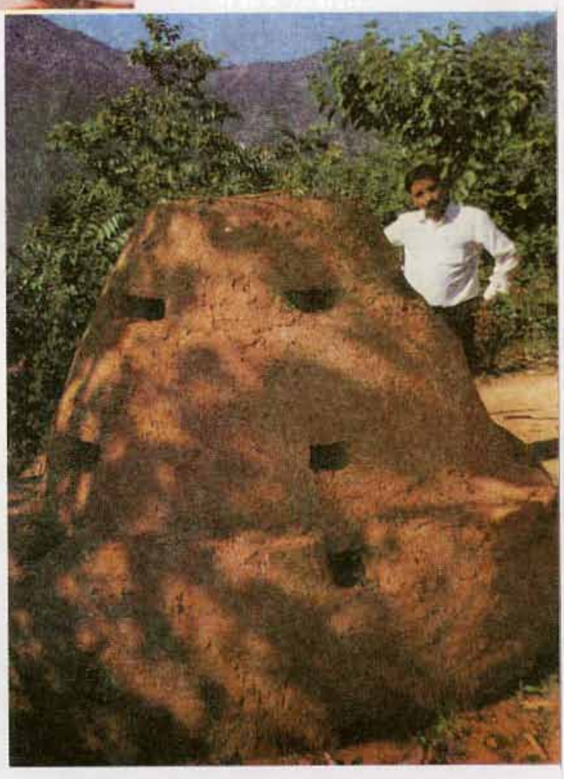
TERI, 1996c. *Rural Energy Sector in India*. Report submitted to the Royal Danish Embassy, New Delhi. New Delhi, India : Tata Energy Research Institute.

TERI, 1996d. *TERI Energy Data Directory and Yearbook - 1996/97*. New Delhi, India : Tata Energy Research Institute.

Vasudevan, P. and Santosh., 1987. 'The Role of Women in Energy Related Activities in the Mountains'. In Kumar, V.; Ahuja, D. (eds) *Rural Energy Planning for the Indian Himalaya*. New Delhi: Wiley Eastern.



Solar photovoltaic home system (35 watts) installed on the roof of a commercial building for lighting purposes and to operate the fax machine during power cuts, Garampani, Nainital, India



Mud and stone-built charing drum on the demonstration site of the Himalayan Environmental Studies and Conservation Organization (HESCO), Chamoli (Garhwal), India